PART I

History of Astronomy during the Vedic and Vedanga periods
English Translation
of
BHARATIYA JYOTISH SAstra
(History of Indian Astronomy)
by
Sankar Balakrishna Dikshit
[Translated by Prof. R. V. Vaidya, M.A.V.T.]

PART I
History of Astronomy during the Vedic and Vedanga periods

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OUTSIDE INDIA :

The High Commission of India,
In the remote past, when man first appeared on this planet, he would have looked with awe and wonder at the glory of the heavenly bodies like the sun, the moon and the stars. He would not have failed to notice that these bodies kept moving across the sky. However, centuries must have rolled by before some inquisitive and careful observers could discover that there was some periodicity in the movement of these heavenly bodies and such a rhythmic movement could be utilised to reckon time and to keep a count of the days and the months in the year. This was the beginning of Astronomy, which is one of the earliest sciences ever to be discovered in the history of mankind. When and where exactly this occurred, or if it occurred at several places independently of each other, it is difficult to say now, because the early man did not have with him any means of keeping a record of his thoughts and observations. In India, which is one of the oldest civilizations in the world, we get evidence of astronomical observations as early as 4000 B. C. in the verses of the Rig-Veda and in some developed form later in the Yajur-Veda. As early as 1300 B. C. the Hindus developed a luni-solar calendar known as the Vedanga Jyotisa Calendar. This was in vogue upto the third century A. D. Thereafter, astronomy in our country took a sharp turn and a new system based on scientific principles called the Siddhantic system came into prominence. This development which continued upto the 12th century A. D. came to a standstill due to continued foreign invasions thereafter. The great epics, the Ramayana and the Mahabharata, contain some astronomical knowledge in a rather rudimentary form. Puranas which are works of a later period contain astronomical knowledge in an improved form, apparently due to the influence of the Siddhantic system of Astronomy.

For a country like India, with its culture and civilization dating back to many millenia, it is essential that the achievements of earlier generations in the various fields of knowledge should be carefully unearthed and fully recorded. This history of Astronomy of the ancient and medieval periods of India falls under this category and a thorough study in this field requires to be made. But the difficulties in undertaking such a comprehensive study are enormous in that the information has to be gathered from the vast store of Sanskrit literature extending from the Vedic period upto the present time, and in our literature, the astronomical observations are not recorded in a clear, cut language but so to say have
been shrouded in allegorical language and concealed in stories and anecdotes, the full significance of which it is difficult to surmise. One such comprehensive study, perhaps the only one of its kind, has been undertaken by Shri Sankar Balakrishna Dikshit in his treatise in Marathi “Bharatiya Jyotish Sastracha Prachin Ani Arvachin Itihas” in the year 1896 and this is perhaps the only book recording the history of the Indian Astronomy from the ancient to the modern times. Late Dr. M. N. Saha, F.R.S., while working as Chairman of the Calendar Reform Committee recommended that an English translation of this excellent treatise “Bharatiya Jyotish Sastra, a history of Indian Astronomy—ancient and modern” should be published by the Government in order to facilitate Indologists, both Indian and foreign, to carry on research on Indian Astronomy. The work of the translation of this treatise from Marathi to English was gladly undertaken by Prof. R. V. Vaidya, M.A., B.T., a Marathi scholar and Superintendent of Shree Jiwaji Observatory, Ujjain and who was also a member of the Calendar Reform Committee. This translation was examined and touched up here and there by Late Prof. P. C. Sen Gupta, M.A., a renowned Professor of Hindu Astronomy of the Calcutta University. With the transfer of the entire work of the Calendar Reform Committee to the India Meteorological Department, it decided to publish this work. The final editing of the book has been done under the supervision of Shri N. C. Labiri, M.A., Officer-in-charge of the Nautical Almanac Unit at the Meteorological Office, Alipore, Calcutta.

The book is rather voluminous and it would take considerable time to publish the whole book in one volume. Hence it has been decided to publish the book in three parts. The present volume which is Part I traces the history of Indian Astronomy in the Vedic and Vedanga period from the ancient times upto 1000 B.C. Attempts are being made to bring out the other two parts comprising of the Siddhantic period and the Modern period as early as possible.

India Meteorological Department, Lodi Road, New Delhi. 18th April, 1968.

L. S. Mathur, Director General of Observatories.
BHARATIYA JYOTISH SASTRA

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AUTHOR'S PREFACE

The subject matter of this book has been presented in broad outline in the Introduction and a detailed idea of the subjects dealt with can be obtained from the table of contents and the subject-index at the end. I do not consider it necessary to dilate here on the utility of the book. If it be asked why the science of astronomy came into being at all, I have nothing more to say than that the science owes its origin to the natural curiosity of man. This science must have attracted the attention of man from times immemorial; in fact, one may safely say that it is the very first science evolved by man. This being so, I do not think that any apology is required for undertaking the survey and discussion of the growth of this science in our country.

The present work has no parallel in Sanskrit literature. Our people are not much inclined to assess the merit of different works in the light of chronological sequence; an author born a couple of centuries ago is, in their eyes, almost on a par with one who flourished a thousand years ago. Again, they are not disposed to trace the history of any science nor have they developed the habit of recording the lives of ordinary men. These appear to be some of the reasons why the like of this book was never produced in the past.

I propose to relate here in brief how the opportunity arose for writing this book. About the Śaka year 1862 I began to take interest in the question of the Śayana Paṇcāṅga and eventually in Indian astronomy. As I went on dipping into old works I was led to estimate that comparative worth, to determine the chronological order of their compilation and to study the various stages in the growth of astronomy; and I began to feel that a work of this nature would be a welcome addition to our literature. In Śaka 1806 a vigorous movement for calendar reform had been launched in this province. As a result of this the DAKŚIṆĀ PRIZE COMMITTEE of Poona published an advertisement in December 1884 for a book devoted to the consideration of the chaotic condition of our Paṇcāṅgas in the light of the history of our astronomy. As I had a liking for the proposed subject I was naturally prompted to undertake the work. The prize announced for the work was Rs. 450 and the time limit prescribed for it was the end of the year 1886. But by that time I could not procure the necessary material, particularly the ancient works and it was not possible for me to begin the writing. A request was then made to the Dakśinā Prize Committee to extend the time limit, which was granted. But even then nearly six months passed simply in collecting the necessary information. At last I set my hand to the task of writing in November 1887 and submitted Part I to the Committee in the beginning of 1888. Writing and the search for more material went on pari passu, though not without impediments. At long last I managed to present the whole work to the Committee in three instalments, by the end of October 1888. The contents of the work would have amounted to 426 printed pages of a book of this size and they included the treatment of many more subjects and in much greater detail than what the Committee had expected of me. The work was approved by the Committee and I received the full prize in 1891. Later I began to think of publishing the book; but how could I undertake such an expensive project? A few days later the proprietors of the Aryabhusan Press agreed to shoulder the responsibility. By this time, however, an advertisement for a treatise on Paṇcāṅga was published by the Gaikwad Government, for which a prize of 1000 Gaikwadi rupees was announced; accordingly I sent to the Gaikwad Govt. the relevant part of the book.
in the beginning of the Śaka year 1815, i.e. in 1893 A.D. A number of people had been suggesting to me that the book should be published but to my mind it was not yet complete; some new matter that had come to hand was to be inserted at the proper places and some more was still to be collected. Moreover, I intended to await the decision of the Gaikwad Govt. about the work already submitted.* I came over to Poona in July 1894. Many people urged me to publish the book and therefore, the proprietor of the Aryabhushian Press, commenced the printing in March 1895. While the book was in press, I went on reading old books not seen before and collecting still more information, as can be seen from the footnotes appearing at several pages of the book.

A part of the matter originally submitted to the Daksinā Prize Committee has been abridged and at times even omitted, so that the original volume which covered 425 pages has now been reduced by 40 pages; still, the present work has grown into a volume of 524 pages. This amounts to an addition of 140 pages to the original, not to mention the index which is altogether new.

Our people have not even a faint idea at present about the wealth of astronomical knowledge and astronomical literature in our country. The knowledge of the ordinary man is confined to the names of an astronomer or two like Bhāskaracārya and at the most the titles of a few works on astronomy. This work, however, contains an account of a host of astronomers and their works; even the mere enumeration of their names covers two long lists at the beginning of the indices. The reader cannot but be astounded to see this marvellous wealth of knowledge, and as he reads the history of the growth of astronomy he will come to realize the great calibre of our ancestors from their extra-ordinary efforts, researches and curiosity and his heart will be overwhelmed with delight.

It is needless to say that being scientific the present work will not be readily intelligible to all and sundry like works of fiction. It cannot, however, be said that every section of the book will be found unintelligible. Supposing the book is divided into sections of eight pages, then every such section contains something or other equally intelligible to all readers. The reader should, therefore, not despair if some passage is found to be abstruse, but should proceed with the reading. I am sure that no reader would be found who is unable to understand even a single page of this work. One reader may understand one subject, another may understand some other. One reader may find a particular part interesting and useful while another may be able to appreciate something else. The headings printed on the left side of the page at several places would give a glimpse into the subjects under discussion. Those headings and the table of contents or a glance at the subject-index at the end will enable the reader to find out any passage or subject that he likes. At some places technical terms have been used and if their meaning is not clear they may be looked up in the Index at the end for the page numbers for which their definitions, meanings or explanations can be found. Some of the terms have been explained in my book “Jyotirvīlāsā”. I was particularly keen on brevity in order that the volume may not run into great length. This has led to the introduction of lengthy compound words at some places in the book; but these can be easily understood from the context.

* The decision has been recently announced. My work has been approved and the prize awarded to me.
According to some the book has become voluminous, while others think that it has become too concise. On reading the advertisement of my book, a notable gentleman wrote to me that the proposed subjects would require at least 1000 pages. As there is truth in both the views I have chosen to adopt the via media. Condensation of material cannot go beyond what is already done. On the other hand, if expansion is allowed, every page of the book can grow into four pages. Brevity could no doubt be achieved by omitting some of the subjects. But in view of the fact that opportunities for the publication of a work of this nature are few and far between, I have included in this book all available information on various subjects, that seemed noteworthy in my opinion.

It is not claimed that the work is complete as it is. It has nothing to say about the astronomical references occurring in Vālmiki's Rāmāyana. Nor does it contain anything about the astronomical references from any of the eighteen Purāṇas. Some people suggested the inclusion of all these. But how much can I do single handed? Again there are still several works on astronomy which I have not seen. At present the Ānandaśrama of Pooa alone has about 500 books on the subject. I have seen all of them; still many of them have not been taken into account in this book. The 'Aufrecht' catalogue, referred to in this book contains the titles of about 2000 books on astronomy. How to procure them and when to read them? Nevertheless my work contains all important information found in astronomical books, as also all astronomical information available from other works. Fortunately our country can proudly boast of several learned scholars at present who are far superior to me in capability. Any of them may take up the work where I leave it. I shall feel satisfied if my labours prove useful to them at least to some extent.

Some had suggested to me that I should deal with such problems as the problems of divine incarnations like Rāma and Parāśurāma in this work; but so far I have not found reliable data that would lead up to the determination of such dates, nor do I think that they would ever be found. But one must not anticipate too much; for as the poet says, the world is wide and time is endless. The trend of my views on this question can be obtained after going through the book in its entirety. The conclusion of Part I is an attempt to determine the probable periods during which particular periods were compiled.

The question as to what subjects have been or ought to have been dealt with in this book seems to have evoked quite a variety of beliefs that this work contains tables for computing almanacs, that it contains different methods of calculating planet's places on the basis of any Siddhāasta work, that it explains the theory underlying all these methods, that it also gives a method for independently computing an accurate almanac like the one computed with the help of the Nautical Almanac, that it also includes choice Jātaka works which would enable one to cast correct horoscopes. In short, some people seemed to believe that this work contained the very quintessence of Jyotiṣa śāstra—both astronomy and astrology. It is needless to say that it is impossible to incorporate all these subjects in this work. But I am glad to note that such beliefs clearly reflect a strong desire for knowledge on the part of our people.

It has already been pointed out that there is no work like this in Sanskrit literature. Some information can be found in English scattered at several places; but if it is collected together it will not amount even to one fourth of the present work.
The conclusion will show that several articles have been written in English by scholars of repute. No one had, however, treated the subject in such a comprehensive manner. It is also obvious that it was never before treated from the Indian point of view.

Every statement about the contents of old works made in this book without citing some authority is based on my reading of these works; and I have most of such important works on astronomy in my possession. Every conclusion purporting to be the result of mathematical calculation, has been arrived at from careful calculations personally made by me and I am sure that they are correct; still as it is human to err, some errors might have crept in through oversight. In certain cases the necessary works were not available to me for reading and I had to rely on their authors and works while writing about their contents; in all such cases I have cited the authority for my statements at the proper places. Again, where extracts have been taken from other books bodily or in a summarized form I have cited chapter and verse for every quotation. Except for this, not a single line of this book is based or borrowed from any other book or its translation.

Members of the Dakṣiṇā Prize Committee had made a few suggestions to me for the improvement of the original work. All of them except the one for abridgement have been carried out. At some places in the original work I had severely criticized European scholars. The Committee suggested that all such severity should be entirely dispensed with. Accordingly, I have toned down all such passages, though I have maintained the main points of criticism. I cannot, however, help observing here that even some of our eminent scholars look upon the verdict of Europeans as gospel truth, howsoever absurd it may be. This indicates lack of confidence in one's capability and scholarship.

Rao Bahadur M. G. Ranade suggested that controversial matters like the views of European scholars and my criticism of them should be expunged from this book and reserved for discussion in some English journals, so that the book may not become voluminous. Accordingly, I did discuss some of the questions in English journals; still I did not feel it proper to remove the relevant portions from this book. It will be found useful by some readers at least if not all. If fortunately, this work is translated into English, this detailed exposition of my views will come to the notice of European scholars and receive proper consideration from them. A European scholar has written to me that parts of this work will have to be specially translated, if an English translation of the whole is not soon forthcoming.

I want to urge my readers in all earnestness to keep a sharp look out for ancient works. I shall feel highly grateful and equally so, our country, if any one informs me of the discovery of some works not yet seen by me. Not much account could be given in this book in respect of works compiled in such regions as Telangānā, Drāvid and Bengal. It is desirable that people should get as much information as possible about the more importance of such works as also about works like Nāḍigrāntkas. Again, the descendants of many of the authors mentioned in these pages might be still living; and if they impart some more information to me it will no doubt, prove useful.

As regards publicity of old works, it has been noticed that the Telangānā and Dravidian works are not widely known in other provinces. This seems to be due to the difference of script in which they are written. The works produced in Bengal
are also not available in this province. Even then, looking to the difficulties of travel and communication in ancient times, one is really surprised to see how voluminous works could reach even the remote corners of India, how works like Grahahāvī, so frequently mentioned in this book, gained currency all over the country in a very short period of time, and how even mediocre works have been popularised. This wide-spread currency of books seems to be due to the fact that astronomers used to be patronised not only by Hindu Kings but also by Muslim Emperors. Moreover, it appears that most of them could count upon liberal reception from the Vidyāpītha (Academy) at Varanasi.

It is true that the number of works on astronomy is enormous. As however ours is a very extensive country, a multiple of works devoted to the same subject of every day use were compiled in different provinces. Again, some works, specially the Karana works, became obsolete and useless in course of time, which also gave rise to different works in different ages; further, several people appear to have compiled several works on the same subject because it depends more or less on the ingenuity of the author or whether his work would be found to be perspicuous or nct. These are some of the reasons for the multiplicity of astronomical works and their wide-spread currency.

The Vedic mantras or Sanskrit verses have been frequently quoted in this book. If a full translation of all these is given, it would mean an increase in size. It has, therefore, been given, not in all cases but only where it was very necessary to do so. At some places only a gist of the quotations is given, and at places where even that is not given, it can be gathered from the context to a certain extent. In giving the meaning of Vedic mantras, the original text has been followed. Words that must be taken as understood for proper construction of the passage have been given in square brackets and equivalents of words or phrases in parenthesis*. Nothing has been added that is not in the original. The printing of Vedic mantras or Sanskrit verses is faultless on the whole. It was, however, impossible for me personally to write out the whole press copy. Consequently some errors might still have remained, if these were not noticed while correcting proofs; but I could not help it.

Biographical sketches of astronomers have been given in the Madhyamādhikāra (Chapter on mean motions); these mainly deal with authors who compiled works on astronomy. If any of them happen to be compilers also of works on Saṁhitā and Jātaka, such works have been taken into account at the same place. As for the authors who have compiled no astronomical works but only works on Saṁhitā or Jātaka, their lives have been given in the sections devoted to these Skandhas (branches).

The life of each astronomer, as a rule, contains information on mostly the following points — his date, place, works compiled, commentaries on the works and an estimate of his capabilities. If any of his ancestors or descendents also happened to be authors, they are also taken into account. In addition to this, the remarkable feature of his life work, if any, has been mentioned in the contents. The contents give a list of works or their authors along with the Śaka year which indicates the year of compilation unless the words birth Śaka are added.

*This distinction could not be scrupulously observed in the English translation — Translator.
I am of opinion that the ‘anusvära’ (a dot denoting the nasal sound) need not be added to the last letters of the words ‘jethe’, ‘tethe’, ‘koṭhe’ etc. and I also hold some independent views on the question of orthography. My views have been followed in certain cases; but the copyists, proof correctors and even the compositors have become so very familiar with the rule of the terminal dot, that the ‘anusväras’ have found their way into this book, even though eliminated in the press copy.

It is my opinion that the names of ancient authors should not be mentioned in the honorific plural and this rule has been generally observed. As even the Almighty is spoken of in the singular, I do not think that the plural form e.g., “Bhāskarācārya Mhaṇatāt”, implies any greater respect for the author. It can safely be said that there is no honorific plural either in Sanskrit or even in English. It is at present customary, however, to use the plural form while speaking of certain personages living or recently deceased. I have generally retained only this, lest a breach of the formality should jar on the ears of my readers.

As we are these days more familiar with the Christian era than the Śaka era, it is more convenient to discuss the dates of events in terms of Christian era. Our astronomical works, however, invariably use the Śaka era. Let the work belong to any part of India whatsoever, it is bound to use the Śaka year, even if it is not in use in every day life there. I have accordingly used the Śaka era almost everywhere in the book. However, the year indicated as B. S. (before Śaka) can safely pass for B. C., because the difference of 78 years is negligible where dates of very remote antiquity are concerned. Everywhere in this book the Śaka figure indicates the expired year unless it is specifically stated to be current. The planetary positions should be taken as Nirayana or as calculated by the Grahalaghava system unless the word Sāyana is specifically used. Words like Sūrya-Siddhānta, Ārya-Siddhānta, and Brahma-Siddhānta used without qualification, should be taken to mean the current or later Sūrya-Siddhānta, the first Ārya-Siddhānta and the Brahmagupta-Siddhānta respectively.

It goes without saying that the index is very convenient for the purpose of reference. But experience alone can show how difficult it is to prepare an index. As it would have a long time to prepare it single handed, I have myself prepared only the subject index. In preparing the remaining indices I received considerable help from the present students of the Poona Training College. But as the work has passed through many hands and the lists were copied out five times before their final printing, some errors of omission and commission may have crept in at places; but no one could help it. It is the practice of our writers to include their works on Arithmetic and Algebra among those on astronomy and the practice has been adopted in preparing the index; similarly, the names of almanacs, Sanskrit and Marathi works and their authors have been included in the Sanskrit list. The letter Tī (denoting Tīp or footnote) has been left out at places before the page numbers in the index.

It would be difficult for the readers fully to realise what pains were taken to procure old works while writing this book, what people were coaxed and cajoled and in what way, how speedily the work of reading was done, and what mental and physical strain I had to undergo on the whole, while writing the present work and getting it printed. The pleasure of the pursuit was the only true reward of these labours.
The sale of the book is bound to be poor because it is scientific and of course I could not have shouldered the expensive and risky work of printing. But Mr. Hari Narayan Gokhale, a proprietor of the Aryabhushan Press, Poona, who is my former playmate and a fellow townman undertook the work and completed it with success. He has thus obliged me as well as the whole of Maharashtra. If he had not been pressuring me to get the book printed and continued to press me to finish it soon while the printing was in progress, it would never have seen the light of the day, for it would never have really reached completion to my satisfaction till the end of my life. Had the whole manuscripts been ready at the outset, the publisher would have printed it within two months; but the publication was so long delayed, because my reading went on ceaselessly at the same time. The publication of a work of this kind must inevitably take a long time. Still, whatever work could be accomplished so far, has been brought to completion as far as possible. I shall feel much obliged if any defects found in this work are brought to my notice or suggestions made in regard to its contents.

I have received help from several people in several ways from the day I started writing till this day of publication. Even if I merely mention their names and the kind of help offered it would easily cover a page or two; instead of doing this I wish to express my gratitude to all of them most sincerely even though in a general way.

It was a convention with the ancient writers on astronomy to give a brief account of themselves. I could write the major portion of the book because of this convention. Now I propose to follow suit and give a brief account of myself before I conclude the preface. I was born on Tuesday, the 14th-cum-15th lunar day (tithi) of the bright half of Ashadh, Shaka 1775 (according to Grahalaghava Pañcanga) i.e. on 20/21 July 1853, at the village of Murud, in Dapoli Taluk, District Ratnagiri, my birth descendant being Gemini. My ancestral line from father backwards runs thus; Balakrishna, Ramachandra, Ballala and Shankar, and my mother’s name was Durga. I am a Chitpavana Brahmana of Nityundan ‘gotra’, Hiranyakeshi branch. The original surname of our family was Vaisampayan. This family has inherited the priesthood and religious leadership of the village of Murud which was founded by a saint some centuries ago; our original ancestor was his disciple and this vocation was conferred on him by the saint. About two years of my childhood were spent in elementary education at the village school and later in a local Government Marathi school, from April 1862 to October 1868. These very years were partly devoted to some study of Sanskrit and reciting of the Vedas. Part of the next two years passed in working as a candidate at Dapoli Court and a part in learning English. I was a student in the Poona Training College for three years from November 1870, when I obtained a first class certificate in the final examination of the third year. While studying at the Training College, I attended an English school one hour every day for two years. In 1874 I passed the Matriculation Examination, but I could not join College owing to several difficulties. I worked as the Head Master of the Marathi School at Revadanda from February 1874 to February 1880, and later on as Head Master of the Marathi School No. 1 at Thana up to August 1882. Afterwards I worked as an Assistant teacher at the English school at Barsi till the end of October 1889 and as an Assistant at the Dhulia Training School till the end of June 1894. Since then, I have been working as an Assistant Teacher at the Poona Training College. I wrote and published the following Marathi books in the years noted against them:
HISTORY OF INDIAN ASTRONOMY

(i) Vidyārthī Buddhī Vardhīnī (1876). (ii) Srṣṭa Camatkāra (1882). (iii) Jyotirmīlāsa (1892). (iv) Dharma Mīmāṃśā (1895) and the Indian Calendar written in collaboration with Sewell has been recently published. I have also written a book entitled "Bhāratīya Prācīna Bhūvarṇana"; but since, it is not yet complete as it ought to be, it has not yet been published. That ours is not a family of Jōsīs, (astronomers or astrologers) is evident from the above account. My natural aptitude for learning and the habit of reading newspapers led me to take interest in the Sāyana controversy and eventually to the study of astronomy. Whatever knowledge of these subjects I possess, is wholly self acquired. Some people appear to think that I have some knowledge of astronomy that is not accessible to others; but my knowledge is so meagre that any intelligent man can acquire so much within six months if he has a fair knowledge of Marathi, Sanskrit and English, an aptitude for Mathematics and an inquiring mind. Many persons approached me with a request to teach them astronomy—it matters little that their enthusiasm was short lived. So vast are the treasures of astronomical knowledge, which, for various reasons, lie beyond the reach of my power of understanding, that my own knowledge is next to nothing in comparison. May Savīṭā (the Sun god) the self existant and stimulator of intelligence, inspire all of us to acquire knowledge.

Poona, Saturday the 31st October, 1896,
Sāyana Amānta Kūrtīa, Kṛṣṇa 10
Śaka 1818.

SANKAR BALAKRISHNA DIKSHIT
BHARATIYA JYOTISH SAstra
A History of Indian Astronomy
—Ancient and Modern

INTRODUCTION

If on an autumn or winter night we sit in an open on a vast plain outside, we are naturally tempted to gaze at the heavens above. Thousands of tiny glowing stars would appear twinkling all around in the sky, some of them very small and some large. A closer look would then reveal that these shining articles are not stationary. Some of them would appear to be coming up from below, while some others going down on the other side. While we keep continually gazing at them some large bright star is suddenly noticed rising on the horizon; and while we are looking at it in wonder, all of a sudden, some bright shining light at the lowest part of the sky appearing to touch the earth attracts our attention. The light gradually brightens in splendour and the stars on that side of the sky begin to fade out.

After a short while, the reddish disc of the moon is seen making its appearance which is indeed a most delightful sight of the night. As the moon slowly rises higher up in the sky, it spreads its most enchanting light on the earth, and a number of stars fade out one by one in the brilliance of that light. While we are thus feasting our eyes, we may perhaps see a sudden flash of light and some star may appear to drop down from the sky. Sometimes we may be startled to see half a dozen such stars, small or large, dropping down from the heavens within a short interval of time.

The human mind is naturally attracted to such normal phenomena and the wonders of the sky being far more gorgeous and captivating than those of the earth, they attract one's attention to them all the more powerfully. People, who are somewhat indifferent to their worldly affairs for some reason or other, are more likely to be attracted by the wonders of the sky. Leave alone those who habitually and naturally take interest in such heavenly things, but a class of people may be found even among the common mass who can claim a fair knowledge of the stars, such as the cowherds who keep all night vigil in the open for protecting their cattle, or the peasants who get up early morning and attend to their work in open fields, or our sea-faring fishermen who seek guidance from the stars while navigating at night. Others too have a nodding acquaintance with the stars. In fact very few people would be found in our country who do not possess any elementary knowledge of the sky.

The sun and the moon rise and set regularly everyday. The seasons like summer, the monsoon, and other seasons also recur in their regular order. Today, however, we are not struck with wonder at these phenomena because of our familiarity with them; but the primitive man at the beginning must have been overwhelmed with wonder at the regular recurrence of these phenomena, and his inclination must have been drawn to the study of the bright objects in the sky, that is to say, to the study of astronomy from the earliest times. The sun rises in the morning. It slowly comes up. After some time it reaches the highest point in the heavens, and then goes down slowly and the rays of the sun gradually lose intensity of heat till such time as
the sun vanishes. Then follows the darkness which continues for a long time. Next day, the sun rises again almost at the same point and not in any direction at random. The observer then wonders, “Is it yesterday’s sun which has risen today or is there a new sun rising every day? If it be the same sun where did it dwell at night? Why does it not rise in any direction at random? Why are its hot rays vary in intensity? The sky appears to touch the horizon at the place where the sun rises; then how is it that the sun comes above out of that very place? If there be an ocean in the east and an ocean in the west, the sun appears to be emerging from one and plunging into the other; does it really sink in the ocean?” We do not attach any importance to such thoughts today; but in the beginning human mind must have been haunted by these thoughts and much time must have elapsed before any of these problems could have been finally solved. The knowledge of human being grows by tradition and the experience of the past and this proves useful to the posterity. Even in modern times, year after year rolls by till we come across a new discovery, which might eventually seem to be trivial but at the time of its invention it is taken as an established truth.

It is then obvious that at the beginning of civilization considerable time must have elapsed before the truth about even the most common place experiences came to be definitely known.

The questions above about the sun as having disturbed the primitive mind is not merely a figment of fancy. Evidence of such primitive thought is found in the Jain literature which shows that the Jains believed in the existence of two suns. The Purāṇas too have postulated twelve different suns for the twelve months of the year. The twelve Adityas of the Vedic literature are also well known. Although these notions appear today to be fantastic, it is clear that there was a time when people really cherished such beliefs. For instance the following verse from the Rigveda would show that the sun was supposed to have actually sunk itself in ocean before rising the next day.

यद्वा यत्त्वो यथा भूवनायपिन्नत || अत्रा समुद्र अग्रोमुहसुर्यसंज्ञस्तन ||

ॐ सं. १० ७२ ६.

“Oh gods! you draw out the sun (for the purpose of rising up again in the morning) which was sunk in the ocean.”

The following mantra from Taittiriya Brāhmaṇa may similarly be cited:

य उवगानमहतोर्षिवाद्र्यक्ष्यमानःतत्तवस्थमयात्
समा वृषभो रोहितायर्युवायं विपक्षिकान्त्या पुनायु

“May the resplendent sun, that comes up from the centre of the expanse of water of the vast ocean, purify me.”

The sun rises in the morning. It reaches the highest point at noon and sets in the evening. As if it crosses the whole sky in three strides. This phenomenon has been described at various places in the Vedic literature. That the sun transfers its heat and puts it into Agni (fire) at night is also described in many places.

अभिम्बिचावित्वं सायंग्रिविशत्त || तस्मादहिंदौरान्वतं वदुः ||

ॐसं. २ १ २ ५
“The sun enters Agni in the evening. Hence Agni is visible at night even from a distance."

In this verse the sun is said to be entering Agni at night. The primitive man’s attention must have been drawn to the moon just as much as to the sun or even more. Unlike the sun, the moon does not rise regularly at night. Sometimes when it rises at sunset the moon appears full in size, and then, a days pass on the moon rises later and later every day and gradually grows smaller in size. It also rapidly changes its position among the stars.

It slowly approaches the sun and a day comes when it becomes completely invisible and then after a day or two, the moon makes its appearance in the west after sunset on the other side of the sun; but at that time, it appears only in the form of a crescent, as if it were newly born. It is well known that on this day even now we find that people joyfully offer her the frills of their garments and pray to her for new garments and long life, chanting all the while the following Mantra which is found in all the four Vedas.

नवो नवो अभित्र ज्यांमानी लप्खं केतुष्यसामे यः ॥
भाग्य देवेश्वो विविषायाय अच्छंमातिर्तं बीविः मायः ॥

ॐ सं १० ॐ १६.

The moon gradually increases in size as days pass and again becomes full some day. Many descriptions of the moon’s waxing and waning are found in ancient and modern works. And what is more, the digits of the moon, the dark spots on her face, her soft and serene appearance and her refreshing light, have provided an outstanding theme for poetic imagination in all countries at all times.

The moon becomes full after 29 or 30 days, and it becomes full again and again after the same number of days. The primitive man must have adopted the day (i.e. a day and night together) as the natural unit of time, after observing that the period between two successive sunrises is almost the same. Similarly, after observing the rule about the full moon stated above, he must have adopted the period between the consecutive full moons as the second but a longer unit of measuring time. This period seems to have received the same term as that given to the moon in many languages. In the Vedic literature, the moon is named as māsa. As an example the following lines may be seen:

Ṛk Samhitā and Atharva Samhitā—

सूर्यमासामिय उच्चरात्। ख्रृं सं १० ६४ १०। अपि सं २० १६ १४।

Ṛk Samhitā—

सूर्यमासाविचरान्ता विच। ख्रृं सं १० ६२ १२।

That the name māsa originally given to the moon was later applied to the above mentioned period is well known.
After these two units, the day and the month, were firmly established, man must have observed that the rains, winter and summer recur after some definite period of time. It was also observed that the rains and other seasons recur after twelve months, where a ‘month’ denotes the period indicated by the full-moons. This (long) period of twelve months appears to have been called in the Vedas—Śarad, Hemanta etc. after the seasons in the Rk Samhitā. The term Sarad in the sense of a year, occurs there more than twenty times and the term Hima more than ten times. These words are found in many places in other parts of the Rigveda as well. The very word Vasā meaning ‘a year’ also signifies a particular season.

शतरूपशरदं वर्षमानः शतं हेमाब्रह्मविनुर्वंतात् ॥

ऋ. सं. १०. १६१. २. अश. सं. २०. ६६. ६.

“Do live and grow for a hundred autumns (i.e. years), for a hundred winters and for a hundred springs.”—Rk Samhitā and Atharva Samhitā.

The words Śarad, Hemanta and Vasanta all meaning a year occur together in the above verse. Even the term Samvatsara is very often found to have been used in the sense of a ‘year.’

Any way the year is the third natural unit of time, but longer than the day and the month. So far we have had a glimpse of the origin of the three units of time. An attempt to describe in detail the gradual development of the basic astronomical concepts would involve a long exposition. This however is not necessary at this stage. The main features of this development are going to be described in detail later on.

Just as the observation of the sun and other heavenly bodies creates a sense of wonder, even so their regularity and other characteristics strike one as most surprising and inspire a feeling of reverence for them. It is but natural that one should be led to infer that these celestial phenomena are controlled by some eternal truth and that the magnitude of that truth is simply too great to be described. The following verses from Rigveda are worthy of note in this context:

सर्वेऽरतमि वृक्षः सूर्यं शुभमि क्रोः ॥

ऋ. सं. १०. ८५. १. अश. सं. १२. १. १.

“The transcendental truth supports the universe, the sun is supporting the sky; the twelve suns remain supported by truth and so remain the moon in the sky.”—Rk Samhitā and Atharva Samhitā.

Even today we hear many people remark that all have discarded truth in this sinful Kaliyuga, but the sun and the moon have not.

Some celestial phenomena are joyful to watch, some are amazing while some others are even frightening. When the eclipses, shooting stars and
comets inspire a sense of awe and even fear in many a mind even in the present times, it is quite obvious that in the beginning these phenomena would have been regarded by the human being as extremely frightful and portentous of divine wrath. Many of us must have read how Christopher Columbus told the inhabitants of an island that because the god Sun was displeased with them he would hide himself on a particular day and how those people were frightened to see the prediction come true. Again it is a historical fact that the war, which had continued for five years between the people of Lydia and Media, about the year 584 B.C., came to an end by the mutual signing of a peace pact, because a total solar eclipse had occurred during the year and both the fighting parties were struck with horror to see the day suddenly turning into night.

It is also known to many of us that the Mahabharata gives a description of how the two eclipses of the sun and the moon had occurred in the same month just before the terrific battle between the Kauravas and Pandavas was fought resulting in a tremendous loss of life. Similarly, in the Puranas we come across descriptions of shooting stars and meteors and appearances of comets preceding such calamities.

The natural units of reckoning time, i.e., the day, the month and the year which guide human activities, depend upon celestial phenomena. The knowledge about seasons which is necessary for agriculture depends upon the sun. That the rains are caused by the sun and the tides by the moon, and that it being felt that the wrath of Almighty is foreshadowed by some particular positions of the heavenly bodies, tend to show that curiosity must have aroused in human mind towards astronomical knowledge right from the creation of the human race. Again, certain ideas must have planted themselves in the human mind from very ancient times; for instance, it might have been thought that since agriculture and other vocations of life are carried on when the sun and the moon occupy certain positions in the sky, it is quite possible that they would have been thought to prove beneficial when performed while the luminaries are in a typical position; as for example, the fields may yield a bumper crop if the seed is sown when the moon is conjointed with a particular star and on the other hand crops are destroyed if sown when it is conjointed with another particular star; some religious rites if performed when the sun turns from south to north or vice versa (that is on solstitial days) give beneficial or harmful results as the case may be. If marriages and such other rites are performed at certain auspicious moments they turn out to be beneficial; when two planets were observed as passing very close to each other in the sky, they came to be interpreted as 'fighting with each other' and then one of them (the fainter of the two in luminosity) was regarded as having been defeated and this fight was supposed to be indicative of victory or defeat of a certain king on the earth; it was also surmised as to what particular rites, if performed would nullify the malefic effects indicated by the appearance of eclipses, meteors or comets. Furthermore, it was but natural that ideas and convictions should have gradually begun to crop up in human mind that if the heavenly bodies have such a close association with the worldly affairs and their good or evil results, they must be affecting the individual life as well and then the people must have attempted to foretell what benefic or malefic effects would be experienced by any individual in his life, because the sun, the moon and the planets were occupying certain positions in the sky at the time of his birth and would be subsequently occupying other positions.
The quest of knowledge regarding such matters led to the creation of three branches. The following questions, for instance, are associated with Mathematics (Ganita): Finding out the number of days in a month, the number of months in a year and the number of days in a year; when will the winter solstice or the summer solstice occur after a particular day; what position in the sky will a particular planet be occupying on a certain day; when will an eclipse take place, and so on. These questions are related to Mathematics. The knowledge of the effects of eclipses, comets, planetary conflicts on the world and the knowledge as to what days are auspicious or otherwise for the performance of marriages and other rites—these questions form the second branch; and the third branch comprises the knowledge which enables one to judge the benefic or malefic effects that would be produced by a particular position of planets at birth or later on in the life of an individual. These are said to be the ‘Three Branches’ (Triskandha) of astronomy.

All the ancient and modern works in astronomy hold that the science is divided into these three branches. The first is called Ganita, the second Samhita, and the third Horā or Jātaka. The Ganita branch is also known as Siddhānta.

Nārada observes:

निषोलसंहितायोऽराष्ट्रयामकः। वेदस्य निर्मलं वक्ष्योऽथिनास्त्रयास्त्रयुल्लासः॥

नारदसंहिता. १. ४.

“The excellent science of astronomy comprising Siddhānta, Samhita and Horā as its three branches (Sections) is the clear ‘eye’ of the Vedas”.
—Nārada Samhita 1. 4.

Mahādeva (Śaka 1185), the commentator of Śripati’s Ratnamālā says:

प्रह्याज्ञितपदायपरिणतिःप्रमणवस्तुनिरस्त्रपमत्तत्स्पुरवर्गतात्त्वावस्थायप्राच्छचिक्तास्त्रयावस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं वर्णोऽस्त्रयं

“I am desirous of describing in brief, the interpretation of Samhitā rules which are necessary to be followed, while performing ceremonies relating to post-natal sacrament, naming the child, thread ceremony, marriage, travelling, etc., knowing fully well that Samhitās are ‘fruits’ of the tree of astronomy, of which the various forms of Horā are the ‘branches’ and elementary arithmetic, algebra and calculation of planetary places are the firm ‘roots’.”

Ganeśa Daivajña observes (about Śaka 1440) in his commentary on Muhirta Tatvā of Keśava.

श्रीकेशवो...गणितसंहिता...जातरसंहिता...चोक्षय...संहितासंहिता...विकृयो...प्रतिज्ञानिते

“Sri Keśava, having expounded......the Ganita branch and......Jātaka branch declares before proceeding to......the Samhitā branch.”
The attention of our people was drawn to the study of celestial bodies from very ancient times; still considerable time must necessarily elapse before any subject can evolve itself into a science. Similarly, a long time must have elapsed before the standard works on the subject of astronomy could be written, and it is obvious that the works which were written in the beginning of the evolution of the subject must have contained simple statements of facts of an elementary nature and those too of only broad outlines. The most ancient of the astronomical works extant in these days is the *Vedâṅga Jyotiṣa*. It deals with the mathematical aspect of only the sun and the moon; the *Aṣṭharva Vedâṅga Jyotiṣa* may be a latter work*. This deals with some aspects of the second and the third branches of astronomy.

It seems as if the *Samhitās* of Garga and Parāśara belong to a later age. After the knowledge of astronomy had considerably developed it must have been grouped into three divisions or branches including *Ganita*. But this stage must have been preceded by certain works in which all the branches were discussed together. It appears that works of this type did exist and they too were known by the name *Samhitā*. Varāhamihira says in his *Bṛhat Samhitā*:

\[ \text{Jyotiṣastraṃ kṣetreṇaヴァyā sāṃkhārayaḥ।} \]
\[ \text{tākṣarastirṇoṃnasya nāma muniṃ: saṅkhārayaḥ sāṃhitā। अध्याय १।} \]

“The science of astronomy which comprises a variety of subjects is established mainly on three branches. But the treatment of the subject in its entirety is also named *Samhitā* by the sages.”

We have no clue for ascertaining whether there were any works more ancient than the *Vedâṅga Jyotiṣa* and the *Samhitās* of Garga and others. None of these are available at present. Nor can we say with any degree of certainty whether the *Samhitās* of Garga and others that are available at present, have all retained their original composition and structure. In the case of Garga *Samhitā* some two or three versions are available. Nevertheless, it is evident that some *Samhitā* works containing a treatment of all the three branches together must have been in existence at one time, as is evident from the above quotation from Varāhamihira, let alone the question whether such treatment was complete in itself or only fragmentary. As the knowledge of astronomy was progressing and as each branch was nearing perfection, different works, each devoted to some specific branch, came to be written and the term *Samhitā* was then exclusively applied to one branch in particular. Varāhamihira’s *Pañcasiḍḍhāntikā* shows that there were independent works or the different branches written before his time (i.e., before Śaka year 427). Āryabhaṭa’s work, which deals exclusively with *Ganita*, belongs to a slightly earlier date than that of Varāhamihira. It will, however, be shown in detail, in the following pages, that the *Ganita* branch had become independent at a still earlier date. As for Varāhamihira himself, he has to his credit independent treatises on all the three branches.

Let us now enumerate the subjects commonly found in the works on each branch. The mathematical branch consists of three sections

*Many subjects have been mentioned here only very briefly in order to give a general idea of later works; their detailed survey will be made at appropriate places.*
(i) *Siddhānta*, (ii) *Tantra* and (iii) *Karana*. The *Karana* works deal with planetary calculations only. Bhāskarācārya defines *Siddhānta* as follows:—

"The wise people describe the *Ganita Skandha* (i.e. the branch of mathematical astronomy) as that work, which gives in detail all the units of time from *Truti* (moment) to *Pralaya* (Universal deluge) and deals with the motions of planets, and which treats of mathematics in the form of questions and answers. It is mainly divided into two parts. It also describes the position of the earth, the stars, the planets and also the instruments for observation."—*Siddhānta Siromani, Madhyamādikara*.

*Siddhānta* or *Tantra* generally consists of two parts, one mainly deals with the calculation of planets' places and the other chiefly describes the structure of the universe; and this includes the knowledge of the celestial sphere, the construction of instruments, the units of the measurement of time and other allied subjects. These two parts are not and cannot remain separate. Almost all *Siddhāntas* show as an intermingling of the two. Some people define *Siddhānta*, *Tantra* and *Karana* in the following way:—

In the *Siddhānta* work the beginning of the *Kalpa* is taken to be the epoch; in the *Tantra* the epoch is the beginning of a *Mahāyuga*, and in the *Karana* any Śaka year can be the epoch, and the calculations of planets' places are made on the basis of the respective epochs. As a matter of fact there is no difference between them in regard to the computation of planetary positions excepting that each adopts a different epoch. The part of the work devoted to planetary calculations in all the three varieties contains a number of chapters called *Adhyāya* or *Adhikāra*. In general, the chapters are as follows:—

1. The mean places of planets.
2. The true places of planets.
3. The three problems (time, place and direction).
4. The lunar eclipse.
5. The solar eclipse.
6. The shadow cast by the gnomon.
7. The rising and setting of planets.
8. The elevation of the moon's eusp.
9. The conjunction of the planets.
10. The conjunction of planets and stars.
11. The luni-solar parallel.

It is not the fact that all works contain the same number of chapters as above. Although there are variations in the number and order of chapters, yet all of them have been included in the above list of eleven chapters.
There is no unanimity of opinion regarding the subject matter of the Samhitā branch. In general, the Samhitā may be regarded as divided into two parts. The first deals with the movement of planets in the Zodiac and their mutual conflicts, etc., the consideration of benefic or malefic effects of meteors, comets, eclipses and omens on the world. The second is devoted to the selection or consideration of auspicious moments or otherwise, for starting on a journey, the celebration of a marriage etc. Varāhamihira's works show that in his time both the branches enjoyed equal importance, but from Śrīpati's time, that is from Śaka 960, the first part began to lose its importance and from about Śaka 1450, the second part gained so much importance that only the chapter on muhūrtā began to pass for the third branch. This can be confirmed from the titles and the subject matter of the following works:—Muhūrtā Tatva, Muhūrtā Mārtaṇḍa, Muhūrtā Cintāmani, Muhūrtā Cuḍāmani, Muhūrtā Dīpaka, Muhūrtā Gaṇapati and others. The works on Muhūrtā do contain some of the subjects described by Varāhamihira in his Brhat Samhitā but not with any degree of importance.

The Horā branch originally represented the study of the ascendant of birth in one's horoscope, and the prediction of all the happy and sorrowful events of life; but afterwards it was divided into two parts, the above mentioned part being one of them. In the beginning, the complete Horā section was known as Jātaka, but later on this particular part relating to the ascendant came to be known as Jātaka and the second part as Tājik. The principal subject of Tājik generally is the study of events, good or evil, in any individual life, from the ascendant of the annual horoscope which is cast for the moment of his entry into any new year of his age reckoned on solar basis. Under this system of horoscope reading, the radical ascendant is regarded as a planet and is known by the name Muhahā (Muntha?). Some authors have coined the Sanskrit term Tārīṭāka for Tājik. This part of Horā, viz., Tājik came into vogue from about Śaka 1200, that is by about the time of increasing Muslim domination in our country.

In the books on astronomy in this country, the chapter which generally deals with such problems as positions of the sun, the moon, the earth, etc., in the universe, the causes of their motions and the nature of such motion is known as Bhuvana Samsthā, Jagat Samsthā, Bhuvana Kośa or by some other equivalent names. These three subjects will be discussed in detail later on at the proper place; but to introduce the subject, the celestial sphere, the motions of planets, the movement of the solstitial points, and the Yuga system of measuring time are briefly described below.

BHUVANA SAMSTHĀ (The Celestial Sphere)

According to our astronomical works the earth is at the centre of the Universe; the moon and other bodies revolve around it; their order is, the Moon, Mercury, Venus, the Sun, Mars, Jupiter, Saturn, and the starry belt; the Zodiac revolves round the axis joining the two fixed poles. The earth is round, it stands supportless and is enveloped by air which is called bhāvāyu or earthly-air. Above this is the sky, where blows the wind called pravaha by the force of which the moon and other heavenly bodies are kept in
motion, and they revolve round the earth. This description is found in all Siddhānta works and Tantras, but not in Karana-works. It is also found in the Pañca-Siddhāntikā. In no man-made or written works on astronomy do we find any expression of views more ancient than those found in the Pancā-Siddhāntikā and hence the lines presenting the above ideas are quoted below:

पचमीमात्रंक्षस्ततरसमस्यामेण सहजपतिः: ।
खेलस्तनांस्य सातो इत्यादितयो वृत्तः: ।
मेरो: समपरि बिल्लिका भ्रोमन स्वभावो नीबोऽधीनः ।
तत्र निबबसं नरता प्रवह्य भास्यते भगवः: ।
चंद्रादूर्ध्वमुनितसर्वरितकृ हस्तातो भागिन्न।
अध्यायं १३ बैलोवपस्थानः.

"The round ball of the earth, composed of the five elements, abides in space in the midst of the starry sphere. like a piece of iron suspended between magnets. 1. Straight above meru in space one pole is seen; the other pole is seen below, placed in space. Fastened to the poles the sphere of the stars is driven round by the pravaha wind. 5. Above the moon there are Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, and then the stars. 39."—Trailokya Samshāna, Chapter 13.

The starry belt, along with planets, appears to make one complete revolution round the earth in about one day. But it was only Āryabhaṭa I, who held the modern view that this diurnal motion is not real but apparent and is caused by the diurnal rotation of the earth; others held that the diurnal motion of the starry belt was real and almost all the authors of Siddhāntas have blamed Āryabhaṭa for holding a divergent view.

The planets appear to move from west to east with respect to the stars and in the science of astronomy this kind of planetary motions have principally to be dealt with. The Sūrya-Siddhānta has explained this eastward motion of planets as follows:—

पश्चाद व्रजसिद्धांतविवक्षाः सततं प्रहा: ।
वेजमानानातु लब्धेतु तुल्यमेव स्वमार्गं: ।
अध्यायः २५ स्वयमार्गिकाः.

"The planets being overtaken by the stars moving with greater speed in their westward motion, fall behind equal distances in their orbits (and hence they get an eastward motion)"—Madhyamādikāra-25.

In substance, this means that the diurnal motions of planets being less than those of the stars, the planets lag behind and hence they appear to move eastward with respect to the stars.

Āryabhaṭa I had already taken it for granted that the diurnal motion of the stars was not real and hence it was not necessary for him to make any assumption like the above to explain the eastward motion of the planets. He had already assumed a real eastward motion for them.
Another kind of assumption which has been made about the motion of planets is that their eastward motions in their orbits are equal. But the distances of planets from the earth being unequal, the orbits of farther planets are wider than those of the nearer ones; and that is the reason why we notice difference in their eastward motions. The moon being nearest to the earth has the swiftest motion and Saturn being the farthest of all planets, its motion is the slowest. The Pañca-Siddhāntikā says:

प्रामण्यस्वत्तुल्यवा प्रहास्तु सर्वं स्वमंडलत्गः।
पव्वति वायु शीघ्रः स्वर्ग नक्समंडलमयस्यः।
उधवस्वत्तुल्यवो विचरति महुत्कर्षो मंब।

यो १२ खंडायस्यस्यान।

“All planets move towards the east with the same velocity each in its own orbit. 39. The moon which is placed (lowest) below the sphere of the stars revolves quickly in its small orbit; Saturn which is placed highest above revolves slowly in its large orbit with the same velocity.” — Trailokya Samstāna, Chap. 13.

One complete revolution of a planet in the zodiac is called bhagana. It is obvious that the time for one bhagana must have been determined after observing the times taken by the planet in making several revolutions. The astro-mathematical works give the number of bhaganas which each planet completes in the period of one Kalpa or one Mahāyuga. The motion of a planet as calculated from these periods using the bhaganas mentioned by the Pañca-Siddhāntikā must be the same for every day. This is called the ‘mean motion’. But the motion of a planet as actually seen in the sky is not always the same. For instance, Jupiter takes about twelve years for one revolution and hence its mean daily motion comes to be about 5°; but the actual observation of the planet shows that Jupiter sometimes moves faster than that and sometimes slower; its daily motion is sometimes found to be as much as 15° and sometimes it is slower than even 1°; not only this but sometimes the planet also appears even to move in a reverse direction i.e. from east to west (this is called retrograde motion). The planet’s daily motion as is actually seen is termed ‘true or apparent’ motion; similarly the planet is actually found to be somewhat ahead of or behind the position calculated from its mean motion. The real position of a planet is called its ‘true place’ and that found by adopting the mean motion is called its ‘mean place’.

To find the true place of a planet at a given moment, which in other words is to find where the planet will be observable in the sky at a particular time, is the main subject of the mathematical branch of astronomy.
THE AYANA CALANA

(The shifting of the solstitial points)

The period that elapses between two successive ‘conjunctions’ of the sun with a particular star is termed Nākaṣṭra saura varṣa or ‘Sidereal Solar year’. The two points of intersection of the ecliptic and the equator are called Sampāta or Krāntipāta (i.e. equinoxes). The equinox from which the sun enters into the northern side of the equator and which marks the spring season is known as Meṣa or Vasanta Sampāta, that is, the vernal equinox.

Let us suppose that at some time there is a star coinciding with this equinoctial point and that when the sun comes to that point the year commences. The equinox has got a motion, and it recedes back at the rate of 50° per year. On account of this, the stellar zodiac appears to be moving to the east by an equal arc. The time taken by the sun to return to the same equinox is termed as Sāmpāṭik Saura (i.e., tropical) year. This is also called the ārtaṇa (seasonal), and the sāyana year. When the sun would return to the same equinox it would, as it were, find the above-mentioned fixed star still 50° ahead, and it would require about 50 palas (twenty minutes) more to arrive at the star. Hence, the sidereal year is found to be longer than the tropical year by about 50 palas. The seasons depend upon the tropical year. If there is a particular season when the sun comes to an equinox, the same season would recur every time the sun returns to the same equinox again; on the other hand, it is evident that the same season would not be found recurring at every conjunction of the sun with a star. If one point of the orbit shifts its position every other point also does so. As the equinoctial point recedes, the solstitial points also fall back; hence if the winter solstice is found to occur when the sun is near a particular star, the future solstitial transits will be found occurring gradually further westward from that star. The motion of the solstitial points which is the same as that of the equinoctial points was first detected from the westward position of the sun with respect to stars at the time of successive solstices. Hence, this motion is termed as Ayana Calana or the shifting of the solstitial points.

THE YUGA SYSTEM OF MEASURING TIME

The measure (length) of the Kaliyuga is 4,32,000 years. Those of Dvāpara, Tretā and Kṛta are respectively twice, thrice and four times of this. These four yugas constitute the Mahāyuga and its measure is ten times that of the Kaliyuga and is equal to 43,20,000 years. One thousand such Mahāyugas make one Kalpa, which is known as Brahma’s day. The Kalpa contains 14 Manus. So far, a period equal to 6 Manus and 27 Mahāyugas has elapsed from the commencement of the Kalpa up to the present i.e., the 28th Mahāyuga; and after passing through Kṛta, Tretā and Dvāpara of the current Mahāyuga, we are now passing through the Kaliyuga.
71 Mahāyugas make one Manu and a period equivalent to a Kṛtayuga, known as ‘Manu-sandhi’ (i.e., the transition period between two Manus), is reckoned in the beginning of each Manu period. This means that a period equal to 4567 Kaliyugas have elapsed from the commencement of Brahmī’s day up to the present Kaliyuga. All Siddhāntas with the exception of that of Āryabhaṭa agree on these points, although they hold somewhat different views on other matters.

According to the modern Sūrya-Siddhānta and Āryabhaṭa I, all the seven planets including the sun and the moon were together in the beginning of the present Kaliyuga. In other words, the mean longitude of each of these bodies was zero; but according to Brahmagupta and Āryabhaṭa II, all the planets had such a general conjunction only at the commencement of the Kalpa, and not at that of the present Kaliyuga when they were situated within a range of 3 to 4 degrees from one another. There is yet another divergent view which will be explained later on.

This book relates the history of the study of the positions and motions of heavenly bodies and that of the development of the various aspects of astronomical knowledge in our country. The ancient name of our country is Bhārata Varsa, Bhārata Khaṇḍa, or Bhārata. Because this book contains the history of astronomical science in our country, it is titled “Bhāratiya Jyotishā Sāstra—(its) Ancient and Modern History”.

Samhitā and Jātaka, the two branches of astronomy, depend upon the motions of planets and stars. The chief aim of our astronomy is the prediction of actual planetary positions, that is foretelling what place in the sky a particular planet would be occupying at a particular time. Its complicatedness is inherent. An accurate knowledge of the mean motions and positions of planets emarates from an accurate knowledge of their true positions and motions. Even before they acquired the capacity to predict accurately their apparent positions, the ancients did possess a tolerably accurate knowledge of planets’ mean motions and positions. This was the preliminary stage. The Siddhāntas and other available astronomical works deal with the calculations of true positions and motions of planets. A considerable period of time must, however, have elapsed before man’s knowledge of astronomy reached that stage.

The history of astronomy has, therefore, been divided into two major divisions, viz., (i) the Siddhāntic period and (ii) the pre-Siddhāntic period, and accordingly this book has been divided into two parts. ‘Part One’ gives the history of how the people in pre-Siddhāntic age had taken increasing interest in astronomy, how the relevant knowledge had grown, and how it reached the stage of foretelling the true places of planets, this history being traced from the casual astronomical references found in the Vedas, Vedāṅgas Smṛitis and the Mahābhārata, and the subsequent history up to the present time is given in ‘Part Two’. The pre-Siddhāntic period and consequently Part One, has again been sub-divided into two sections: (i) the Vedic period and (ii) the Vedāṅga period. The first section deals with the history of astronomy collected from references found in the Vedic Samhītas, Brāhmaṇic works and some Upaniṣads. The second section deals with the history of astronomy gleaned from the Vedāṅgas, the Smṛti works and the Mahābhārata. The
Vedāṅgas contain two works whose whole subject matter is astronomy. These, however, deal with the mean motions and positions of planets and they are more ancient than the Siddhānta works, and that is why their study is given a place in Part One. A discussion of the limits of the periods to be assigned to the Vedic, the Vedāṅga and the Jyotiṣa-Siddhānta ages is given at the end of the part. ‘Part Two’ is devoted to the history of the three branches of astronomy.

The history of mathematical astronomy in this part has been presented in the order of adhikāra or chapters, as already mentioned, viz., the mean motions, true motions, etc. A description of the celestial sphere, the system of observation, the precession of solstices, etc., have been given in the same part. In the treatment of these subjects references to several works and authors are required to be quoted, and without their knowledge some difficulty is likely to be experienced in rightly appreciating the discussion. Hence a detailed history of astronomical works and their authors is given in the chapter on the mean motions of planets in the beginning of ‘Part Two’ and a discussion of the mean places and motions of planets will be found in the same chapter. The chapter on the ‘true motions’ is devoted to the study of true positions, motions of planets and a detailed description of the five parts of the Pañcāṅga (almanac) and that of different Pañcāṅgas current in different provinces of our country.

An adequate idea regarding the subjects and the order in which they are dealt with in the two parts may be obtained from the table of contents.
PART—I

HISTORY OF ASTRONOMY DURING
THE VEDIC & THE VEDANGA PERIODS
Section I
The Vedic Period

Let us consider what subjects relating to astronomy are found in the Vedas and in what manner they have been treated. It need not be explained that the Vedas are not essentially a literature solely devoted to astronomy, and it is, therefore, obvious that no astronomical information would have deliberately been presented through them. Hence, all that one can do is to draw certain general inferences from the astronomical ideas occurring incidentally among other things, and where such inferences cannot be drawn in the absence of sufficient material of a consistent nature, to make a bare statement of stray ideas that may have been elicited.

Even a cursory glance at the Vedas will at once show that our ancient ancestors had a great liking for the observation of natural phenomena, particularly the wonders of the sky. If one looks into any of the Vedas or even any part or any chapter thereof, it would not generally happen that one does not come across some passages describing the sky, the moon and the sun, the dawn and the sun beams, the stars and asterisms, the seasons and months, the day and night or the wind and clouds. The description itself is enchanting, life-like, beautiful, amazing and awe-inspiring. The author refrain from giving specimens of such descriptions for that would be a digression needlessly leading us far afield.

ORIGIN OF THE UNIVERSE

Let us now see what description do we find in the Vedas about the “creation of the world” and the “structure of the universe”.

वेदान्त न वर्ण जाना प्रवचन विषयया ॥ उत्थाप्य शास्त्रमानोग्य: यथा यावतेः यथे ॥

श्रद्धास्तिरितिसंग कर्म इवाधमत् ॥ वेदान्त युगेन युक्तेष्ठ तथाजयत ॥

वेदान्त युगेन प्रवृत्तेऽविकारः सणायात ॥ तत्र अवः साभार्यत तदुत्तात्मांस्वर ॥

भूज्य्वं उत्तात्मपात्रो भुव आचाः अन्धायत ॥ अविद्येऽि अजयायत द्वायारितिः परिः ॥

अविद्येऽि जनित्य वस्त्राय वृहित तत ॥ तत्र द्वेय अवजायत मया अध्यंत्यायः ॥

कृत्य सं १० ७२

“(1 and 2) We describe the births of gods in plain words—the (assembly of) gods which even though born in a former yuga sees the reciter (stotā) in the latter part of the yuga, while śāstras were sung (in sacrifices) like the Karmā Brahmanaspati created the gods. The sat (real) was created from asat (non-existent) in the first half of the divine yuga.

(3) The sat was created from asat in the first divine yuga; then the directions came into existence and then the uttāna-pada followed.

(4) The uttāna-pada gave birth to the earth, which in its turn gave birth to directions. Dakṣa was born of Aditi. Aditi was born from Dakṣa.
(5) Oh Dakṣa! The praiseworthy and immortal gods were born after your daughter Aditi.” Rk Samhitā, X, 72.

This means, in a general way, that some kind of Being or Existence arose first, then came into existence the directions and then the earth.

The following lines from the Rk Samhitā may be seen:—

अतः तत्वतः ज्ञात्व च ब्रह्मादि स्मरणस्य जायते || ततो रामयज्ञमेत तत: समुद्रे धर्ममः || 111
समुद्रविभागस्य संसर्गस्य व्रताजयत || अभिरक्ताया विवेक्षितविष्ट: विकाम्योऽहारि || 111
सूर्यचन्द्रस्य साता यथा प्रौढःकलयत् || विवाह च पृथिवीः चानुभवमेव स्वः || 111

च. सं. 10. 180.

“(1) Truth (of thought) and truthfulness (of speech) were born of ardour penance, thence was night generated, thence also the watery ocean.

(2) From the watery ocean was the year afterwards produced, ordaining nights and days, the ruler of every moment.

(3) Dhātri in the beginning created the sun and the moon, the heaven, the earth, the firmament and the happy (sky)).”

These mantras occur in other Vedas also. The following description is given in a passage in Taītirīyā Brāhmaṇa:—

णन्द्रो वा इत्यग्नि सतिनमात्रेष्वः || तेन प्रजापतिः प्रभावत || कथा विवेचनातिति ||
तो पद्मयुक्तकर्णं तिलकति || शरीरमेव || ततो || वर्णनमविमुखः विद्वान् ||
स वर्णवृत्तं कुष्ठोपनयमधि || स पृथिवीमय व्राहुः || तत्स व्राहुः विद्वानं ||
तत्सुपयुक्ताण्डविश्वविश्वम् || यह विश्वविश्वम् ||

अध्यक्ष १ अध्यय १ अनुबाक ३.

The quotation describes that there was water in the beginning and that the earth was created thereafter. The Taītirīyā Samhitā also gives similar account of the ‘creation’ in the following lines:—

आपो वा इत्येक्षमेवस्य लोकमात्रेष्वः तस्मात् प्रजापतिियाँयुक्ता वरस्ता इममपवत्त्वां वरस्ते भूयाः।।
इतरं सम्बन्धं पृथ्विय घण्मत् सा प्रधि सा पृथिविभिः तत्स्वर्तविभिः पृथिविभिः ||

अध्यक्ष १ अध्यय १ अनुबाक ३.

According to this, water, air, and the earth, is the order of creation. The following passage from one of the Upaniṣads shows a more systematic treatment of the subject of creation.

तत्स्यत्र एव च मात्रात्वन्त तत्स्याऽपि जगतैः संभूत: || आकाशादियोऽकाशेऽवर्त्ति || अधृते राष्ट: ||
अथ वृहदी पृथिवी: || पृथिविः ओकाशोऽवर्त्ते ओकाशोऽवर्त: ऋपितः ||
तेजीयोऽपिनिष्ठ २. १ (श्रद्धा वल्लि प्रथम छंड)

“From this Soul (Āman), verily, space (ākāśa) arose; from space, wind (vāyu) ; from wind, fire ; from fire, water ; from water, the earth ; from the earth, herbs ; from herbs, food ; from food, semen ; from semen, the person (puruṣa).”—Taītirīyā Upaniṣad; 2.1 Brakma Vālli.
A description of the creation of the universe is found in several places. We come across a curious statement made by Taittiriya Brāhmaṇa that although the Vedas do describe the creation of the world and the order, no one can state the actual cause of creation, for no one knows it.

It says that after the deluge submerged the first universe, and prior to the creation of the next one, there existed neither the ‘Real’ nor the ‘Unreal’. There was neither sky nor water, neither death nor immortality, neither the sun nor the moon to illuminate the day and the night. There was only one all-pervading Brahma. It then desired to create and the Universe was created and so on. It then goes on to say:

"Who really knows whence and how this Universe was created? Or who can tell it? Even the gods were born later; who knows Him from whom the world was created? Who knows the ‘tree’ from which the heaven and the earth were created and in what ‘forest’ was it growing? It is only He, the controller of all these things, who dwells in the ‘Supreme ether’, who knows this. Perhaps no one knows if even He knows this or not."

It is clear that the above passage implies that because no one knows the cause of creation of the Universe, no one definitely knows the order in which creation took place.

At one place in the Rigveda a sage remarks as follows:

"There are three heavens. Two of them lie within the Sun and one of them in the abode of Yama ......................... (The moon, the
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tars and) other gods dwell there. If there be one who has known this, let him come here and relate it to us."

The object of the sage is to state that there can be no one who actually knows this.

Even then it seems that even in the Vedic age, people had a fair knowledge of the structure of the world and at least that of the configuration of the earth.

CONFIGURATION OF THE UNIVERSE

In many places, where a reference is to be made to the world, terms like Rodasī, Dīvāpythivī or their equivalents, denoting a combination of the heaven and the earth have been used, which in turn shows that the world was supposed to be divided into heaven and earth as its two parts. In some places the heavens are described as being three in number. Three heavens have been indicated at several places in the Rigveda. In some places the heaven is described as the highest part of the sky or the surface of the sky. But in many other places the Universe is supposed to be divided into Dyu (sky), Antarikśa (space) and Pythivī (earth) as the three parts; of these, the Antarikśa lies in an intermediate position between the heaven and the earth and is the abode of the winds, clouds and lightning and the birds fly in it. These three parts are described in clear words in the following well-known lines of the Puruṣa-Sūkta:

नामया अस्तित्वस्य शीर्षो चो: समगर्तम। पद्मो भूमि।

and corresponding to their high and low positions they are believed to have been created respectively from the head, the navel, and the feet of the ‘Supreme Being’.

The following verses may further be noted:

य: पूर्विकी स्थियमवस्तुः पर्वतान्त प्रकृतितां अरम्भस्त।

ये अंतरिक्ष विसमे वर्षीयो ये भामलमनल जनास इति।

"Oh people! He is the same god Indra who kept the shaking earth in firm position .......... who adjusted the expansive space and who supported the heaven."

त्रिन्या अविना विब्याविन भेषजाः त्रि: पार्थिवाति त्रिसहस्तमयः।

"Oh Āśvins! May you give us heavenly medicines thrice from heavens, thrice from the earth and thrice from space."

The interpretation of the word Adhhyāḥ in the original text is “from the place where water-laden clouds dwell”, meaning the sky (antarikśa); many proofs could be given in support of this interpretation and therefore it is clear that the word antarikśa stands for that space in which water-laden clouds move.

चेमीः रजसे विद्युश्चेत्यवातो अध्यूः। सर्वद्विषर्ग अति।

"Oh Indra! May you give us the luminous water-laden clouds thrice from the earth and thrice from space."

चौः सं। १००३।
THE VEDIC PERIOD

"Oh Agni (fire), please come here along with all those Maruts (gods) who dwell in the expansive space".

These lines show that the space is the abode of 'Maruts' i.e. wind.

meaning "(Varuṇa) who knows the path of the birds flying through the space" shows that 'antarikṣa' is the space in which the birds fly.

It is clear from the following lines from Aitareya Brāhmaṇa (11-6) that 'antarikṣa' is that space which lies between the heavens and the earth.

That the sun is moving through the highest region of the heavens is described in many places. The following lines may be seen for this:

"Oh Sun-god with agreeable lustre! Cure the disease of my heart after ascending the highest point in the heavens."—Rk Saṁhitā.

The idea that the sun shines at a very great distance from the earth can be seen from some of the following lines:

"Agni (fire) had to stand in a lower position before wind and space on account of the earth. The wind stooped low before the Sun and the sky on account of space. Similarly, the sun had to stand low in position on account of the moon and the stars; and the moon had to 'bend low' before Varuṇa (god of rains) on account of stars"—Taittirīya Saṁhitā.

The description appears to imply that the fire rests on earth, the wind takes shelter in space, the sun traverses the sky and the moon moves through the zodiac. It appears from this that the moon was supposed to occupy a higher position than that of the sun.

* Six sentences following this, have been given with the necessary change in the gender and number of each of the words Teja and Samudra (Sea) etc., in the original. They have not been repeated here.
The word *loka* occurring in the first three lines of the above passage refers to the Universe. It praises Him with the words “Thou art the world, thou art Unending, Infinite, Eternal and Indestructible.” It is needless to point out that the sequence occurring in these sentences does not necessarily imply a high-and-low lineage of created objects. In some places, the relation indicated is cause and effect; in some, the container and the contained, and in some others, the part and the whole. It, however, embodies in it the sequence mentioned here before wherein, the heavens are above the space, and space above the earth, and also the idea that the sun is supported by the sky.

**THE EARTH, SPACE AND THE HEAVENS**

The above discussion in short shows that the earth, space and the sky used to be regarded as the divisions of the Universe. A definite statement is found in the Vedas to the effect that the region which the clouds, the wind, and the lightning are seen to occupy, is nearer to the earth; and that the region in which the sun, the moon and the stars appear to move is far away from the earth. Nowhere in the Vedas do we find the division (of the Universe) into Heaven (*Svarga*), the Earth (*Pthvī*) and the nether-worlds (*Pātāla*).

From the quotations given above, it appears that the moon was believed to be occupying a position in the sky higher than the sun, and this belief is contrary to scientific truth and to the astronomical theory propounded in post-vedic period. The scientific fact that the actual position of stars is higher up than the sun, is no doubt implicit in the above description. The reason why the moon was believed to be occupying a position higher than the sun was probably the fact that no stars are visible during the day time when the sun shines, and therefore it was possibly believed that the sun had nothing to do with the stars. That is not the case with the moon. Because the stars near which the moon moves are visible and because of its swift motion, it appears to be moving amongst them. Hence, it was but natural for the people to believe that because the stars are higher up than the sun and the moon moves in their region, the moon is also higher than the sun. We, however, get the following quotation from the Vedas confirming the fact that the true position of the moon is nearer to us than the sun and hence lower than the sun.

† It is not necessary to give here the original lines which follow this. However, the whole stanza is purposely given with a view to helping correct understanding of the thoughts from context and also because the important astronomical time units viz., the year, the season, the month, the half-month, a “day and night” occur together in one place and because these are given as they actually occur according to their relative order of the whole and its part.
THE VEDIC PERIOD

THE MOON’S PLACE

Sāyanaçārya, while commenting on the above verse, observes:

“Yāska pakṣe tvāpa iti antarikṣanāma. Yavhatirapo mahadantarikṣam
...........tarantaṁ brkam candramasam.”

This shows that according to Yāska and consequently according to Sāyanaçārya also, the lines suggest that the moon is lower in position than the sun, because it moves in the space (sky). The moon is called a ‘bird’ that is one who traverses the space, in the first verse of this Sūkta and this lends an additional support to the view.

THE INFINITYNESS OF THE UNIVERSE

The following lines express the idea that the earth as compared with the Universe is very small and the Universe is very expansive.

यद्वितिथि पृथिवी दशामूलिकानि विद्वा तत्संतत कृष्टय: ॥
अब्दाहृ ते मध्यवन् विज्ञुति सो सदामु शवसा वहिणा मुखत् ॥

अण. सं. १ ५२२. ५२

“(Oh god Indra ! ) if the earth were to magnify itself to ten times its size (and if) men would live for eternity, then and then only the glory of your famous might and valour would be equalled by the heaven”—Rk Samhitā.

Here the term ‘ten times’ is only symbolic. It would be taken to mean many times. The object of the sage in giving this description in the verse is to suggest that the prowess of Indra is very great and it can equal the heaven in greatness. But the life of man who describes it is very short and the earth is also very small in size. If the earth were to grow to a bigger size and if men dwelling on it were to live to eternity, the prowess of Indra will be much exalted and will spread over the infinite universe. What we have to observe is that the idea that the universe is infinitely greater than the earth is clearly stated in this verse.

That the universe is infinite has been described in several places. The passage already quoted from Taittiriya Samhitā (3.11.1) may be seen as an example of this.

SUN, THE SOLE SUPPORT OF ALL WORLDS

The following lines may be seen as a proof that all worlds are supported by the sun.

संत युंजति रथमेकचक्रमेको अद्वो वहृति सङ्कलाभः ॥
विनाशित चक्रमेकमेक्य यथैवाविश्वा मुखनाभितृतस्यः ॥

अण. सं. १ १६४. २

“Seven horses are harnessed to that one-wheeled chariot ; but only one horse bearing ‘sapta’ (i.e. seven) names draws it. The wheel has three hubs or navels and it is eternal and unhindered, and all worlds stand supported by it (i.e. chariot)”.—Rk Samhitā.

Although the word ‘sun’ does not occur in the verse it undoubtedly relates o the sun.
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सन्ते चक्रवर्त विवाहुत उत्सानायं दशमुखल वह्नति ॥
सूर्यस्य च ज्यूस रजसत्यावृत्त तरस्मानाविभित्ता भूमनानि विख्यत ॥

ऋ. सं. १. १६४. १४.

“That wheel which traverses only one path and which is indestructible always keeps revolving......It being the sun’s eye—it keeps on revolving. All worlds rest upon it.”—Rk Sanhitā.

मित्र जनानं यात्तयति प्रजाननं मित्र वास्तर पृथिवीयूतं हारं ॥
मित्र: कृष्टे रान्तिषा वाच्यते... ।

३. सं. ३. ४. ११.

“Mitra (Sun) (knowing the worth of each one) inspires him. Mitra supports the heaven and the earth. Mitra sees the men and the gods.”—Taittirīya Sanhitā.

This verse appears even in the Rigveda, but in a slightly different form. Many more such quotations could be given.

SUN, THE CAUSE OF THE SEASONS

The following line can be cited to show that the sun is the cause of the seasons :—

पूर्वाश्च ्प्रविश्न पार्थिवानामनुर्यु प्रवाहनेवधावनुष्टु ॥

ऋ. सं. १. १५. ३.

“The Sun generates all the earthly directions one by one and controls the seasons.”—Rk Sanhitā.

Many other quotations could be given to show that the seasons are created by the sun, but they are not given here for want of space. Readers will come across some lines in the study of seasons which forms part of the subject of time units.

SUN, THE CAUSE OF WINDS

That the sun is mainly responsible for the blowing of winds may be seen from the following lines.

विनातारं वजति वसविचारं वजति तस्मात्तुस्तरः पश्चातथं भूमिः पवनम्:
पवते सवितुप्रसादः हृदेत्यत्वते ॥

४. ब्र. २. ७.

“(The Hotā) recites the ‘Yājya, mantras in honour of the sun. The wind blows from north-west because he worships the sun and because the wind blows after being born of the sun.”—Aitareya Brāhmaṇa.

It is not the intention to maintain that the Vedas hold that the earth and other planets depend upon the sun, because of their attraction by him, and that they revolve round him, but there is no doubt that we do find the idea in the Vedas that the sun is the support of the universe in as much as the seasons are created by him and that all the worlds depend upon him for light, heat and rain.
SEVEN HORSES OF THE SUN

We, no doubt, come across a description of the sun’s chariot as having seven* horses. However, statements are by no means wanting in Vedic literature which go to show that it is all metaphorical and that the sun has neither a chariot nor any horses.

"The sun born without horses........swiftly jumps high up in the sky:"
—Rk Samhitā.

ONLY ONE SUN AND ONE DAWN

The following verse from Rk Samhitā will show that there is only one sun and not two, or many in number.

"Only one sun is the lord of the universe, one dawn gives light to the universe".

It is worth noting that in the above lines, the dawn is said to be only one. The dawn is the twilight before sunrise. At many places in the Vedas, we come across the curious description of there being many dawns, because a dawn is observed every day before sunrise, but the fact was no doubt known that just as there is only one sun, so there is only one dawn permanently associated with him.

THE EARTH, ROUND AND SUPPORTLESS

DAY AND NIGHT

"He (i.e. the sun) neither sets nor rises. What is believed to be his set is (as a matter of fact) his turning himself round at the end of the day. He makes night on this side and day on the other. Similarly, what is taken to be his rise in the morning is (as a matter of fact) his turning himself round at the

* Commenting on “Amiye Saptaras mayah”, Sri Shanker Pandurang Pandit, the editor of Vedartha Yatna, writes (on page 683, Vol. II, of the issue for April 1878), “that the sun has seven rays is stated here in Rk 8-72-16 in clear words. From this it appears that the modern theory of the sun’s rays consist of seven colours was not unknown to the Aryans in ancient times".
end of the night, when he makes this day on this side and the night on the other side. In fact he (the sun) never sets.*—Aitareya Brähmana.

The knowledge of the earth being round in shape and being suspended in space and separated from the sky, is clearly perceived through the above mentioned allusions from the Brähmanas. Even in Gopālika-Brähmana (9-10) of the Atharva Veda, we come across lines almost similar in meaning.

It seems that it was known to the people even in the Rigvedic age that the earth is round and stands supportless.

The following verse may be seen

चक्रागत: परीरंगं पूर्विब्य द्रहष्णेन चृणिना चुंबयना।
न हिष्यतासतिस्तितन्तेस्त इदं परि स्वात्रो अस्वात्स्यः।

२३. १३. ७.

"The messengers (of periphery of the earth), who are shining with golden ornaments were unable to vanquish Indra, even when they were flying round the earth's periphery and running with great speed. He then covered** them with sun's light."—Rk Samhitā.

If the earth were flat, the sun's rays, immediately after sunrise, would have fallen at one and the same time on the whole earth, or at least on half of its surface; but references show that the rays instead of falling at once, do so one after the other. The following verse may be seen :

आया रजोविनिर्विचित्रविविलितक्षोक्तवेम्: इति चतुष्टयं धर्मं।
प्र बाहु अव्याकृ तिस्य स्वच्छ पौन्निः निवेशयस्निपुनस्य प्रस्नवनक्षुभिवः॥

२४. ४३. २.

"The brilliant sun filled with light the regions of the heaven, the space and the earth."—Rk Samhitā.

The sun is rising and stretching out its arms, putting the world to sleep by turns and awakening it by turns by means of its luster.

The mantra "the sun rises causing a gradual sleep and a gradual awakening" may be taken to mean that as the sun traverses the sky, there is night fall in some parts of the world which are thus enveloped in darkness; and because it gradually throws light on some other parts, there is day time there. This betokens a knowledge of the roundness of the earth.†

Any such references in the Vedas as to show the earth as having been divided into Meru-mountain, Jambudvīpa and other seven islands can not perhaps be found.

* The speaker is observing this with respect to his own place. The words "this side" refer to the side on which he stands with respect to the sun. By the words "turns himself round" he means to say that the sun, after moving in one direction till evening, changes his direction after dawn after sunset.

**Commenting on this verse, Shri Shanker Pandurang Pandit the editor of Vedarth-Yatna, observes (Vedarth Yatna, Page 380, Vol. I), that "The words "Parināhman chakranāsha" clearly show that our Aryan ancestors, at the time of composing these verses doubtless knew that the earth is not flat but round spherical in shape".

† It is clear that the Samhitās of all the Vedas, the Brāhmaṇa works and the Upaniṣads were not compiled in the same age. It is very difficult to assign limits to their times.

<end>
So far we have considered as to what is found in the Vedas about the creation of the world and the structure of the universe. Let us now see what do we find about the units of time like the year, the month etc., the positions and motions of the sun and the moon, the stars, eclipses, planets, etc.

UNITS OF TIME

The Kalpa.—Let us first consider the ‘time-units’. The term Kalpa used as one of the time units in the astronomical works of post-Vedic period, not only does not find a place in the Vedas, but also the word Kalpa is not found having anywhere been used in the Vedas in the sense of some kind of time-unit.

The Yuga.—The word Yuga has occurred in several places in the Vedas, where it denotes some unit of time. As it would be convenient to consider this subject properly, all those references which contain the word Yuga or the names of any of the four Kṛtādī Yugas are given below.

"Maghavā (Indra) adopted the same famous name for the Stotras in this humanyuga, which the very mighty Indra had adopted when he marched with the thunderbolt in his hand to kill Dasyu."—Ṛk Samhitā.

Sāyanācārya observes that the word yuga has to be taken to mean the four Kṛtādī yugas.

"Oh Aśvins! you revolve round the worlds ............ with the second wheel of your chariot."—Ṛk Samhitā.

The period can however be divided into (i) The Samhitā age, (ii) The Brāhmaṇic age and (iii) The Upaniṣad age, and their sub-divisions would be too many to mention. Instead of dividing the time into several parts for the sake of drawing a few conclusions regarding the astronomical knowledge of that period, it is convenient to leave it to the readers after simply mentioning the works from which those Vedic references have been taken, and that is why all these references in the Vedic period have been included. It is needless to say that the ‘Brāhmaṇas’ are more ancient than the ‘Upaniṣads’, and the ‘Samhitās’ and specially the Ṛk Samhitā are the most ancient.

*In translating the Vedic mantras the author has strictly adhered to the original and nothing has been added which does not exist in the original text.
“Dirghatamā, the son of Māmata, having grown old in the 10th yuga, became
the charioteer (in the form of Rīvika) of the Karma (action) which leads to
some (divine) result”. —Rk Samhitā.

Sāyana, in his commentary on the above verse, says that Dirghatamā
after happily passing his life for 10 yugas through the grace of Ashwes,
finally attained old age. He does not state in clear words what a ‘yuga’
should be taken to mean, still the context of his writing suggests that it
should be interpreted as ten kṛtādi yugas.

३२० ३२० विविध्या भृगुइयोगनारिध यहां बेहिं नवसिः

“Oh God of fire (agni)! Give riches and success to us who offer new words
of praise to thee for the sake of sacrifices in each yuga” —Rk Samhitā.

या ओषधि: पूर्वां जाता देवेयस्थित्रयुगं पुरुषा

“The herbs which created by Gods in three yugas before” —Rk Samhitā.

In his commentary on the above line Sāyana interpreted the word
Triyuga as either the three yugas Kṛśa, Tretā and Dwāpara or the three seasons
Vasanta (Spring), Varsā (Rains) and Sarad (Autumn).

The same mantra occurs even in Taittirīya Samhitā in the form—

या जाता ओषधि: देवेयस्थित्रयुगं पुरुषा

Even in Vājasaneyi Samhitā the same mantra is found in the following form,
and Mahādhar, the commentator has interpreted the word ‘Yuga’ as the three
seasons—spring, rains and autumn :

या ओषधि: पूर्वां जाता देवेयस्थित्रयुगं पुरुषा

A reference to the word ‘Yuga’ is made in Vājasaneyi Samhitā in the follow-
ing line :—

शृङ्खलन ५० सत्रयस्तः त्वनिरा बेहिं मानुषा युगं

या संस १२ १११.

In all these references the word yuga has undoubtedly been used to denote
some unit of time, but none of them clearly indicates the number of years which
the word is supposed to denote. In the Vedāṅga Jyotiṣa, a yuga is supposed to
be a unit of 5 years. It cannot, however, be said for certain that the word is
definitely used in the same sense as in the above lines, nor can it be said for
certain that it is not so used; for it will be seen later on that the names Sanvatsa-
sara, Parivatsara, etc., which form parts of the five-yearly yuga of the Vedāṅga
Jyotiṣa do occur in the Vedas.

In the quotation “Dirghatamā became old in the tenth yuga” it is not the
object of the writer to point out some infirmity of Dirghatamā. It is clear
that he intends to express some speciality about him; and if it be taken to mean
units of 5 years it would on the other hand show his infirmity, as he would be
regarded to have attained old age at fifty. Therefore, instead of assuming
that the span of life was a thousand years, if it be assumed as of some limited
number of years, say a hundred years, the term yuga has to be taken to mean
at least a period of ten years. From this and from the Rigveda quotation “We
praise you in new terms in every yuga”, it appears that the yuga must have been
a unit of time smaller than the span of human life, that is smaller than 100
The Vedic Period

years. It cannot, however, be said that the idea of a yuga representing a much longer period of time, never existed. The remarks "It so happened before in the divine age", "the human ages of the present time" cannot emanate from a speaker unless he has in his mind that a yuga does indicate an abnormally long period of time.

It must be said that the word yuga had no standard meaning and consequently it has to be believed that even in the Vedic times it must have had its meaning in the general astronomical sense of a "period of time after which a phenomenon occurring once repeats itself in the same order". The eclipses of the sun and the moon which occur in some order or at certain intervals during a period of eighteen years, recur in the same order and at the same interval, so as to be visible at some place or the other on the earth; this can, therefore, be said to be a sort of an 'eclipse-yuga' of 18 years. It is clear from the Vedāṅga Jyotiṣa and from other examples that the word yuga has been used in astronomy in accordance with the principle underlying this sense. All planets come together at the commencement of each of the four yugas and of the Mahāyuga, and after making a number of revolutions in each yuga they come together again in the beginning of the next yuga. This period is termed a 'yuga' and though the yuga is employed in the astronomical works in the period of 432,000 years or its multiples, it is found used even in its original sense. For instance, in the Bhaṭaprakāśikā, a commentary by Śūrya Deva Yajva on the work of Āryabhata I, the following lines give the measures of the yugas of the nodes and aphelia of planets:—

काशाद्विकत्वमस्मिष्टाः त्रियुगमण्येकौध्। युगम बुधायाहाथाः ॥
रथुमंस्थ्यमस्मस्मिष्टाः प्रहोः ह्रद्वन्ति ॥

"The yuga (cycle) of the node of Mercury consists of 35,750,224,800 years and that of the sun's apogee of 119,167,916,000 years." The number of years for each is of course different, which shows that the word 'yuga' is used in the above lines to denote the periodic measure of time after which a phenomenon recurs. Hence, after reading the Vedic verses one is inclined to think that the word yuga must have been used in these lines, in its original sense and the measures of time indicated by the word must have been used in these lines in its original sense and the measures of time indicated by the word must have been different for different phenomena. It cannot, however, be said as to what was the actual measure of time and what was the recurrent phenomenon on which it depended; and although the definition of Mahāyuga meaning 4,320,000 years has not come in vogue in the Vedic age, yuga was no doubt used in the sense of some very lengthy measure of time. Not only this, but that the idea that the yugas were four in number was prevalent at the time of compilation of the three Vedas, can also be clearly seen from the line "Yā jātā osadhayo devabhyaḥ triyugam purā".

Kṛta and Other Words Occurring in the Vedas

Now the lines in which the words Kṛta and Tretā occur are quoted below from Taittirīya Samhitā:—

प्राची दिशां वर्षं नृत्त्वां रक्तस्य निर्विद्यम व्रह द्रव्यं विकल्पस्म: स उ पंचदश बलिनिद्यविवन्य:
रक्तस्यायाम ज्योति श्रीमः... श्रान्तियावः... भुवणिविवन्यायाम भवनिमि अष्टावायाम बोधिनः... नित्यस्यायाम भवनिमि
प्रेमिश्वरे ते स: पात्रु तेनोंवस्त्रिभिम अष्ठायाम भवनिमि सासन्त्वायाम बोधिनः... नित्यस्यायाम

सं. सं. ४. ३. ३.
It will be seen that just as a prayer, 'May the manes, etc., protect us' occurs at the end of the stanza, the prayer 'May Kṛta and Dvāpara protect us' also does appear there.

The commentator Mahādhara renders 'Ādinavadarśa' as one who can see fault known as Ādinava, and 'Kalpi' as one who imagines. The Taittiriya Brāhmaṇa gives a similar but slightly different line under 'Puruṣamedha', which runs thus:

‘A Sabhāvi should be procured for Kṛta, an ādinavadarśa should be offered to Tretā, bahiśsada to Dvāpara and a sabhāsthānu to Kali'—Taittiriya Brāhmaṇa.

This stanza names the 'sacrificial persons' which should be offered to different deities. The commentary by Mādhava gives the meanings of these terms as follows:

'Sabhāvi' is one who sits in the gambling hall; an 'ādinavadarśa' is the observer examiner of the game (of gambling); a 'bahiśsada' is the one who witnesses the game without taking part in it, and a 'sabhāsthānu' is the one who does not leave the hall even when no game is being played.

The story of Hariścandra occurs in the Aitareya Brāhmaṇa. Hariścandra had no son. He invoked god Varuṇa to grant him a son, promising that the son would be offered to him in sacrifice. He then got a son who was named Rohita. After some years when the son was being sacrificed, he ran away into a forest. After wandering in the forest for a year he returned to his village. At that time, Indra, taking a human form, met him and advised him to return to the forest. This happened repeatedly for four years. When Rohita returned again, Indra said to him.

‘One who sleeps becomes Kali, one who sits becomes Dvāpara, one who gets up becomes Tretā, and one who becomes a wanderer attains Kṛta. Therefore keep on roving, keep on roving.'—Aitareya Brāhmaṇa.

'The four stomas are Kṛta and five are Kali and hence the Jyotistoma sacrifice should be Catusṭoma'—Taittiriya Brāhmaṇa.

This gives a limit to the number of 'stomas' i.e. (oblations). Some say five and some only four. Offering five would be Kali which is bad and offering four would be Kṛta which is good, and that is why the rule of offering four has been stipulated.

It can not be proved that the words Kṛta, etc. have been used in the definite of time; still the idea that they represent four deities is quite
clear from the above sentences. Similarly, the belief that Kṛta indicated something good, and others were increasingly inferior, Kali being the worst, is also indicated in these sentences. As it is evident from several lines in the Vedas that yugas were regarded as units of time and they were believed to be four in number, there is no doubt that the origin of the deeply rooted views about the yugas in the post-Vedic age lies in these very lines from the Vedas in which the terms Kṛta and others occur. The word Dvāpara occurs in Gopatha Brāhmaṇa (1.28) in the sense of a unit of time.

THE FIVE-YEAR CYCLE

In the Vedāṅga Jyotiṣa the yuga is taken to be a cycle of five years. The names of these years are Saṁvatsara, Parivatsara, Idāvatsara, Anuvatsara and Idvatsara. Although these names do not occur in the Vedāṅga Jyotiṣa itself, there is no doubt that these were the names of the years, in as much as they occur in the Vedas, and writers like Garga and others have given these very names. Let us see what the Vedas state about this:

संवसरस्य तथा: परिष्ठयन्तमंडकाः: प्रारूढःतिय वशुः।
प्रारूढःशस्त्र: सोमिनो वाचस्पति ब्रह्मकृष्ण: परिवसरेऽशम्।

श्रि तं: २. १०२. ३, ८.

It can not be definitely said that the words Saṁvatsara and Parivatsara have been given in this verse to show that this is the correct order of the names, still it is certain that the names did occur in this very order. And looking into the fact that when any thing is to be said about the year in a general sense, the word year is generally rendered in the Rigveda by some such words as Śarad, Hemanta, etc. which denote a season, it is thought that the above words must be the names of two of the years comprising the five-year cycle. The word Parivatsara, however, occurs in the Rigveda at one more place (10-62-2); the names of the other three years are nowhere to be found.

संवसरोत्स परिवसरोत्स वाच्यस्त्रोत्स ब्रह्मरोत्स २

वा. सं. २२. ४५.

संवसराय परीवर्त्याम्भोरोत्स वाच्यस्त्रायस्त्रायात्तिवरोत्स निन्द्रास्त्रायत्तिकहरूः ब्रह्मराय ब्रजबराय संवसराय प्रतिज्ञां ५

वा. सं. ३०. १४. ४.

This mantra occurs in Puruṣamedha and states what particular kinds of women are to be offered to Saṁvatsara, Parivatsara, Idāvatsara, Idvatsara and Vatsara. In both the mantras from Vājasaneyī Śamhitā, the order of the names of five years is the same. The second mantras mention the name Saṁvatsara again after giving the five names beginning with Saṁvatsara.

The Taittiriya Brāhmaṇa gives the following lines:

अनिष्ठयं संवसर:। अनिष्ठयं परिवसर:। चंद्रमा इदावसर:। वायुरुक्तसर:।

ले. बा. १. ४. १०.
“Agni (fire) is the Saṃvatsara, Āditya (the sun) the Parivatsara, 
Candramā (the moon) the Idāvatsara, and Vāyu (wind) the Anuvatsara.”
—Taittiriya Brāhmaṇa.

These lines mention only four names. Of these, the first three are given 
in the same order as in the Vājasaneyī Saṃhitā and the fourth is Anuvatsara. 
which is different therefrom.

Taittiriya Brāhmaṇa says,

<table>
<thead>
<tr>
<th>संवत्सराय पद्मरिणी</th>
<th>परिवसरायत्रिज्ञातो</th>
<th>इदावसरायापरस्कृती |</th>
</tr>
</thead>
<tbody>
<tr>
<td>इदावसरायाचितार्थी</td>
<td>वस्त्राय बिजयरी</td>
<td>संवत्सराय पलिवरी</td>
</tr>
</tbody>
</table>

तै. ब्रा. 3. ५. १

An almost equivalent quotation from the Vājasaneyī Saṃhitā has already 
been given above. Both of them give the same order of year-names; there is, 
however, some difference in respect of the animals to be offered in the sacri-
fice. Even in these lines there is the repetition of the name Saṃvatsara at 
the end after the mention of the usual five names.

तै. ब्रा. 3. १०. ४.

A similar quotation from the Vājasaneyī Saṃhitā has been given above. 
This gives the additional name of Iduvatsara as the fourth year, thus making 
the total period consisting of six years.

Mādhavacārya, however, interpretes Iduvatsara as a synonym for Anu-
vatsara.

Apart from this the names like Saṃvatsara, Parivatsara and other names 
are found in many places in the Taittiriya and Vājasaneyī Vedas.

These passages mention a varying number of years, some of them men-
tion five, others six, whilst some others only four and these too have been 
given in a different order each time. It cannot be definitely said whether 
these represent the five yearly cycle which was current in the Vedāṅga 
Jyotiṣa age. However, the reference to the 5-year cycle and the names of 
years comprising it in the post-Vedic works which occurs at several places 
must have had some support of tradition.

In short, it seems that a system, similar in many respects to the 5-year 
cycle system of the Vedāṅga Jyotiṣa must have been in use in the Vedic age.

THE YEAR

Let us now consider the connotation of the two terms, the year and the 
month. The word Varṣa which at present denotes a unit of 364 or 365 days 
or some such interval, is not found in the same sense in the Rk-Yaju-Saṃ-
hitās or the Aitareya, the Taittiriya, the Tāṇḍya or the Gopatha Brāhmaṇas, 
but it does occur in the Satapatha Brāhmaṇa (2-2-3). In Rigveda, the names 
of seasons like Śarad have been used denoting a year. Similarly, the words 
Saṃvatsara and Parivatsara are found so used in some places. In both the 
versions of the Yajurveda words like Śarad and Hemanta have not only been 
used several times in the sense of a year, but the word Saṃvatsara appears to 
have been used much more frequently. The word ‘hāyana’ has been used in
THE VEDIC PERIOD

the sense of a year in the Gopatha Brāhmaṇa (6-17). The word ‘sama’ has also been used in the sense of a year in the Vājasaneyi and Rk Samhitās. The following mantras may be cited in this respect:—

तेषां आधिक्षिकतामृतम् लोकं ज्ञातः समां: ॥ वा. सं. १६. ५६.
कुर्बन्धेवेःकर्मणि ज्ञेभवेति श्रतं समां: ॥ वा. सं. ०. ४०. २.
समानं मास आकृतिः ॥ क्रं. सं. १०. ५५. ५.

Months were Lunar

It was but natural that in the Vedic age the months were lunar, and it is needless to give here any quotations in support of this. Some of them will be given when the study of the ‘month’ would be exclusively taken up. The term ‘Pūrṇamāsi’ which is applied to full moon days and which literally means “the tithi on which the month ends” is well known. It has already been pointed out that the term ‘māsa’ which was originally a synonym for the moon was later applied to the time-unit of a month. No convenient means is available for measuring a solar month like the lunar one, which is naturally measured by the moon. The measure of a solar month can generally be known only by calculations. Therefore, it is clear that at the beginning man must have adopted the lunar month for their use and that the solar month came into being afterwards.

The Year was Solar

The first impression would be that because the months* were lunar, the year also must have been lunar. It is, therefore, to be considered whether the year was a lunar or a solar one; and if solar, whether it was sidereal or tropical. The following quotations clearly mention the measure of a year in terms of days or months.

वेदात्मको घृततत्तो द्वावय प्रजावतः ॥ वेदाय उपजायते.
क्रं. सं. १. २५. ५.

“Dhṛtavrata (Varuṇa) knows the twelve months; (and) the animals created during that period; (and) he knows (the intercalary month) which is created (near the twelve months)”—Rk Samhitā.

Although the word ‘intercalary’ has not been explicitly stated here, it is clear from the context that the intercalary month is intended and this ‘Re’ is rendered in this very sense traditionally. The western scholars also accept this sense. That the year commonly consists of twelve months has been clearly stated in this Re.

द्वावयं नाहितज्ञकै वर्षं च चक्रे बारिष्ठेत्तथ ॥
आ पुष्या अन्ये मिथुनाः अन्त्र सत्य शतानि विंशतिः तथः ॥
क्रं. सं. १. १५४. २२.

*This statement may appear vague, because only the term ‘year’ is under consideration here. A study of the civil, lunar and solar months will be taken up later.
"The wheel (of time) having twelve spokes revolve round the heavens, but it does not wear out. Oh Agni! 720 pairs of sons ride this wheel"—Rk. Samhitā.

"Twelve spoke-boards, one wheel, three navels. Who understands these? In these there are 360 Saṅkus (rods) put in like pegs which do not get loosened"—Rk. Samhitā.

It is clear that this curious description refers to the year, the 12 months are the twelve spokes of the wheel and the 360 days are the 360 nails. 'The day and night' is a couple and 360 such couples give the number 720.

"Oh Soma (Juice)! You are taken in by the ‘upayāma’ (i.e. a dish, a pāṇ). You are Madhu, you are Mādhava, you are Śukra, etc."—Taittirīya, Samhitā.

This gives the following names of the twelve months; Madhu, Mādhava, Śukra, Śuci, Nabhas, Nabhasya, Iṣa, Úrja, Sahas, Sahasya, Tapas and Tapasya. It also gives Samsarpa as the name of the intercalary month. Mādhava-cārya, while commenting on the above lines, observes that the word Amhaspaṭi means the suppressed or decayed month.

"Madhu and Mādhava are the (two) months* of spring; Śukra and Śuci of summer; Nabhas and Nabhasya of the rainy season; Iṣa and Úrja of autumn; Sahas and Sahasya of late autumn; and Tapas and Tapasya of sisira (winter)—Taittirīya Samhitā."

*The word ‘Rtu’ appears to have been used in sense of a ‘month’ in the original.
"One should remain consecrated for six nights, because there are six seasons in a year........... Consecration should be observed for twelve nights because there are twelve months in a year........... Consecration should last for 13 nights because the year has 13 months* etc.”—Taittirīya Saṁhitā.

It has 360 ‘Stotriyas’ because the year has so many nights.”—Taittirīya Saṁhitā.

"(Oh Ritugraha !) You have been adopted by ‘Upayāma’ (i.e. a dish)[for the Madhu............."]—Vājasaneyī Saṁhitā.

Some of the lines quoted from Taittirīya Saṁhitā (1·4·14) are almost similar to those given above. These contain similar names of the twelve months of the year, viz., Madhu, Mādhava, etc., but the last verse names the thirteenth month as ‘Aṁhaspati’.

The quotations “Madhusca Mādhavasca.............” from Taittirīya Saṁhitā are found in Vājasaneyī Saṁhitā also (see 13·25, 14·6, 15·16, 27 and 15·57).

The translation of the above passage has been partly omitted in the text because it is not necessary for explaining the point. It is now given in full below.

*One should remain consecrated for 15 nights. Half a month has 15 nights. A year is made up of half-months. Remain consecrated for 24 nights, because 24 half-months make a year. Remain consecrated for 30 nights, because thirty Akṣaras make the Virāt. One should remain consecrated for a month because a month is a year”. Here a distinction is made between 30 days and a month. Similarly, looking to the reasons put forward for the observance of a period of a particular number of nights, one would expect the author to recommend the adoption of a period of 30 nights, on the plea that a month consists of 30 nights, but it is not so stated. Hence it appears beyond doubt that in the Vedic age, the lunar month was known to be slightly shorter than the period of thirty Śāvana (civil) days.

2 DGO/59
The above lines first give the terms *Samarspa, Malimluca* (now usually given as a synonym for the intercalary month) followed by Madhu and other names of 12 months, and then comes the thirteenth name ‘Amhaspati’. This shows that *Samarspa, Malimluca* and *Amhaspati* must have some differences in their meanings.

"They purchased ‘Soma’ juice from the thirteenth month, and hence the thirteenth month is censurable".—*Aitareya Brāhmaṇa*.

"A year has 360 days, a year has 720 days and nights together".

"Should the reins in a horse-sacrifice be twelve cubits in length or thirteen? The year consisting of (six) seasons is a kind of bullock whose hunch is the thirteenth month. The horse-sacrifice is the best of all sacrifices. The year in the form of a bullock has got a hunch (in the form of the 13th month)".—*Aitareya Brāhmaṇa*.

It is clear from the above quotations that the year was solar in the Vedic age. The natural means of measuring a year used to be one complete cycle of seasons, just as the natural means of measuring a day was the period between two consecutive sunrises or that for measuring a month used to be the period between two full moons. The year as a unit of time could not have come into existence if seasons were not to exist. It is, therefore, obvious that the year must have been solar. During the earliest stages of observation, the seasons were naturally supposed to recur after 12 lunar months. Although, one complete cycle of seasons required 11 days more than 12 lunar months, it must have been difficult to guess this correct measure in the beginning and one year must have been supposed to consist of 12 lunar months for a considerable period of time. As a result of this supposition, however, the month which used to fall in summer must have shifted to occur in winter and later on in the rainy season and thus have gradually receded through all the seasons. Every month of that calendar, like the Muharram of the Muslims, was bound to pass through all the seasons, thus completing a revolution in 33 years. After the passage of several such cycles of 33 years, it must possibly have occurred to people to insert an intercalary month; and the fact that such an intercalary month used to be reckoned in the Vedic times goes to prove that the year was solar in those days. This may appear very trivial today, but it certainly was no ordinary matter that our people conceived the idea of inserting an intercalary month in those days of hoary antiquity. As a matter of fact it is extremely significant."
The ancient Romans who at one time were a very powerful nation used to regard a year as consisting of 10 months for quite a long time. Some of those parts of the Vedas which contain references to intercalary months were compiled before 1500 B. C. Even European scholars accept this view. The reference to intercalary months has not been made in such passages as a matter of special or unusual interest. It, therefore, appears that the idea had become a matter of common experience long before that time.

Now there is no clue to find out the number of months that used to lapse before the intercalary month was inserted. According to the current practice an intercalary month is inserted after about 32 or 33 months by mean reckoning. The figure would vary by a month or two if true motions are taken. Even then it occurs after 32 or 33 months on an average. It used to occur after 30 months according to the Vedāṅga Jyotiṣa. It is not known after how many months an intercalary month used to occur in the Vedic age. However, there must have been some rule for this.

The terms ‘Malimluca’, ‘Saṁsarpā’ and ‘Āmhaspati’ occur in the lines quoted above. The following lines show that the intercalary month is known as ‘Malimluca’.

रेवणां संवितो मासवचां: स्वातो मलिम्लुचः

—व्यास:

“The lunar month which is skipped over by the sun is known as Malimluca”

—Vyāsa.

सास्त्रे वर्णकेतारिः संक्षेपाधिक्यस्वत्वमां मलिम्लुचः शुहोष्यः

—भौगोलिक.

“When the sun is found to cross only one Rāśi in two months the former is called the Malimluca and the latter the Śuddha or proper”—Maitreya Sūtra.

The terms Saṁsarpā and Āmhaspati are defined as:

असंक्षेपाधिक्यस्वत्वमां संपर्यहस्यतो समी

—नारदसौहित्य.

This shows that the Asamkrānti or intercalary month was called ‘Saṁsarpā’ and the Dvisamkrānti or missing month as ‘Āmhaspati’.

The author of Muhūrta Cintāmaṇi has, in Chapter I, verse 47, described the characteristics of the above two months as follows:—

‘When missing month occurs, two intercalary months also occur in that year. The one preceding it is to be known as Saṁsarpā and the one following it as Āmhaspati’. It is not known if the terms carried some such meaning in the Vedic age.

It has been shown that the year was solar. Whether it was tropical solar or sidereal solar will be considered later on.

THE MEASURES OF SĀVANA LUNAR AND SOLAR YEARS

Let us see whether any kind of year other than the solar was in use. Out of the five astronomical measures of time viz. Sāvana (sacrificial), lunar, solar, sidereal and Jovian, no description of either the sidereal or the Jovian year is found in clear or even in implicit terms in the Vedic literature. The remaining three terms will now be considered.
The period between two consecutive sunrises is known as Sāvana day. The term Sāvana has its origin in the ‘Soma-sacrifice’. In a ‘soma sacrifice’ the ‘soma’ juice has three ‘savanas’ i.e., it is offered three times during the period of ‘a day and a night’. This idea is expressed by Mādhavaśārvikā Ṛṣi in his work ‘Kāla Mādhava’ as follows:

Therefore, that which pertains to ‘savana’ is sāvana, that pertaining to ‘candra’ (moon) is cāndra and that which pertains to the sun is ‘saura’ (i.e. solar).

The soma-sacrifice which is completed in one day of 24 hours is known as ‘aha’ in the Vedas (and it appears that the day also used to be known as ‘aha’). A group of such six ‘aha’s is known as ‘śadaha’ and five such śadhahas make a ‘māsa’ or a month. Several such śadhahas and māsas are required to be observed in a samvaṭsara-satra i.e. an annual sacrifice; and all of them together make 360 days. (In addition to these, the viṣuvān or equinoctial day falls in the midst of these days.) Mādhavaśārvikā Ṛṣi says:—

This and other similar quotations go to show that the ‘Sāvana’ year was in use for sacrificial purposes; and it must have been in use in day to day affairs, for it was easier to measure it than the solar or the lunar year.

It has already been shown on page 17 that the months were lunar; consequently a lunar year also must have been in vogue. Its congruence with the solar year, however, used to be made up by the insertion of an intercalary month.

It seems to have come to notice that the lunar year did not consist of 360 days but was somewhat shorter.

Proofs have already been adduced (see foot-note on page 19) in support of the argument that a lunar month was noticed to be not exactly equal to 30 days. There is a sacrifice known as Utsargināmayana which is another form of Gavāmayana sacrifice. A stanza from the Taṁtiriya Samhitā relating to it quotes the line.

meaning “a day is omitted after some sadahas and māsas are observed”. It indicates the circumstances under which a day is to be omitted during the period when a sacrifice continues. Because a lunar month is equivalent to 29 ½ days, two such months would be equivalent to 59 days. Therefore, if a ‘śadaha’ sacrifice is commenced on the first day of a lunar month, the second lunar month would end one day earlier than the completion of two sacrificial months (i.e. 60 days). The sacrificial priests, after actually noticing this discrepancy, must have felt the need for omitting* one day from one

*Mādhavaśārvikā Ṛṣi writes about this ‘omission’ in Kālamādhava:—

द्वादशाश्वस्त्रहस्तुप्रतीत्र वेयहस्त्रहस्तु द्वितिये च द्वितियेऽस्य

(भारतवर्गमानसारतु संपाद्यायसूचनिति वैशालिनी

(अभावस्ययामानसारतु संपाद्यायसूचनिति...)

उच्चते।
of the *sadahas* and this must have resulted in the introduction of the *utsargināmāyahana* sacrifice.

The reason for omitting a day has been given in the *Tāṇḍya Brāhmaṇa* as follows:—

**Yatha vam ṛtirāpmaḥ evaṁ sarōnuṣūṭ:***

तौः. ब्रा. ५. १०. २.

"If a day is not omitted the year will swell like the bellows made of leather".

The line *'utsṛjiyāṁ notsṛjiyā' given in the stanza following the one in which the lines quoted above occur shows that the Brahmapādins held deliberations for several days on the question as to whether to omit a day or not, and it was but natural that it so happened. It can not, however, be clearly understood as to how many days used to be left out during a year; still the idea that a lunar year consisting of 12 lunar months was shorter than 360 days was no doubt prominent in it. In short it may be stated that the civil, the lunar and the solar years were in vogue in the Vedic age.

**THE AYANAS**

Let us now consider the *ayanas*. *Ayanas* are two — the *Uttarayāṇa* and the *Dakṣināyana*. There appear to be two views regarding the period of time to be indicated by them and the sun’s position at those times. The authors of Siddhāntic Astronomy are, however, unequivocal on this point. The two terms have clearly been defined by them, *viz.*, the period of the sun’s movement from the beginning of Capricornus to that of Cancer is known as *Udāgāyana* and that from Cancer to Capricornus as the *Dakṣināyana*. If the sun be observed on any consecutive four or five days during Udāgāyana at the time of rising or at any other fixed time, it would every day be found at a point shifted to the north as compared with its position on the preceding day, irrespective of whether the sun is at the north or south of the celestial equator. During Dakṣināyana the sun is found to be moving from north to south. According to some writers Udāgāyana in the northern hemisphere is the period from the beginning of *Śiśira* to the end of *Grīṣma*, and according to some others it is from the middle of *Hemanta* to the middle of *Grīṣma*. The above astronomical meaning of Udāgāyana has generally been accepted in all modern works, but the word *’ayana’* appears to have been carrying a different sense in early days. *Satapatha Brāhmaṇa* contains the following:—

**वसंतो ग्रीष्मो वर्षः। ते देवा ऋतवः सर्वग्रंः: विभिन्नस्ते पितरो......स (सूर्यः) यन्त्रोवचवल्लं।**

देवेषु तह्ः भवति......यत्र दक्षिणावल्लं पितरुः तह्ः भवति.

शत. ब्रा. २. १. ३.

The words Udāgāyana and Dakṣināyana have not been explicitly used here, but it is simply stated that the sun is said to be entering the region of gods when it turns north and the spring, summer and the rainy seasons
are stated to be the seasons belonging to the gods. It, therefore, appears that the interpretation in vogue was that Udāgāyana denoted the period during which the sun kept to the north of equator, and Dakṣiṇāyana, the one during which it kept to the south.

Some astronomical Śaṃhitā works appear to use the term ‘ayanas’ in this very sense, for they speak of the Udāgāyana as the day of the gods; and to the gods residing on the Mount Meru, the sun in its northward course is continuously visible for six months, which shows that the term Udāgāyana is to be applied to the continuous position of the sun to the north of the equator. The Bhāgavata also gives the same meaning.

तत्साहार्थः बध्मानो बिच्छिन्नेनाति एष्टुतरेण
तृतीयः ६. ५. ३.

In the above line of Taittirīya Saṃhitā it has been stated that the sun moves towards the south for six months, and towards the north for another six months. An extract from Nirukta regarding the progress of the soul after death has been quoted in the succeeding pages (see paragraph on Niruka infra) and it refers to the sun’s northward and southward motion. A similar description is found in most of the Upaniṣads, but it is all in a general sense. With the exception of the above quotation from the Śatapatha Brāhmaṇa, nowhere in the Vedas any reference has been found that clearly shows what measure of time was denoted by the word ‘ayana’. The words Udāgāyana and Uttarāyana occur in the Maitrāyaṇi-Upaniṣad and in the following lines from the Nārāyaṇa Upaniṣad (anuvāk 80).

य..........उदयेने प्रसीयते वेदानांवेदां महिमां प्रवर्त्तितुम् वर्षाधिवास्यं साप्त्यं ग्रहयो दक्षिणे प्रसीयते
पितृवा पितृवम् महिमां गतवा चन्द्रमस साप्त्यंयस्यं दृष्टान्तावतामानोति.

नारायण उपनि. अनु. ८०.

Excepting these two works, all others have generally used the words Devayāna and Devaloka for Udāgāyana, and Pīṇyāna and Pīṭholaka for Dakṣiṇāyana. Nothing can definitely be said as to whether these words carried the same meaning as the word ‘ayana’ in the Śatapatha Brāhmaṇa or whether it was used also in the other sense in some other places, and as to which of the two was more ancient and when the other sense came into vogue. There is, however, no ambiguity about the interpretation of the ayanas as given by the astronomical works as quoted above, and this is found in all works on astronomy and is generally accepted at present.

SEASONS

Let us now consider the question of seasons. This has already been partially discussed above.

The names of seasons like Śarad and Hemanta occur at many places in Rk Saṃhitā. The word ‘Rtu’, however, does not occur by itself as frequently in the Rk Saṃhitā, as it does in both the schools of Yajurveda and Bāhyās Brāhmaṇa. The Rigveda Saṃhitā does not on the whole appear to attach much importance to the seasons. The 28th and 29th sections of the 3rd chapter of the 5th aṣṭakā of Rk-Saṃhitā give about 50 to 60 sentences
in which prayers to gods like ‘Śaṁ na Indrāgni bhavatāṁ’ meaning ‘may gods Indra and Agni bless us’ are found but nowhere is found a single sentence to the effect that the year, seasons, months and nakṣatras may bless one. One would expect to find in an equal number of stanzas in the Yajurveda at least some stanzas devoted to prayers to seasons.

Number of Seasons

Excepting the Rākṣamhītā all other Vedic works mention six as the number of seasons at various places, and at many of these places the names of all the seasons have been mentioned collectively (see Tai. Saṁ. 4. 3. 2; 5. 6. 23; 7. 5. 14; etc. Some of the places have already been pointed out above).

At several places however it is stated that the seasons are five in number: for instance,

पंचशास्त्रोपन यजेत II pancha va śratva: sambhavat:

तै. व्र. २. ७. १०.

“Sacrifice should be performed in five Śāraddiyas (i.e. seasons)............. because a year has 5 seasons”. Since the year was supposed to have five seasons, it seems that Hemanta and Śīśira formed one season. The following line may be seen for this purpose.

हायासासास: panchatvāḥ hamsatigiravāḥ: samsāsā.

ए. व्र. १. १.

“Twelve months comprise five seasons of which Hemanta and Śīśira together form one”.

Even from the Taśitśrīya Saṁhitā, Taśitśrīya Brāhmaṇa and Śatapatha Brāhmaṇa it is seen that when the year was supposed to have five seasons, Hemanta and Śīśira were taken together to form one. Even Mādhavaśācyāra observes (under ‘determination of seasons’ in Kāla Mādhava) that in such cases the season of Śīśira should be included in Hemanta and cites authorities in support of his argument. In some rare places (see Śatapatha Brāhmaṇa 3. 4. 4. 17.) the seasons are said to be three in number.

The First Season

In the Vedas, wherever all the six seasons are mentioned collectively, they are found to begin with Spring. In addition there are explicit statements that Spring is the chief season, e.g.

पुष्च वा एतवृत्तम् II yahsanāt: II

तै. व्र. १. २. ६, ७.

“Spring is the mouth of the seasons.”

तस्य ते (संवरसस्त) वस्त्रम: शिर: II pūjyām bhūskram: pah: II yvar: II pùḻyān II śarvār: pah: II hamsatī māthya II

तै. व्र. ३. १०. ४. १.
"The spring is the head (of the year); the summer is the right wing; the monsoon forms the tail; autumn the left wing, and winter the central part."

Similar statements are found at two more places. Here Hemanta is stated to be the middle of the year, and the rainy season its tail.

If the year be compared to a bird, the following chart would correctly represent the position stated above;

(Mouth)  
**Spring**

(Left wing)  
**Autumn**

(Belly)  
**Winter**

(Right wing)  
**Summer**

(Tail)  
**Monsoon**

**Commencement of Seasons**

हस्सकृतिमुखमूल्यपात्र भवति कोरहि तदेव यदुतुत्तम भुक्तः

त्स. सं ६. ५. ३.

"Two faced is the vessel of seasons; who knows which one is the mouth of the seasons?"

This remark seems to suggest that none can know when a particular season commences. And that is correct. The seasons depend upon the sun's position. If in a certain year a solar month begins, say, simultaneously with a lunar month, it would in the following year commence from the 12th day of the light half and in the subsequent year from the 8th day of the dark half. Therefore, the commencement of a season with respect to the tithi is irregular. Not only this, but it is somewhat irregular with respect to the sidereal solar month also. At present rains start within 4 or 5 days of either ahead or after the beginning of the nirayana Mrga nakṣatra. The commencing day of a season varies from place to place also; it is, of course, obvious that the variation would be about five to ten days; still it was but natural for the ancients to express their thoughts as in the above quotation.

It would be very difficult to obtain an accurate knowledge of the transition moments of two half-months or those of the seasons in the absence of an accurate knowledge of the motions of the luminaries and of the means of measuring time. The following myth will show how difficult it was for the primitive man to note the ending moments of the full moon and the new moon as also the ending of one season and the beginning of the next.

प्रजापतिः हे प्रजा: सूर्यनाथ रात्रि विस्त्रीय गः स व सद्रस्तर एव प्रजापतितस्तन्तयतानि

प्राणियोहरारिणानि: संधी गोयालमात्री वामाबाहु चतुर्दशमिः सं ३५. ११ स किलकते: पवित्रम् ११

न प्रजापतीसहूः तमेत्रेविश्वसे वा अभिव्यक्तिः होक्रेवाहारिणानि: संधी तथ्यावस्थस्तन्त्रश्च

समवधु: पौर्णमिण चामाबाहुस्त्र च पौर्णादिति चामाबाहुस्त्र तथ्यावस्थस्तन्त्रश्च

हर्षार्थार्थेत्रेवतु मुक्ति तत्यावस्थस्तन्त्रश्च

तत्र: श्र्त्रो १. ६. ३.
“After mankind was created by Prajāpati, his parvas (knuckles) became loose. The samvatsara (year) itself represented the Prajāpati. The two ‘points’ of day and night i.e. twilight, the full moon and the new moon, and the commencement of seasons—these are his parvas. The gods diagnosed the disorder. They cured the ‘joints’ of day and night and set them in their correct places by maintenance of agnihotras (sacred fires). The full and the new moons were correctly adjusted by the Paurnamāṣeṣṭi and Darśeṣṭi and the ‘joints’ of the seasons were set right by means of the ‘Cāturmāṣyayajña’ (i.e. four monthly sacrifices)’.

This story points to some kind of the association of the knowledge of time with the sacrificial system.

THE MONTHS

Let us now consider the question of the month. It has already been dealt with at some length in the course of the discussion under the heading ‘The Year’. Madhu and other names of months have already appeared in the foregoing discussion. In addition to this, some more names are found in Taittiriya Brāhmaṇa and they are now being given in the following quotations which include some different names of seasons and half-months also:

अध यदाह || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || एव एव ततो ||
एव होवे तेषामाना || एव मासा || अध यदाह || अरिन्दमास उद्धोप्यानडंडत || प्रजापति:
संवसर हि ति || एव एव ततो || एषःहेवे ते यस्यक्रमे || एव अष्टव || एव संवसर: ||

तं. ब्र. ३. १०. ६.

The half-months referred to above are given in the following list. These are the names of the 24 half-months occurring in one year:

1. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
2. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
3. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
4. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
5. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
6. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
7. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि
8. जावक || पवित्रपन पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि दिति || यस्याः पवित्रितपनसहस्त्रानसहस्त्राश्चर्यपञ्चाणिः हि

These are the names of 24 half-months occurring in a year.

Following is the list of names of months,

1. अशोक || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि ||
2. अशोक || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि ||
3. अशोक || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि ||
4. अशोक || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि ||
5. अशोक || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि || अशोकेऽपि ||

It contains 13 names, apparently including that of the intercalary month.

अरिन्दमास: सुवधा इत्यादिचाम्ब्रमा अशु: ||

तं. ब्र. ३. १०. ६.
This appears to be the list of six seasons. It may possibly be interpreted as the three seasons (of the year) viz., Agni (Fire), Sūrya (The Sun) and Candramā (The Moon).

At the end, the ‘saṃvatsara’ (year) is declared to be representing the Prajāpati in the following:

\[
\text{प्रजापति: संवत्सर महास्त:} \\
\text{तैं भव. ३. १०. १.}
\]

**Names of Months**

(Madhvādi and Caitrādi systems)

It can clearly be seen that the Madhvādi and Aruṇādi systems of names have a close association with the seasons and not with the nakṣatras. These names are not found in the Rigveda Saṃhitā, But the Brāhmaṇic works of the Aitareya, the Taittirīya and the Vājasaneyi Saṃhitās appear to attach considerable importance to Madhu and other names. In these works, however, one does not come across terms like Caitrī etc., involving nakṣatras and having for their derivations such definitions as these:

(i) That the full moon day on which the moon becomes full near the star Citarā (Spica) is to be termed Caitrī-Pūrṇimā, and

(ii) That lunar month in which the Caitrī-Pūrṇimā occurs, is termed Caitra.

To come to know that the moon always becomes full near particular nakṣatras is the first stage; that introduction of names like Caitrī, Vaiśākhī, etc. for these full-moon nights after a lapse of time is the second stage and the third stage is the establishment of a complete nomenclature to start with, as being governed by the rule “Sāśmin Pauniṣamasiti” (Pāṇini 4-2-21) meaning “it is so called, because the full moon night of that name falls in that month”. The names of nakṣatras are found in all the above mentioned Vedas at many places; but it is only at two places that the moon has been explicitly mentioned as becoming full near a star. The passages are quoted below.

These occur in the following stanzas from Taittirīya Saṃhitā, which also contains references to time-units in the discussion of the problem, regarding the time when one should consecrate oneself for the annual sacrifice known as ‘Gavā-mayana’ and that is why it is quoted here in full.
"Those who are desirous of performing a ‘saṃvatsara’ (yearly) sacrifice should consecrate themselves on the Ekāṣṭakā tithi. The Ekāṣṭakā is the wife of the saṃvatsara himself. He dwells with her on that night. Hence, such people (as are consecrated on the Ekāṣṭakā Tithi) are taken as consecrated in the very beginning of the year.

Those who become consecrated on the Ekāṣṭakā day get ‘consecrated’ against the troubles of the year. Their seasons bear the names of last two seasons. Those who consecrate themselves on the Ekāṣṭakā day become consecrated against the ‘confusions’ of the year. The year becomes disintegrated for them. Their seasons bear the last two names of the list. One should get consecrated on the full moon day of the Phālguna, because Phālguna full moon is the ‘mouth’ of the year. Hence, (such people) are taken as consecrated from the very beginning of the year. But such people have to accept one ‘nirāya’ (draw back) viz. that the ‘Viṣuvān’ (equinox) occurs in the cloudy season (sānmedhya). Hence, one should consecrate in the Citrā-full-moon day. The Citrā-full-moon day is the ‘mouth’ of the year. Hence, those (who commence their sacrifice on this day) are said to be consecrated from the ‘mouth’ of the year. This involves no drawback. One should pass through consecration on the 4th day before the full moon day, thereby, they secure the kṛaya i.e. the purchase of soma juice. Thereby they avoid making the Ekāṣṭakā fruitless. They secure the occasion for extracting the soma juice in the ‘former half-month’ and secure the proper position of the half-month and the months also. They rise in the former half-month and the herbs and trees grow after them. They (i.e. sacrificers) get fame as prosperous persons and consequently all prosper”.

This passage also occurs in the Tāṇḍya Brāhmaṇa (5.9) of Śāma Veda. It, however, contains a few different words and one or two different sentences*.

The words ‘Phālguna Pūṇamāsa’ and ‘Citrā Pūrnamāsa’ occur in the above passage. They only mean the full moon nights associated with the stars Phālguna and Citrā. It should be noted that neither the words Phālguna and Caitra nor the terms Phālguna and Caitra occur therein.

*The Tāṇḍya Brāhmaṇa mentions one more draw back of the Ekāṣṭakā in the words “aponaḥbhinandantobyavayaṇi”, meaning the sacrificers do not salute water before taking on “avabhiritva” bath and the word “sānmedha”, which has been used for sānmedhya, renders it as “on a cloudy day”.

The Vedic Period

क्ष: संपत्ते तेनेकाल्पकां न छब्दु कुर्विति तेषां ॥२॥ पूर्वंशं गुर्या संपत्ते पूर्वपंशं समा अभिसंपत्ते ते पूर्वपंशं उत्तिर्धित स्तन्त्रस्वते अववहिर्म्यो वनस्यतोन्तिद्विति तत् क्षण्या कोकिर्निख्यीथरासुरुप्रमेयात्रात्म प्रजामा हित तदनु सवे राजुविति ॥

तै. प. ६. ७. १.
“Fire should not be kindled on the Pūrva Phalguni nights;” (since) Pūrva Phalguni is the last night of the year. It should be kindled on the Uttara Phalguni. This is the first night of the year.”

Although the word ‘full moon night’ is not explicitly mentioned here, still the full moon night when the Pūrva Phalguni stars come together with the full moon, appears to be implied in it. That the moon becomes full near the Phalguni nakṣatra is the idea suggested by these words. However, not only the word Phalguni does not occur in it, but even the word “Phalguni-purnamāsa” does not occur in it as it does in the lines quoted above from the Saṁhitā.

The above lines show that the phenomenon of the moon becoming full near certain stars had been noticed in the times of Taittirīyā Saṁhitā and Brāhmaṇa. Still it must be remembered that the names Caitra etc., had definitely not come into vogue in those times.

The words “Phalguni Purnamāsi” occur in this. Even the Sāṅkhya-yāna Brāhmaṇa (which the author has not seen) is said to contain the following line:—

Any way, the word ‘Phalguni’ occurring in all these quotations only means “associated with the Phalguni star”. The words ‘Phalguni Pūrṇamāsi’ occurring in Satapatha Brāhmaṇa (2-6-3) has been defined by Sāyanācārya as “that full moon night which becomes associated with the two Phalguni asterisms is known as the Phalguni”. The Sāmavidhāna Brāhmaṇa (2.4) contains the line,

In this ‘Rauhini’ simply means “associated with Rohini star”, it has nothing to do with the ‘Rauhina’ month. Similarly, the Pauṣi, the Phalguni, etc., stand for those full moon nights which are associated with the stars of corresponding names. In short, it can be said that only the terms ‘Phalguni’ etc., had come into vogue at the time when Brāhmaṇa works were compiled. Nowhere in the Saṁhitā and Brāhmaṇa do the words Phalguna, Caitra, etc., occur in the sense of names of months, and this shows that these terms were not then in vogue. Much time must necessarily have elapsed before the term Phalguna, Caitra etc., came into vogue, even when the terms Phalguni, etc., had gained currency. This point can be easily understood if one considers as to how long a time has to elapse before a scientific theory becomes an established truth.

In short, the terms Caitra, etc., were not in vogue in the Saṁhitā and Brāhmaṇa period. Thus it can be proved from the historical point of view that these terms came into use after a very long period of time after the terms Madhu, etc., became current.
The Vedic Period

It will now be shown that even the Nature works in the same order of development.

In the beginning, man must have been guided by the moon for counting the months; and the cluster of stars situated in the path through which the sun and the moon are generally seen to move, must have received the names of 27 stars. But the position of the stars remains practically constant in relation to the ecliptic and, therefore, even after the names Madhu, etc., had come into vogue and the 27 nakṣatras had received special names, a considerable period of time must have elapsed; firstly, before it was minutely observed that the moon moves through particular groups of stars and that it becomes full near some of them and secondly, before the terms (Caitrī, Paurnīmā, etc.,) came into vogue on the basis of that observation and thirdly, the terms Caitra etc., finally arose therefrom and became current as the names of months.

For instance, the star Aldebaran (Rohini) lies about 5½° to the south of the ecliptic and must have remained in that position for thousands of years, but the moon does not move exactly on the ecliptic. It attains a position with maximum latitude of 5° to 5½° north or south of the ecliptic. Its path cuts the ecliptic. Had the points of intersection, that is, the moon’s nodes (Rāhu and Ketu) been stationary, its position relative to the stars, would have remained unchanged; but the nodes have got motion. They make a complete revolution in about 18½ years. It is on account of this that the moon and the star Rohini at times come together in the course of 18½ years. Sometimes the moon occults the star while sometimes it is seen to be at a distance of about 11° of latitude from it. The phenomenon of the moon sometimes occulting a star and sometimes remaining away from it at a latitude of about 11°, is no mean source of confusion in one’s attempt at detecting the rule about the occurrence of the full moon near the stars. It is in fact much more confusing and to add to this, there is another kind of minor confusion. For instance, during the period from September 1884 to March 1888, the moon regularly used to occult the star Rohini (Aldebaran), once in the course of every revolution and this phenomenon was observable at one place or the other on the earth. But it was not that every such occultation of Rohini occurring during the revolutions of the moon would be seen at a given place on the earth. This interesting phenomenon could be seen in our province only on 3 or 4 occasions. On other occasions this phenomenon used to take place sometimes by day or sometimes when the moon was below the horizon. On some occasions, the moon used to appear only at a very short distance from Rohini. Moreover, this position is not necessarily true in the case of all stars. In other words, the moon does not necessarily occupy a distance of ±5° maximum latitude from each star in each revolution of the node; for it sometimes comes very near to some stars and goes away from others; it moves via north in the case of some, and passes in a southerly direction in the case of others. Other kinds of confusion involved in perceiving this phenomenon of the full moon near the stars and formulating a rule about it are also worth noting.

For instance, if the moon becomes full near a particular star in the first month, it will become full again near the next second or third star in the

*This point cannot be fully discussed here. One can understand this by noting the moments of its conjunctions with the stars during any period of 5 to 7 years, as given in the tables on the lunar conjunctions with stars in the Śāyana almanac.
next month. The rule about the full moon’s proximity with certain stars would be easily discovered, if after the completion of 12 lunar months the moon becomes full near the same star in the second round of 12 months as in the first.

But it so happens that if it is found to be full near, say, Aśvinī, in the first month of the first round, it would appear to have become full near Revati in the first lunar month of the second round. It is also not true that the moon becomes full only near those 12 asterisms to which Caitra and other lunar months owe their origin. As a matter of fact, it becomes full near each of the 27 asterisms in some month or the other. There is still another difficulty; there are only four out of the 27 stars which do not fade but remain visible even when the full moon is in close proximity with them, and they are Maghā, Jyeṣṭhā, Citrā and Rohini. Some of the rest become invisible when the moon approaches them within a distance of 7° to 8° and there are still others which fade away in the moon’s lustre when it is still further away.

In short, it is obvious that long time must have elapsed before the rule about the moon’s becoming full near particular stars could be established after the asterisms received their names. The next stage was the application of the names Caitra, Vaiśākhī, etc., to the full moons, and the stage next to this was the naming of lunar months after the stars.

In short, it is proved, from the natural order of progress and from the historical point of view, that the terms Caitra etc. came into vogue when considerable time had elapsed after the introduction of names like Madhu, etc.

The Solar Months

References to the civil and lunar months are definitely found in the Vedas; but an explicit mention of solar months is not found anywhere in them. The solar month is the time which the sun takes to cross each of the 12 equal divisions of the ‘bhacakra’ (zodiac). Meṣa and other names of Rāśis are not found in the Vedas; but that is immaterial. But even a corresponding set of names for the 12 equal divisions of the ‘bhacakra’ are also not found anywhere. Now, it cannot be said for certain that Madhu-Mādhava given in the Vedas as names of months were not the names of solar months for, while their connotation indicates some relationship with the seasons, that is indirectly with the sun, they are also used as synonyms for the seasons (see page 18). We do not, however, find any statement that they ended on days other than the full moon or the new moon days. On the other hand, we find it definitely mentioned that months end either on the full moon day or the new moon day. Hence, these appear to be the names of lunar months or in other words of the months which end on full moon or new moon days. The year, however, was undoubtedly solar, hence why should it be considered improbable that solar months different in measure from lunar months were also in vogue? In all probability, they were in current use and there are grounds to believe that just as Madhu and other names were applied to lunar months they were equally applicable to solar months also.

The Amānta and Pūrṇimānta Months

Let us now see if the months were Pūrṇimānta or Amānta. That month which ends with Amāvasyā or the new moon is called Amānta and the one which ends in Pūrṇimā or the full moon is called Pūrṇimānta. Both these
modes of reckoning are found in the Vedas. That (night) on which the Māsa (month) becomes pūrna (full or complete) is Paurnamāsi. Hence, the very word Paurnamāsi indicates the Pūrṇimāṇa reckoning.

bhūya pūrṇamāsi shrutamupati vatrāmavakṣayaḥ ॥

तैं सं १ ६ ॥

"Religious vow is commenced with a sacrifice on the full moon day and with calves on the new moon day".

In this quotation the word coupled with ‘Amāvasyā’ is Pūrṇamāsa, which shows that the month used to become full on the Paurnamāsi day.

The following quotation from a stanza in “Utsargīnāmayana” shows that the months ended both on Amāvasyā and Pūrṇimā

अमावास्या मासांसपायाहस्तुञ्जति अमावास्या हि मासानु संपश्यति पौर्णमासया 
मासांसपायाहस्तुञ्जति पौर्णमासया हि मासांसपश्यति ॥

तैं सं ७ ५ ॥

The following lines immediately following the above stanza specially appear to favour the Pūrṇimāṇa system :

यो है पूर्ण आसंवलत परर स संवलत य: पूर्णावलत प्राणामस्तिस्तुञ्जति यवयोगमासया 
मासांसपायाहस्तुञ्जति सवसरायेव तत्त्वाण दश्यति तदनु सत्रिण: प्राणाम सदहस्तुञ्जूिध्यथा 
दृत्यवन्दो विपत्तेवं सवसरायं विपत्तेदातिमों पूर्णाबब्बोमासया मासानु संपायाहस्तुञ्जति

सवसरायेव तदुवां दश्यति तदनु सत्रिण उदशतिनि नारि पाणामासो यवयोगमासया 
मासांसपायाहस्तुञ्जति देवान्मेघ ताबाजन यथा प्रत्यवरोहितः ॥

तैं सं ७ ५ ॥

In the chapter on ‘Universe’ in the Atharvaśrutī, the description of the ‘Creation of Samvatsara’ is followed by these lines referring to the month and the half-month :

मासो वे प्रजायति: ॥ तस्य कृष्णपदे एवारं: शुक्ल: प्राण: ॥

"The month is verily the Prajāpati; its dark half is the Sun and the light half the Life (soul)."

In this, the dark half is mentioned first; this shows that the Pūrṇimāṇa system was in vogue. But the Taittirīya Brāhmaṇa gives the list of names of days in two halves of a month (see page 43); the list gives the names of days in the light half first and those in the dark half afterwards; this leads one to believe that even the amānta system was in use.

THE PŪRVA AND THE APARA HALF

If the Pūrṇimāṇa system be adopted, the dark half of the month comes first and the light half afterwards, and hence, the term 'pūrva' should have

*The Kalamādhava, after considering the doubts raised against these quotations, has given the verdict that these lines describe both the pūrṇimāṇa and the amānta systems,
been applied to the dark half and ‘apara’ to the light one; but it is not so. The ‘pūrva-apara’ terms are applied respectively to the light and the dark half.

पूर्वपक्षः हेवानष्टश्च अपरक्षस्मकयुतः। ततो देवा अभवन। परागुरः।
तै. ब्र. २. २. ३. १।

“Gods were born in the ‘pūrva-pakṣa’ and the demons (asuras) in the ‘apara-pakṣa’ that is why the gods won and demons were defeated.”

पूर्वपक्षस्विचलतयः। अपरपक्षः दूरीं।
तै. ब्र. ३. १०. ४. १।

“The pūrva-pakṣa is the girdle and the apara-pakṣa is the dirt”.

Although the terms light and dark are not explicitly mentioned, the fact that ‘Śukla’ indicates something auspicious and ‘KRṣṇa’ something inauspicious, one may presume that the term ‘Pūrvapakṣa’ stood for ‘Śukla’ and ‘apara’ for ‘KRṣṇa’. The names of the 15 days of each of the ‘Pūrva’ and ‘Apāra’ halves are given later on, and the terms ‘Pūrva’ and ‘Apāra’ have been used in the sense of ‘Śukla’ and ‘KRṣṇa’ in them. In the ‘Nirukta’ (11.6) it is said in the mantra concerning the moon,

नवो नवो भवति जातमन हिति पूर्वपक्षादिकमिश्रप्रस्थातां केतुबच्छानामिन्यप्रमि
ल्यापरपक्षंतवमधवस्थयं।

The word ‘Pūrvapakṣa’ has clearly been used in the sense of ‘Śukla-pakṣa’ and the ‘Apāra-pakṣa’ in the sense of ‘KRṣṇa-pakṣa’. The words ‘pūrvāpara’ are found used in this very sense in the post-Vedic works.

THE DAY

Let us now consider the civil day, the solar day and the lunar day (i.e. tīthi). The solar month does not explicitly occur in the Vedas and hence, it is clear that the solar day also was not in vogue. One expects the civil day to be mentioned in the Vedas and so it is. It is very convenient for civil purposes. Quotations have already been given showing that the sacrifices were performed with respect to civil days.

Names of Days

The Taittirīya Brāhmaṇa gives different names for the days and nights in the light and dark halves of the month. They are:

संस्त्रां विन्यां दशं कृत्तित। एतानुवाको पूर्वपक्षस्वयोहरात्राणां नाम वेयतत।
प्रत्स्तुत उद्धुरं हुतांहतातित। एतानुवाकायपर्णक्षपत्राणां नामवेचयत।
तै. ब्र. ३. १०. १।

The ‘anuvākś’ (stanzas) mentioned here are given in the same Brāhmaṇa in one ‘anuvāk’ at a different place. They are:

संस्त्रां विन्यां प्रत्स्त्रां जनान्वितिन्नत। संक्लयानां प्रक्लयानमपक्षमान्द्रुपक्षूक्तं २५०४।
श्रेयो वसीय आयतं संभृतं मृतं।
तै. ब्र. ३. १०. १।
These are the names of the days (excluding nights) of the ‘Pūrvatpakṣa’. They are 15 in number mentioned in groups of five in each line.

दशै दशाः दशाता बिहविन्या सुविन्यन् ॥ अयायायानां व्यायामानां प्याया सुन्तेरा ॥
आयूर्वेशाणा युतायाना पूर्वती पूर्वा पौर्णमाती ॥

ले ब्रा ३ १० १ २.

This is a list of the names of 15 nights of a ‘Pūrva-pakṣa’ which stands for the light half as is suggested by the word ‘Pūrṇamāṣī’ etc. occurring in it.

प्रसूतु विहविन्या संतुतुं कथाम किरिव्य तेजः समुद्र ॥
अर्थं भूतमाय मरीचिमदिवसरच्छत् तपस्वत् ॥

ले ब्रा ३ १ ० १ २.

These are the names of the 15 days in the ‘Apara-pakṣa’ or the dark half.

शुक्र शुक्यं प्रसूतु शुक्यायानाधिकुणयाना ॥ पीती प्रपह स्या तृतीतायतंयंती ॥
काँत ा काम्या कामातातयुज्माती कामुक्ता ॥

ले ब्रा ३ १ ० १ २ ३.

These are the names of the 15 nights in the dark half. The names of days given in the list are used in the neuter gender while those of nights are in the feminine. It appears that because the word ‘aha’ meaning “a day” has the neuter gender, the names of days are in neuter gender and because the word ‘rātri’ (night) is in the feminine, the names of nights are also in the feminine gender.

The above line gives “Kāmadughā” and not Amāvasyā, as the name of the last night of the dark half. The last night of the light half is however indicated by the word “Paurṇamāṣī” itself.

The above lines and the references at other places show that Paurṇamāṣī and Amāvasyā are the qualifying adjuncts of ‘night’ and not of ‘tithi’. The words amāvasyā and paurṇamāṣī occur quite frequently in the Taittiriya Saṁhitā and the word ‘tithi’ does not occur at all. Hence, the two words cannot possibly indicate a ‘tithi’.

TITHI

Nowhere in the Vedic literature the author came across the word ‘tithi’ in the sense of the 30th part of the lunar month or the time required by the moon to gain 12° of longitude on the sun. Even though the month is lunar, its 30th part will be shorter than the civil day, because its length is about 29½ civil days. Hence, the mean length of the tithi is shorter than a civil day and there is no easy and natural means to measure it, and on account of this we do not get in the Vedas either the true or the mean tithi in its modern sense.

The word tithi occurs in the Bahuvra Brāhmaṇa at some places and the definition of the tithi as given at one place is,

यां पयात्मितिद्वयं विद्याविरित सा तिथिः ॥

ऐ ब्रा ३२ १०.

“Tithi is that period of time during which the moon sets and rises again”.

The interval between two consecutive moonrises is longer than a civil day by about a “muhūrtā” (i.e., 48 minutes). The sun rises 29 or 30 times during a lunar month and the moon rises 28 or 29 times. Hence, 30 tithis according
to the above definition will never occur in a lunar month. We do not get this definition in other Vedas or post-Vedic literature. This shows that this definition was not much in vogue. It may be that the true import of the definition was different. In any case, the ‘tithi’ in the astronomical meaning and ‘pratipad’ and other tithis are found nowhere in the Vedas. But Pūrṇimā and Amāvasyā are denoted by the word ‘Pañcadaśī’ meaning 15th.

“Tātasaṃ abā ṣāğdruṣṭ. Ārya ṣā ṣāṅgadruṣṭaṃ bāṣṭ. Ārya ṣāṅgadruṣṭaṃ pūrṇimāḥ.

The month wanes on the Pañcadaśī night. (She) becomes full on the Pañcadaśī night”.

Since the term Pañcadaśī has occurred in the sense of ‘fifteenth’, other terms, such as Pratipad, Dvitiyā, etc., must have been in use to denote the first night, the second night etc. In the beginning, these must have been used to denote the nights and afterwards the tithis. The terms Kuśa Caturdasi, Kuśa Pañcamī, Sukla Caturdasi, have occurred in the Śaṁa Viṣṇuḷa Brahmaṇa (see 2, 6; 2, 8; 3, 3).

Aṣṭakā

We come across the term ‘aṣṭakā’ somewhat similar to amāvasyā and pūrṇimā. The following line may be seen:—


The full moon nights are twelve, the aṣṭakas are twelve, the new moon nights are twelve”.

A sentence similar in meaning is found even in the Śatapatāḥa Brahmaṇa (6.4.2.10). From this it appears that just as 12 full moons or 12 new moons occur in one year’s time, so also 12 aṣṭakas occur in one year. The number occurring during the year is said to be 12 and not 24. From this it appears that ‘aṣṭakā’ might be the term applied to the 8th night, either of the light half or of the dark half of the month. The word aṣṭakā comes after the word Pūrṇimā in the above line. It occurs similarly in the following line:—

Pūrṇimāḥ aṣṭakaḥ aṣṭakaḥ.

From this it seems that the 8th night in the dark half of the month must have been termed ‘aṣṭakā’. This has been explicitly stated in the Āśvalāyana and other Śūtras:—

“Tātasaṃ aṣṭakaḥ aṣṭakaḥ aṣṭakaḥ.

In this, the 8th night of the dark half is termed ‘ekāṣṭakā’. The Āpastaṃbha Śūtra applies the term ‘ekāṣṭakā’ to the 8th night after the Māghī Pūrṇimā.

Vyaṣṭakā and Uḍrṣṭa


The 8th night of the dark half is termed ‘ekāṣṭakā’. The Āpastaṃbha Śūtra applies the term ‘ekāṣṭakā’ to the 8th night after the Māghī Pūrṇimā.
These sentences occur also in the Tāṇḍya Brāhmaṇa (18.11.8). According to these lines ‘Vyaṣṭi-kā’ was the 1st night of the dark half of the month and Udṛṣṭa, the 1st night of the light half.

THE MOON’S PHASES

In the Vedas we come across the belief that the phases of the moon increase and decrease because they are drunk by the gods.

यश्व देव प्रियवति तत आप्यायसे पुन:। वायु: सोमव सचित्ता समानी मास आकृति: ।

“Oh Moon! The gods drink you, but later on you become bright again. The wind is the protector of the moon. Thou art the maker of soma (i.e. years), and of the months.”

This ‘richā’ is construed in the Nirukta, as applicable to the ‘soma’ plant as well as the moon.

यमादिश्या अंतुमाणयथावति यमकिस्तमलितय: पिबवति ।

“The suns make her bright, and when she is full, they drink (devour) her.”

The word sun is used here in the plural. It must have been so used to denote the 12 suns of the year. This shows that in the beginning it was perhaps the belief that it was the sun who brings about the increase or decrease of the phases. Afterwards when the word ‘aditya’ began to denote ‘gods’, the belief that gods devour the moon must have arisen.

MOON’S LIGHT

The following line states in clear terms that the moon receives light from the sun:

सूर्यरहस्यवचनम् गंधर्व: ॥

The moon is here spoken of as ‘Śūrya-raśmi’, that is the one who receives rays of light from the sun.

WHERE DOES THE MOON DWELL ON AMĀVASYĀ DAY

The following lines express the belief that the moon is seen nowhere in the sky on the new-moon night, because she comes to earth and enters the medicinal herbs.

सोमवास्यायं रात्रिनेत्या धोडःक्षा कलशा सर्वस्मिन्म प्राणभृतु विविधं तत: प्रात्तर्जयते ॥

The verse states that the moon is not visible on the night of the new moon. Afterward when the word ‘aditya’ began to denote ‘gods’, the belief that gods devour the moon must have arisen.

शत. ब्र. १. ६. ५.
The following line, however, states that the sun and the moon dwell together on the amāvasyā day:

चंद्रमा आमावस्यामिदद्वितीयमुपविशिष्टि...अवितमां चंद्रमा जायते।

ए. ब्र. ४०. ५।

"The moon enters the sun on the new moon day. The moon is (again) born of the sun".

The statement vīz. "the moon is born of the sun" refers to moon's reappearance in the evening of the 1st day of the light half.

DARŚA, PARVA, ANUMATI, etc.

The term 'darśa' is applied to amāvasyā and the term 'parva' is applied to 'amāvasyā' and 'pūrṇimā' both. Similarly the terms 'anumati' and 'rākā' are applied to full moon nights and 'sinivāli' and 'kuhū' to new moon nights. The terms 'rākā' and 'sinivāli' occur in Rk Samhītā (2.32). They might be denoting some deities also.

या पूर्णां पौर्णिमार्था तानुभवितात् तत्र राक्षसा या पूर्णिमावस्त्रया सा सनीवाली तौत-रात्री कुहुः।

ए. ब्र. ३२. १०. ७०. ब्र. ६. १०।

"The former (part of) full moon night is called 'Anumati', the latter is called 'Rākā', the former (part of) new moon night is 'Sinivāli' and the latter Kuhū."

This line appears in the Kaṭha branch of the Vedas also. The Nirukta observes:

सतेनावली सूक्ष्मिति देवपत्नी न्यायिति तैकवता अमावस्यार्थ सनीवालिकाः।

मिन. १६५. १०।

"According to Niruktas (etymologists) Sinivāli and Kuhū are the wives of gods; but according to the sacrificers they are simply new moon nights."

MOTIONS OF THE SUN AND THE MOON

The amāvasyā's and pūrṇimā's occupy an important place in the Vedic literature in respect of sacrifices. It was the sacrifices performed on the new moon and the full moon days which were, beyond doubt, responsible for such researches as were made in the Vedic age, as those relating to the motions of the luminaries but not described in the Vedic literature for want of suitable occasions—researches which gradually developed into the Vedāṅga Jyotiṣa. The Vedic conjunctions like 'Sandhau yajeta' or sandhimabhito yajeta (i.e. one should perform a sacrifice at or near the 'junction' of a parva) suggest that attempts must have been made to find out when the 'parva-sandhi' occurred and they must have attained some knowledge about it.

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*The Matsya and Vāyu Purāṇas speak of “darśa” as follows:

"Aśrītya tārāmāvāsāvīṃ pāśyatah susamāgatau. Anyonyam candrasāryan tāv yād taddarṣu ucyate" meaning when the Sun and the Moon meet and stay together on the Amāvasyā day and keep gazing at each other, that moment is termed ‘darśa’. This shows that the phenomenon of the moon and the sun coming together was well known to Purāṇas also."
THE VEDIC PERIOD

DAYS OF THE WEEK

The names of the seven days of the week are nowhere found in the Vedas. The general term ‘vāsara’ meaning ‘a day’ occurs at two places in the Rāk Samhita:

आदिश्रलस्य रेतसौ ज्योतिष्वर्यस्तिर वासरं ॥ परो यविध्यते बिवा ॥

च. सं. 6. 20.

“When god Indra shines in the heaven in the form of the sun, all people observe throughout the day the lustre of Indra in the form of the sun, who possesses an inexhaustible stock of water.”

Sāyanācārya has translated the word ‘vāsara’ as the ‘day’; he has also construed it as an adjective qualifying ‘jyotiḥ’ and rendered it in two ways as (i) nivāsakām (dwelling) and (ii) nivāsasya hetubhiṣṭam (becoming a cause for dwelling).

THE LENGTH OF THE DAY

The idea that the sun increases the length of the day, or in other words makes the length of the day variable, occurs in the following lines:

सोमराज्य प्रण अयूर्कु तारीरहातीस सूयां वासराणि ॥

च. सं. 2. 48. 7.

“Oh Somarāja! Increase the length of our lives just as the sun increases the length of days, which are vāsara (dwellings of the world).”

The word ‘vāsara’ occurring here is not used to denote a day.

THE EQUINOCTIAL DAY

One finds in the Vedas a good many references to the equinox. A passage already quoted (Page 28) from Taittiriya Samhītā relating to the annual sacrifice refers to the equinoxes. Other references to the equinoxes are given here, since these would be found useful in the study of the question regarding commencement of the year.

Here is a quaint description:

एकवर्षंवस्तवहर्ष्यति विषुवं मध्ये संवस्तरस्यान्ते वे देवा एकार्ववलोकितस्य स्वर्गम लोकैवोकर्ष्यंस एष एक एकवर्षंवस्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति एकाविश्वास्तवहर्ष्यति

"The ‘Ekaviṃśa’ (rite) is performed on the equinox day occurring in the middle of the year. This ‘Ekaviṃśa’ has helped the Āditya to ascend the heaven. This is the same Ekaviṃśa. It takes place ten days before the ‘divākīrta’ recitations and ten days after, and this Ekaviṃśa occupies the central place. This ‘Ekaviṃśa’ or Āditya being enclosed on two sides by ten (days) does not find any trouble while moving through this world. The gods apprehended that the sun might fall down. (They) balanced him by lending him a support of three heavens on this side. The three stomas (recited on the three ‘Śvarasāma’ days preceding the equinox) are themselves the three heavens. They (gods) again feared that he (sun) would fall down beyond, they again supported him by placing three more heavens on the other side. These three heavens are the (three) stomas (pertaining to the three days after the equinox). (On the whole) there are seventeen (stomas) on one side and three on the other and in the centre stands the Ekaviṃśa (Twenty-first)."

The Taittiriya Brāhmaṇa also gives a very similar description (see 1, 2, 4). In addition to the idea of the equinox occupying the central position, it contains other notions also relating to the sun’s high or low position in the sky.

"The ‘viṣuvān’ (equinox) is like the ‘puruṣa’; its former half corresponds to the right half of the ‘puruṣa’ and the latter half to the left half of the ‘puruṣa’. That is why the sacrifice which continues for six months after the equinoctial day is termed ‘uttara’ (i.e. latter). The viṣuvān is like the head of (a sitting man) having left and right arms of equal length”.

The Taittiriya Brāhmaṇa also gives a similar description in the following lines:

संततिर्व एते प्रहः । यत्वरः सामानः । बिसूष्वान्तः विषा कोरः ॥
यथा शालायं पक्षी ॥ एवंसंवस्तरस्य पक्षी ॥

ते. ब्रा. १. २. ३.

Here is something about an animal sacrifice. It states that the year, like a house, has two wings (or parts) and viṣuvān is the central portion.

Thus the word viṣuvān occurs at good many places, where it is said to be in the middle of the annual sacrifice or in the middle of ‘parassāman’ days which form part of it.

Nowhere in the Vedas do we find a reference explicitly defining viṣuvān as that day on which the day and night are of equal length. It simply means an interlude occurring in the course of the ‘sattra’ or ‘sadaḥas’, no matter whether the ‘sattra’ continued for the whole year or for only a few days (see the Tāṇḍya Brāhmaṇa 13.4.16 and the commentary thereon by Sāyaṇācārya). There are only two equinoctial days in the year on which the days and nights are of equal length, and if the annual sacrifice is commenced on one of them, the second equinox will come in the middle of the sacrifice (sattra).
PARTS OF THE DAY

Let us now see how the day was divided into parts according to the Vedas. The works on Dharma Śāstra (science of religion) describe systems in which the day, that is the period between sunrise and sunset, is divided into 2, 3, 4, 5 and 15 parts. The two divisions of the day are the ‘pūrvāhna’ (the former half) and the ‘aparāhna’ (the latter half); the three divisions are ‘pūrvāhna’, ‘madhyāhna’ (noon) and ‘aparāhna’. In the fourfold division each part is equal to a ‘prahara’ (a period of 3 hours), and are successively called ‘pūrvāhna’, ‘madhyāhna’, ‘aparāhna’ and ‘sāyāhna’ (evening). The five parts are named ‘prātaḥ’, ‘sangava’, ‘madhyāhna’, ‘aparāhna’ and ‘sāyāhna’; and lastly the day is also divided into 15 parts called ‘muhūrtā’. The first of these systems, which divides the day into two parts is a natural one and it was in vogue in the Vedic times. The following lines describe the system of three fold division.

“...”

The names of three out of five parts have been mentioned in the following ṛk.

Here the 3 parts, ‘prātaḥ, sangava and madhyāhna’ have been mentioned by name and hence all the five parts can be inferred from them.
This clearly gives the names of the five parts, viz., pṛtah, sangava, madhyāna, aparāhna and sāyāna.

Aṃḍitiṣṭhāvaḥ sarvāṅgḥ ṣaḍhakṣāryaḥ svaṃsiḥ svaṃsanyāsīḥ maṃayāṅgakṣāryaḥ hemakeraḥ.

\[ \text{शत. श्रा. २, २०, ३०, ६०.} \]

सत्त्वा उत्सर्जने हिंसद्राक्षोत संगत: प्रतिसत्त विभिन्न उदग्रास्यपरराशिः प्रतिरूपस्वतं यथनयत् क्रमे।

\[ \text{अष्ट. सं ६, ६४५.} \]

Here the names ‘sangava’, ‘madhyaṇḍina’, and ‘aparāhna’ do not seem to denote the parts of the day, but the transition moments of the four ‘praharas’ of the day.

Mādhava, in his work Kālamadha, while considering the five-fold division of the day, quotes the abovementioned anuvāk from Taittirīya Brāhmaṇa and observes that “the passage seems to describe the creation of the four systems of soma-sacrifice known as ‘agniṣṭoma’, ‘ukthya’ ‘śoḍaśi and ‘atirātra’ which are to be performed at the four transition moments in the five divisions of the day and remarks that the five-fold division of the day is found in many ‘sūrti’s and ‘sūrti’s. The line* ‘pradoṣānto homaśākālaḥ sangavaṇṭaḥ pṛtah’ occurs in the Āsvalayana Sūtra shows that ‘sangava’ is a part of the day and not a transition moment between two parts.

FIFTEEN MUHURTAS

The Taittirīya Brāhmaṇa states the names of 15 muhurtas (or parts) of the day and similar 15 of the night.

\[ \text{अष्ट. श्रा. ३, १०, ६।} \]

The divisions referred to in the above lines have all been mentioned in a single anuvāk in the same Brāhmaṇa a little earlier. They are:

\[ \text{ज्योतिषमोहसेनम् संहोमनः कल्याणः।} \]

\[ \text{शत. श्रा. ३, १०, १।} \]

These are the names of 15 muhurtas of the day in the light half of the month; each line mentions five and in all they are fifteen in number.

\[ \text{शत. श्रा. ३, १०, १।} \]

*Translation—The ending moment of the ‘pradoṣa’ part is the proper time for offering oblations into fire and the end of ‘sangava’ is termed ‘prātaḥ’.
These are the names of the 15 mūhūrtas of the night* in the light half.

These are the names of the 15 mūhūrtas of the day in the dark half.

These are the names of the 15 mūhūrtas of the night in the dark half.

The whole day and night together must have been divided into 30 divisions, just as the month is divided into 30 parts. The post-Vedic works do mention mūhūrtas as parts of the day, but they do not mention the names as given above; the mūhūrtas are found to receive different kinds of names.

THE SUB-DIVISIONS OF MUHÚRTAS

Each mūhūrta is supposed to be sub-divided into very small equal sub-mūhūrtas (15 in number).

“The mūhūrtas are further divided into sub-divisions called pratimūhūrtas; their names being Īdânīm, Tadānīm and others.”

The “pratimūhūrtas” are given below:

KALĀ AND KĀŚṬHĀ

This line from the Nārāyana Upaniṣad mentions “Kalā and Kāśṭhā” as units of time in addition to the mūhūrtas; and one cannot make out their mutual relation or their relation with other units of time. The remaining parts of the day known as ghaṭīs and palas are nowhere to be found in the Vedas.

NAKṢATRAS

Let us now consider the nakṣatras. A few lines from Rk Saṁhitā are given below which contain references to nakṣatras, that is, not to particular

*This is obvious from the context.
star groups but to stars in general which are scattered all over the sky. Some of these mantras are found in the Atharva Samhitā also.

अभो तत्त्वो यवत मुख्यता वंत्यमतुम्। सुरया विदितवचस्येषात्।

“The stars and the night escape like thieves on the approach of the all-seeing sun”.

अन्निनय्यो न क्षणेनभरतं मुख्यता चितरो श्रामिपितस्।

The term ‘nakṣatra’ has been applied to the stars in the above two lines.

In the line, “Dyauriva smayamāno nabhobhiḥ” (meaning like the sky adorned with stars), the word ‘nabhas’ is used in the sense of stars; the word “rocanā” also appears in that sense at some other places.

आयो न तुस्मितिन्यन्ति।

In these lines the word ‘stār’ has been used to denote stars.

In the first two ṛcās the word ‘nakṣatra’ has been used to denote the stars in general and not only those stars which lie on the path of the moon. The term ‘nakṣatra’, as used in the post-Vedic Sanskrit works, denotes stars in general as well as those lying on the path of the moon.

अथो नक्षत्राणामेषपुययो सोम आहित:।

“The moon is placed amongst the stars”.

Here, the word nakṣatra seems to have been applied only to those stars which are situated in the moon’s path.

The Rk Saṁhitā does not mention names of all the 27 nakṣatras in the moon’s path, but only a few of them. The word ‘tīsyā’ which occurs in 5-54-13 and 10-64-8 appears to denote the star ‘Puṣya’. The name Citrā nakṣatra occurs in 4-51-2 and Revati in 4-51-47 ; this appears to denote the star ‘Revati’. The next ṛcā mentions two ‘nakṣatras’ in succession.

सूर्याक्ष ब्रहुत् प्रागच्छ: संबिताच्यामास्तुर्मति। अधभुत हन्यते नाभोक्षयो: पथस्वते।

“The (dowry) of cows which was given by Savitā (sun) had already gone ahead of Suryā. They drive* the cows on the Aghā (Maghā) nakṣatra. The (daughter) was carried away on the Arjuni (Phalgunī) star”.

*The verbal root ‘han’ here does not mean ‘to kill’. The Marathi ‘hānane’ is quite current even at present in the Sholapur district in the sense of lashing or beating and driving.
This ‘ṛcā’ refers to the story that Suryā, the daughter of Savitā, was given to Soma; the cows which were given to him as dowry by the Sun-god, were driven away one day before, i.e. on Maghānākṣatra day, the daughter was carried away on the Arjuni-nākṣatra day.

In this ‘ṛcā’ the word Arjuni has been used in the sense of Phalguni and ‘Aghā’ in place of ‘Maghā’. These words are mostly absent in the post-Vedic literature; there is, however, no doubt that they denote the nākṣatras mentioned, because a variant of this very ‘ṛcā’ appears in the Atharva Śamhitā as given below.

ॐ यान्याः प्राणात्सिद्धतायमवातः || मधासू हरच्छते गावः फल्गुनिः युज्यते ॥
अप. सं. १४. १. १३.

This verse gives the actual words Maghā and Phalguni. Similarly, the verse viz.,

एता वा इन्द्रक्षेत्रं वस्तुनिवृत्त्व यथानन्दयोजेन महायोजेन
हृदे नामादेवो यथव गुहायुष्मानायो वे नामैतस्तः
शत. ब्रा. २. १. २. ११.

This clearly shows that Arjuni is identical with Phalguni. In the Yajur-Veda, the word Maghā is used as ‘Maghāsu’ in plural feminine form so is Aghāsu used here. Similarly, ‘Arjunyoḥ’ has been used like ‘Phalgunyoḥ’ in the feminine dual form. Two acts are said to have occurred here in succession just as Maghā and Phalguni appear in succession*. This order and the gender and number of Aghā and Phalguni, agree with those given by the Taittiriya Veda and post Vedic astronomical works. This proves beyond all questions that the nākṣatras system described in the Yajur-Veda was fully in vogue in the Rigvedic times.

It has been stated above that the same word, nākṣatra, has been used without distinction by Rk Śamhitā to denote the stars situated in the moon’s path and also stars in general; but at one place in Taittiriya Śamhitā, we find a distinction made between the two. The following lines have been taken from the description of the horse to be offered in sacrifice.

शो का अद्वस्य सेव्यत्व शिरो वेद शीवशानेवेद्य भव्यवा वा अद्वस्य
मेध्यत्व किरः: सूर्यायकावाहः प्राणचंद्रमाः भोत्र दिशा: पात्वा अवांतरविद्वतः
पार्वती वृक्षरोव निषेधायं पार्वती: पार्वती माता: संभानार्युवीरजानित
संबस्तर आयावि रस्त्र: केशो निष्ठत्राणं रूपं तारकन्व अस्वानि नभो वारसियां...

तै. सं. ७. ५. २५.

“He who knows the head of the sacrificial horse becomes ‘Śirṣaṇvān’ and holy. The ūṣā (dawn) is the sacrificial horse’s head. The sun is the eye, winds the life, moon the ears, the (four) quarters the legs, other quarters are the ribs; the day and night represent the winking of the eyes, the half-months are knuckles and the months are the sandhāna (joints); the seasons are the limbs, the year is the soul, the sun beams are the hair, nākṣatras the form and the stars are the bones”.

*The words “aryamnah...............avastāt” occurring in the passage cited on the next page are worth considering.
A good many references to nakṣatras are found in the Taittiriya Śrutī. At some places the names of all the nakṣatras and those of their controlling deities have been mentioned. At some other places we get many kinds of descriptions about them, at others, is described the origin of their names, and at still other places, we come across casual references of intermediate stars at random.

The following anuvākā from Taittiriya Saṃhitā mentions all the nakṣatras:—

The Taittiriya Brāhmaṇa gives lists of all the nakṣatras with their deities at three places; the anuvākā is quoted below because it gives a quaint description:—

The text continues in the same manner as before.
In this we have descriptions of the nakṣatras, which are all of this pattern. “The Kṛttikās belong to Agni; Śukra is on the other side, and Jyoti is on this side.” The rationale and purpose of describing nakṣatras as having one thing on this side and another thing on that side are not fully understood. It appears that the things mentioned here are in reference to the benefic and malefic results relating to nakṣatras in some cases and to their forms in some others. The lines referring to Phalguni in this passage is very similar to the āraṇī quoted from the Rigveda above. Again, the sentence ‘Maîtreṇa Kṛṣṇe’ meaning fields should be ploughed on Anurādhā nakṣatra has been quoted further on.

The reason for this direction perhaps lies in the fact that the preceding nakṣatra Viśākhā has the yoke of the plough on that side, and ploughmen on this side. The words ‘yoke’ and ‘ploughman’ appear to have some relation with the figure of the nakṣatra.

The names of all the nakṣatras and their deities, and some quaint and interesting legends about the nakṣatras are found in the Taittiriya Brāhmaṇa Aṣṭakā 3, prapāṭhaka 1 and 2 but these anuvāks cannot be cited here for want of space. They do not specifically mention the deities of nakṣatras, but the relation of the deities with the nakṣatras is in some way suggested in such words as “agnir naḥ pātah Kṛttikāḥ”. (May Kṛttikās and Agni protect us) “Ārdrayā Rudrāḥ prathamānāmeti” (i.e. Rudra becomes famous on account of Ārdrā). Similarly, all the nakṣatras with their deities have been mentioned in the 4th and 5th anuvāks of the same ‘prapāṭhaka’. These anuvāks are very lengthy. The lines about one nakṣatra, which will give some idea about the other nakṣatras, are quoted below:

बृहस्पतिः अहामनः ॥ ब्रह्मवर्षसी स्वामिति ॥ स एवं बृहस्पतेः निवयाः नेवारं वर्षस्य पथिः निर्यथमः ॥ ततो वे स ब्रह्मवर्षस्यथवमः ॥ ब्रह्मवर्षसी हे वे भवति ॥ य एते हयवा यजते ॥ य उ चैनेवेंद्रे वे वजि ॥ सोत्र जुटोति ॥ बृहस्पतेः स्वाहा निवयाः स्वाहा ॥ ब्रह्मवर्ष साध स्वाहूः ॥

ते. क्र. ३. २. ४. ६.

“Bṛhaspati wished to be holy through spiritual knowledge. He offered to Bṛhaspati and Tisya (Puṣya) a ‘charu’ (oblation) of ‘nīvār’ (rice) in milk. Because of this he became holy. He who offers this oblation in a sacrifice and understands it becomes holy; while offering the oblation he chants the mantra ‘An offering to Bṛhaspati, an offering to Tisya, an offering to holy-men’.

The nakṣatras and their deities have thus been mentioned in four places. These, together with their gender and number have been shown in one table on page 48 to 50. The differences, if any, regarding the names and deities of nakṣatras have been indicated by numbers 1, 2, 3, and 4 which denote in succession the four places in which they occur. No numbers are given to those nakṣatras about which there is unanimity in all the four places. The wording of the anuvāks from the Taittiriya Śaṁhitā shows that the genders and numbers of nakṣatras mentioned in it are the same as those given in other places.

The nakṣatras mentioned by Atharva Śaṁhitā are as given in the following lines:

चित्रानि सारं दिवं रोचचानि सरीसुपाणि भूबने ज्ञानिः ॥
अष्टादशं ब्रह्मवर्षसी संबोध्यते सत्सर्वाच्यमिः सप्तविंश्च नाकम् ॥ १ ॥
"I being desirous of welfare, worship the heaven with speeches, because 28 clusters of stars, like wonderful illuminating lights arranged in the form of nimble serpents, shine in the sky" (1st verse).

These lines do not mention any deities for the nakṣatras, and as the first mantra shows, the nakṣatras appear to be 28 in number. The Taittiriya Śruti has mentioned Abhijit nakṣatra in two out of four places; but nowhere does it mention whether the nakṣatras are 27 or 28. The Satapatha Brāhmaṇa has stated at one place (10-5-45), that the nakṣatras are 27 and Upanakṣatras are 27. The above lines from Atharva Saṁhitā appear to have used the name Kṛttikā in the singular number. The Ṣrigāraṇas and Puṣyā are mentioned as Ṣrigāraṇaḥ and Puṣyaḥ (in masculine gender), the word Śvāti has been used as Śvāti ending short i, and appears to be masculine. The name Anurādha has the second vowel short and is used in the singular number. The word Śravaṇa has been used (in place of Śrōta) while the name Bharapi is changed to Bharanyah. These are the points of difference between the Atharva Saṁhitā and Taittiriya Śruti; but otherwise the two works show an agreement. The genders and numbers of some of the nakṣatras cannot be clearly ascertained, but one may presume that they are the same as in Taittiriya Śruti. There is, however, some doubt about the Proṣṭhapaḍā. The words "Vier′rav nāma tārake", occurring at some places (2.8.1; 3.7.4) appear to refer to the nakṣatra Mūla.

Nakṣatras mentioned by the Taittiriya Śruti:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Nakṣatra</th>
<th>The controlling Deity</th>
<th>Gender</th>
<th>Number</th>
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<td>Kṛttikā</td>
<td>Agni</td>
<td>Feminine</td>
<td>Plural</td>
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<tr>
<td>2</td>
<td>Rohiṇī</td>
<td>Prajāpati</td>
<td>,</td>
<td>Singular</td>
</tr>
<tr>
<td>3</td>
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<td>Soma</td>
<td>Neuter</td>
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</tr>
<tr>
<td></td>
<td>(2) Invākā</td>
<td>,</td>
<td>Feminine</td>
<td>Plural</td>
</tr>
<tr>
<td>4</td>
<td>(1, 3, 4) Ādrā</td>
<td>Rudra</td>
<td>,</td>
<td>Singular</td>
</tr>
<tr>
<td></td>
<td>(2) Bāhū</td>
<td>,</td>
<td>Masculine</td>
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<td>5</td>
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<td>Aditi</td>
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<td>6</td>
<td>Tīṣya</td>
<td>Bṛhaspati</td>
<td>,</td>
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<td>No.</td>
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<td>The controlling Deity</td>
<td>Gender</td>
<td>Number</td>
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<td></td>
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<td>Indra</td>
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<tr>
<td>Name of Nakṣatra</td>
<td>The controlling Deity</td>
<td>Gender</td>
<td>Number</td>
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<td>25 Revaṇi</td>
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<td>26 Aśvayuja</td>
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<td>27 Apabharaṇi</td>
<td>Yama</td>
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The derivation of the word nakṣatra has been given by Taittiriya Brāhmaṇa in the following lines:

प्रवत्तुया अणे क्षत्रपालस्वः। तेवार्थ्ये।। क्षत्रपालस।।
नवा इमानि क्षत्रप्रभूविन्नाति।। तत्तत्रत्राभः क्षत्रत्व।। ।

ते. बा. २. ७. १८. ३.

This, in short, appears to mean that those which are not ‘Kṣatā’ (movable) are Nakṣatras. The Nirukta, explaining that the term nakṣatra is derived from its quality of being movable and adds that according to the Brāhmaṇas the nakṣatras are so called because they are not ‘Kṣatā’ (i.e. movable). The Taittiriya Brāhmaṇa at another place writes as follows:

सलिते वा इदमंतरासीलोऽ। यवतन।। तत्तत्त्राभः तत्तत्त्रतः।। यो वा इदु यज्ञे।।
अम्बे स तोकं नक्षे।। तत्तत्त्राभः नक्षत्रभ।। देशगुद्वां व नक्षत्राणं।। य एवं वेद।।
गृहस्वति।। यतिः वा इमानि गृहायन्यास्चतः।। तत्तिन नक्षत्राण।। तस्मादश्लोलानाम
स्थिते।। नक्षत्र्येशस्मलेत।। यथा पापाः कुलसे।। तादृशम तत्त।।

tे. बा. १. ५. २.

"There was water in the centre. The tārakās (stars) are said to possess the property of tārakatva (protectiveness) because they floated and saved themselves. He who performs a sacrifice here goes (nakṣate) to that world. Hence is the ‘nakṣatra’ significantly so called. They are the houses of gods. He who knows this becomes the owner of a house. The nakṣatras are the images of the earthly objects. Hence a rite should not be allowed to terminate and a sacrifice should not be performed on an ugly nakṣatra; it gives the same result as a rite performed on an auspicious day".

These lines are very important as the derivation of the word tārakā appears more to be quibbling, but the second derivation which traces the word to the root “nakṣa” (to go) and the notion that the virtuous in this world should ascend the heaven and become nakṣatras, is noteworthy. Several nations of the world might be cherishing this belief. The idea that the nakṣatras are houses of gods is very important. Here, what can the word ‘deva’ stand for other than the shining planets, actually moving through the stars? The notion that the nakṣatras are the houses (grhaus) of gods suggested the derivation that what holds (grhaṇāti) a house is a (graha) planet and thus the word graha (planet) seems to have been applied to resplendent gods like Venus etc.

Looking to the derivation of the word nakṣatra that they are the images or pictures of the earth or earthly objects, it appears that the nakṣatras must have derived their names from their resemblance to particular figures. But some nakṣatras seem to have received their names for other reasons.
Let us, therefore, see the origin of each nakṣatra's name as given by the Vedas. The names Punarvasu, Citrā, Maghā and Revati out of the 27 names of the nakṣatras, did not originally indicate nakṣatras but were used in a different sense in the Śrāvaṇa. They are quoted here for a better understanding of the nakṣatra names:

अन्नोऽयोऽपति पुनर्वसु जासे भारतश्च रथिम॥

इति सं. १०. १६. १।

Sāyanācārya explains the terms Punarvasu as 'puṇah punarvastārau stotṛṇāh mācchādayitārau (devau)' meaning "the two gods who repeatedly give shelter to those who offer prayers". It is worth remembering that this word is used in the dual form like the star-name Punarvasu.

वार्णीवती सूर्यन प्रोषा चित्रामघ राय इसे बनूनां॥

इति सं. ७. ७५. ५।

उषा अवशोऽर्तिर्मिश्यंकं चित्रामघा विद्वसनुप्रभु॥

इति सं. ७. ७७. २।

These lines suggest that 'Citrāmghā' means "one having wonderful wealth". Yāṣka has rendered the word as a 'store of wealth to be used for charity'.

The term 'Revati' means one 'possessing wealth'. The following quotations may be seen for this sense:

सर्वत्र वा बन्नामशिवं महतेर्वर्मणम्: नित्वत १. ७।

स्वस्ति पय्ये रेवाति

इति सं. ५. ५१. २४।

उपमात्रवृहती रेवतीस्य स्तोत्रस्य पवान नोगहि

इति सं. ६. ७२. ६।

Some of the words in these four have been used in the above mentioned or similar sense in some other places. This shows that the words Punarvasu, Maghā, Citrā and Revati while already current in the spoken language might have been applied to particular nakṣatras later on, and it can be inferred that these must have been applied to different nakṣatras, because of their loveliness, their munificence, etc., these qualities being either actually noticed, imagined or experienced about them. The same thing could be said about some other nakṣatras also.

The Aitareya Brāhmaṇa contains a strange legend about Rohini (Aldebaran), Mrga (Lambda Orionis) and Mrga Vyādha (Sirius) which gives the reasons for these appellations and hence it is given below:

प्रजापतिवर्गः स्वां वृहततर्मववच्यायिनिस्यं श्रवणसमर्थीयं तत्रत्वयं भूतानि रोहिनं भूताः प्राप्तियं वर्गध्ययने

त वेदा प्रायस्यसृष्टि ब्रह्मपतिः करोति तेऽऽत्मनं एनमार्थिवये श्रवणसमर्थीयं भूतानि रोहिनं भूताः प्राप्तियं वर्गध्ययने

या एव घोरतमस्मि आशंका एकाचा समर्थसा संभूता एष देवोवस्तुस्य तत्रूवत्साम भूताः प्राप्तियं वर्गध्ययने

वेद त वेदा अश्वस्य ब्रह्मपतिवर्गध्ययने

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“Prajāpati felt love for his own daughter—the sky, some say, the ūṣā (dawn) others. She became a rohit i.e. a deer. He became a *ṛṣyā* (a white footed antelope) and went up to her. The gods saw him and (began to remark) ‘Prajāpati is now doing a deed improper’. They sought one who would punish him; but they did not find any one among them. Then they brought together in one place their most dreadful forms. Brought together, they became a deity, therefore his name contained the word Bhūta. He was then born who knows thus his name. To him the gods said, ‘Prajāpati here hath done a deed unknown, pierce him’. ‘Be it so’, he replied. ‘Let me choose a boon from you’. ‘Choose’ (they said). He chose this boon. ‘The over lordship of cattle’. Therefore does his name contain the word “cattle”. He who thus knows his name becomes rich in cattle. Having aimed at him, he pierced him, being pierced he flew upwards, him they call the ‘deer’. The piercer of the deer is he of that name (Mṛgavyāḍha). The female deer is Rōhinī. The (Trikāṇḍa) is the three pointed arrow.”
In this figure ten stars have been shown in the Orion group. The group of three stars appearing in a straight line and situated in the middle are known as Trikāṇḍa Bāṇa or three-pointed arrow. The four stars around it are the four feet of the antelope, and the small cluster of three stars to the north of all these stars is known as the Mṛgaśīrṣa (head of the antelope).

Many more small stars can be seen near these stars in the sky. All these stars together are called the Orion by European astronomers. A look at all the stars in the figure will show that the stars Rohini, Mṛga and Mṛgaśīrṣa must have derived their names from the figures of the star-groups. Again, when these clusters after having risen in the east, begin to move towards the west, it appears as if the Mṛga (the antelope) is chasing Rohiṇī (the deer) and Vyādha (hunter) is chasing the antelope, and the legend of Rohiṇī and Prajāpati might have been suggested by this scene.

The Taittiriya Brāhmaṇa (I. 1. 10) gives the legend of Rohiṇī and Prajāpati in a slightly different form. The purport of the legend is:

Prajāpati created ‘praJA’ (people). In so doing, the virāt (Universe) was created from his semen. Gods and demons received it. Prajāpati said ‘She is mine’. She flew to the east. Prajāpati followed her. She thus ran for protection from place to place. In the end it is remarked:—

सा तत उद्भारीरोहिणीः सा रोहिणिभवत् ॥ तद्रोहिणयो रोहिणिष्ठें ॥ रोहिणिभवनिमाति ॥

स्व एवं यो नो प्रतिनिदित्तमाथ्ये ॥ त्राध्योजेनेन् ॥

तत्र या १ १ २० ५

“She then ascended (the heaven). Hence, she came to be known as Rohiṇī. She got this name Rohiṇī, because she ascended heavenward. One should light fire on the ‘Rohiṇī’ nakṣatra’.

The star got the name Rohiṇī because she ascended heaven. The origin of the word Rohiṇī has been given at another place as follows:—

प्रजापति रोहिणिभवनिमाति ॥ तं देवा रोहिणिभवनिमाति ॥ ततो वे तें सर्वानु रोहिणरोहिणी ॥
	तद्रोहिणयो रोहिणिष्ठें ॥ रोहिणिभवनिमाति ॥ त्राध्योजेनेन् ॥

तत्र ब्राह्मण १ २.

The Taittiriya Brāhmaṇa describes the origin of names of some other stars also as in the following verse:—

देवा वे भाग्यं सतोगिमात्रिसंगं तेषामाहृहिणिष्ठरासिः ॥ अर्थायो बाह्यं व्ययात्मकम् ॥
	तें पुनरीपोरुषयत ॥ ततो वे तत् बाह्यं बुधायत ॥ व: पुरा भा । सन् पार्वत्यापन्नस्यात् ॥
	स पुनार्नारीरा निमाति ॥ पुनरेव बाह्यं बुधायत ॥ त्राध्यो भवति ॥

तत्र ब्राह्मण १ २.

“The gods when in good condition desired to light sacrificial fire. (But) their fire remained unlighted, and because of this, their precious wealth left them. They commenced a sacrifice on Punarvasu nakṣatra. The wealth again came back to them.”

Other ideas based on the words ‘Punah’ (again) and ‘Vasu’ (wealth) can be seen at two or three other places.
The origin of the names of Anurādhā, Jyeṣṭhā etc. has been described in the following lines:

अनुराधाराजस्वतिः । तद्भूतादाय व्यासरामभिमैति । ततो न्येष्ठाः । स्वामेश्वर-वृक्षामैति । तन्मूलवर्धानी । यज्ञवाहेर । तदवधिः । यदाध्यात् । यज्ञवाहेर । तद्भूतादाय । व्यासरामभिमैति । तन्मूलवर्धानी । यज्ञवाहेर । तदवधिः । यदाध्यात् । तद्भूतादाय । व्यासरामभिमैति । तन्मूलवर्धानी । यज्ञवाहेर ।

तृतीयं ज्ञति । अपभ्रंशोपपचास्तु ।

तृतीयं ज्ञाति । अपभ्रंशोपपचास्तु ।

Sāyana, while commenting on this, remarks that it was the statement made by the gods with reference to their battle with the demons... (gods say) “we killed the eldest of them all on the Jyeṣṭhā nakṣatra (day) and that is why the star is to be known as ‘Jyeṣṭhāghnī’........etc.”

The five stars of the constellation of Hasta present the appearance of the palm of the hand; and it is clear that the group of stars must have received the name Hasta (hand) from this resemblance.

The Taittirīya Brāhmaṇa has conjured up the vision of nakṣatīrya (stellar) Prajāpati which is noteworthy.

यो वेत व्युत्तिरयो प्रजापतिः वेद । उज्जोरनो लोकयोविदु । हृति एवात्य हृति ।

निष्ठा तिर । निष्ठा हृति तिर । हृति बिशाहे । प्रतिष्ठानूरावः । एव वेत नक्षत्रियः

प्रजापति ।

तृतीयं ज्ञाति । अपभ्रंशोपपचास्तु ।

“He who knows the nakṣatīrya Prajāpati knows him as related to both the worlds. The star Hasta is his hand, Citrā his head, Niṣṭyā (Śvāti) his heart, the two Viśākhā stars his thighs, Anurādhā the place to stand upon. This is the nakṣatīrya Prajāpati”.

Even at the present day the description appears to agree if we look up to the sky and imagine that the figure is formed of a man having raised one hand to one side above his head. Only the star Śvāti does not seem to fit in at the place of the heart. The proper motion of this star is far greater than that of others. Therefore, the description must have been true sometime in a very remote past.

The grammatical number in which the nakṣatra names are used is helpful as an indication of the number of stars in each group. The Mrgāśirṣa group, including the stars representing the head, consists of a good many stars and is called Mrgāśirṣa. Similarly all the stars of the Hasta group have together received the appellation Hasta. Thus, though Mrgāśirṣa and Hasta are spoken of in the singular number they are actually composed of a number of stars. As mentioned above the alternative name for Mrgāśirṣa is ‘Invakāh’ which is in the plural number. The following ten out of the remaining nakṣatras are used in the singular.

Rohini, Árdra, Tiṣya, Citrā, Śvāti, Jyeṣṭhā, Mūla, Śrōṇā, Śatabhīṣak and Revati.

This shows that each of these nakṣatras must be a single star. Punarvasu P. Phalguni, U. Phalguni, Viśākhā and Aśvayu—these five stars are used in the dual number; hence they must have two stars each. The remaining
naksatras viz. Kṛttikā, Āśleṣā, Maghā, Anurādhā, P. Aśādhā, U. Aśādbā, Sravīṣṭā, P. Proṣṭhapada, U. Proṣṭhapada and Apabhraṣṭa, these 10 naksatras are used in the plural. Therefore, each of them must have more than two stars. The Kṛttikās, out of them, contained seven stars as can be seen from the following lines:

अंबायेः स्वाहा हुलायेः स्वाहा || निदर्शयेः स्वाहाभ्रमरयेः स्वाहा ||

नेवयंस्येः स्वाहा वर्षयंस्येः स्वाहा || चुगुणकयेः स्वाहाः ||

तै. ब्र. ३. १. ४.

These are the lines from the Kṛttikeśṭi (sacrifice to Kṛttikā) a part of naksatraśṭi. The names of seven stars are—

Ambā, Dūlā, Nitānī, Abhrayānti, Meghayānti, Varṣayānti and Cupuṇīkā.

That the Sravīṣṭā group consisted of four stars may be seen from

चतुरो देवीरजया: अविष्ट: ||

तै. ब्र. ३. १. २.

The following quotation from Taśtritiyā Brāhmaṇa (3. 1. 2.), shows that the Proṣṭhapada group had also four stars.

प्रोष्टपदासाहि अभिरक्षित सत्वेः || चतुराक्षम कर्म देवा: || प्रोष्टपदास इतियान् वर्तति ||

ते दुर्धिनयं परिश्रवृत्तांत: || अष्ट्वंकश्च नमसोपसा ||

तै. ब्र. ३. १. २.

According to the following lines in the Śatapatha Brāhmaṇa none of the star grups other than the Kṛttikās had more than four stars; or at any rate none of them had more stars than the Kṛttikās.

एकं है नामक चतुरासरी वा अण्यानि नक्षत्राण्यांतः एव भून्याः वर्नकृत्तिष्ठा: ||

शत. ब्र. २. १. २. २.

"Other naksatras have one, two, three, or four only, these Kṛttikās have many".

The number of stars in the naksatras and their deities mentioned in the post-Vedic astronomical works will be compared with those in the Taittiriya Śūti later on in Part II.

The Vedas specially refer to certain stars in addition to the 27 well known stars:

अमी य ऋक्षा निर्विन्य उक्ता नक्षत्रं ददूरे कुस्य चित्रितेः: ||

अत. सं. १ २४. १०.

"These Bears* which appear to be placed at high elevation (in the sky) at night, go away somewhere in the day."

The Śatapatha Brāhmaṇa observes

सप्तर्षीनुहूस्म्य वेपुरकाः इत्यास्ते ||

शत. ब्र. २. १. २. ४.

*The Saptarshi group has received the name as the Great Bear in European astronomy.
The Saptarśis were called bears in ancient times.

There is a reference to the seven stars (Saptarśis) in Tāṇḍya Brāhmaṇa (1. 5. 5.) which is as follows:

उध्वे सतत र्षीबुद्रिष्टिष्ठव
ताण्डय बा. १. ५. ५.

"Worship the seven sages (appearing) above."

In Taittirīya Brāhmaṇa we come across the following lines in which some reference to the star Citrā occurs after the suggestions that sacrifice should be commenced on the Kṛttīkā nakṣatra.

कालकंजा यथ नामायुरा आसन्।। ते छुर्वर्ग्य लोकार्पिनविविष्ठत्।। पृश्व इत्सकामुपावात्।। पृश्व इत्सकामुपावात्।।
स इतिः श्रीवर्ग्य बुध्वत्र इत्सकामुपावात्।। एवा मे चित्रानामवेदित।। ते छुर्वर्ग्य
लोकार्पिनविविष्ठत्।।
स इतिः इत्सकामुपावात्।। तेवाक्यं इतिः चेवाक्यं।। तै उक्षितो इतिः
वर्ग्यन्व।। श्रावुद्यतानन्।। ते चित्रानव नामावापच्छति।।

वै. बा. १. १. २.

From this it is clear that the words "The two which went up became divine dogs" refer to some two stars or clusters of stars.

श्रूनो विह्याश्च बन्महस्ते ना ते ब्रह्म विषयम्।। २।। इव अधि: कालकंजा दिविः देवा इव
भिन्ताः।। तांगश्चानाईः अस्तये।।

अथ. सं. ६. ८०.

This refers to a divine (celestial) dog and three god-like Kālakanja (demons) stars in the sky.

यो ते दशानौ यम राक्षसारो जनुपर्वतुष्टी नृकच्छारी

कः सं. १०. १४. ११.

This refers to two dogs. Even the Atharva Saṁhitā (18. 2. 12) gives this mantra with the variant reading "Pathśadī nṛçaksasā" for the last two words.

There are two star clusters on either side of the Milky Way situated to the east of Mṛga constellation. They are known as Canis Major and Canis Minor in European astronomy. The first group contains Sirius, one of the brightest stars. The second group contains the pair of southern stars out of the four stars of Pūnarvasu. It seems these two clusters are the two dogs mentioned in the Vedas.

इवैं तत्वं स्वरिचानामानासमलच्छानालिहृदमा स्वस्यते।।

कः सं. १०. ६३. १०.

This pṛcā refers to the celestial boat. The Atharva Saṁhitā (7. 6. 3) gives this mantra as "Daivhī. gasom asra.

हिरण्ययो नीर्जरस्त्रिद्विषयवीर्यविना दिविः।। तत्रामुःतस्म पुष्यं देवा: कृष्टंवव्रद्वत्।।

अथ. सं. ५. ४. ४; ६. ६५. २.
Even this mantra from the Atharva Samhita mentions a celestial golden boat; the word ‘Pusya’ in this appears to have some connection with the star Pusya. A constellation situated close south of Punarvasu and Pusya is called Navis (Nau or a boat) in the European astronomy. This appears to be the Nau of the Vedas.

**ECLIPSES**

Let us now see what other astronomical references can be gleaned from the Vedas. Here is a passage from the Rk Samhita which mentions an eclipse.

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तद्व शूर्य स्वर्णान्तसाविभायदाता: ॥ अर्यविद्वय वामुस्यो मूर्तान्यदीयतु: ॥ व ॥
स्वर्णो रघुनाड्व मायास्य विवेको दिवो वर्त माना अवाहनु: ॥
गुत्तहं मूर्य तमसाप्रलेन तुरीयेण श्रृणाः विबंददित्र: ॥ ६ ॥
सामासम तव संततो इत्र्या दुधो भिमसय निग्नात्रतु: ॥
तवं मित्रो अरस सत्यराजावते भैरवात वशणदुर राजा ॥ ७ ॥
गुणेऽ बहुत मयुजान: सर्यांत कौरिण देवास्मसपम्पिन्तु: ॥
अक्षिः मूर्यं विभिच बुसरायचतुः स्वर्णोरपमाय भवक्तु ॥ ८ ॥
य तम शूर्यस्वर्णान्तसाविभायदाता: ॥ अर्यरसनविम्बद्ध्वास्येः अश्चक्तु ॥ ९ ॥

सं. ५. ५०.
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"(5) Oh god Sun! When the demon Rāhu (moon’s ascending node) engulfed you with darkness, all the worlds so appeared that people living in them were unable to know where they stood.

(6) Oh Indra! You destroy the illusions of ‘svarbhanu’ (Rāhu) which are found to exist under the sky. The sage Atri got back the Sun who was engulfed by the impious darkness by means of the fourth Brahmā.

(7) Oh sage Atri! May that malicious demon desirous of devouring food, not devour me with that dreadful darkness. You are a friend and truth is your riches. May you and god Varuṇa protect me here.

(8) The sage Atri, after selecting the grāvā (stone) for extracting some juice for gods and after offering prayers and salutations to them, dispelled the illusions of Rāhu and set his eye on the Sun’s light (i.e. remained watching till the Sun became free from darkness)*.

(9) Atri alone could restore the Sun whom the demon Rāhu had engulfed with darkness and no one else could do it."

There are two or three important points in this description. The first thing to note is that this description of the eclipse does not reflect a highly panic-stricken mood. Solar eclipses are quite frequent, but only a few of them are visible at a particular place; and even out of these few, the total solar eclipse is quite rare. In England, a total solar eclipse was observed on March 20, 1140 A.D. and the next one followed as late as 22nd April, 1715 A.D. which shows that no total solar eclipse was observed during the intervening 575 years. In India, the total solar eclipses do not occur at such long intervals; nevertheless, they are likely to occur once or twice in one’s life time. It is clear

*Śāyana ācārya has translated the third line in a different way and his rendition of the other parts of the passage also is slightly different.
that the ‘ṛcās’ quoted above describe a total eclipse of the sun, still the description does not betray a high degree of amazement or horror. This shows that in those times eclipses had become quite familiar and the dread of that phenomenon had lost much of its edge. Secondly, what are we to understand from the remark that “the Atri alone could restore the sun and no one else could do it”? This perhaps shows that only the members of the Atri family and no one else had the knowledge of the solar eclipse. And what is meant by no one else had that knowledge? Even a child knows it when an eclipse begins. But even then we are told that Atri alone was able to liberate the sun. This means that Atri alone knew when the eclipse would end and no one else had that knowledge which Atri possessed. This shows that the descendants of the Atri family had at least some knowledge of eclipses, if not, the most accurate knowledge necessary for predicting the exact moment of the beginning and ending of an eclipse just as the ancient Chaldeans knew that the eclipses recur with every cycle of 6586 days or 223 lunar months.

Thirdly, though the wish is once expressed in these Ṛks that Rāhu may not devour the sun, it is said three or four times that Rāhu engulfed the sun in darkness, which means that Rāhu and darkness are regarded as two different things. A quotation regarding the belief that the moon enters the sun on the new moon day has already been given from the Aitareya Brāhmaṇa. It appears from this that even though the true cause of a solar eclipse might not have been known at the time of the eclipse mentioned above, one may safely say that the popular beliefs of those times had a leaning towards the knowledge of the true causes. The notion that Svarbhānu or Rāhu devours the sun must have gained ground at a later date.

The Tāṇḍya Brāhmaṇa refers to eclipses at five places (4.5.2; 4.6.13; 6.6.8; 14.11.14.15; 23.16.2), in which the ‘Svarbhānu’ is described as attacking the sun with darkness. In two places (6.6.8; 14.11.14, 15) out of five, the sage Atri is said to have removed the darkness by ‘bhāsa’ (lustre); in the remaining three places, gods are said to have removed the darkness; but even in those places, the word ‘gods’ appears to mean the sun’s rays. In Gopatha Brāhmaṇa (8.19), the ‘svarbhānu’ is described as having attacked the sun by means of ‘tama’ (darkness) and Atri is said to have driven away that ‘tama’. According to a description in the Śatapatha Brāhmaṇa (5.3.2.2) the ‘Svarbhānu’ is said to have attacked the sun with ‘tama’ but Soma and Rudra are said to have removed that darkness.

**PLANETS**

Let us now see what the Vedas have to say about planets. It need not be told that of the nine planets, the Sun and the Moon together share hundreds of references in the Vedas. Rāhu and Ketu are not visible planets at all. Therefore, the remaining five are the only real planets belonging to the solar system. But the author did not come across any reference in the Vedas in which something is explicitly said about all or any of the five planets. There is, however, ample scope for inference.

अग्नि मे पंचोक्षो नरसंहोत तत्त्वमिहे विशः ||
वेष्टन नु प्रवाच्यं सद्योऽचाच्या नात वानुसिद्धं मे अस्य तोषसि ||

ऋ व्य १ १०५ १०
"These mighty five (gods) are seen in the middle of the vast expanse of the sky. Even though they are seen coming together when I compose hymns in honour of gods, they have all gone away to-day...."

In this, the word 'gods' does not actually occur. But there is no doubt that the context requires the insertion of the word. The mighty five are said to be coming together. The five planets, Mars and others, are seen very rarely simultaneously in the sky.

Similarly, Mercury and Venus can never be visible in the middle of the sky. Hence, 'divāh madhye' is simply to be rendered as in the sky. All the planets are at some times visible at night except when one or two planets are heliacally set. The original Vedic gods were none other than the wonders of nature, actually visible luminous orbs and so on. Even the root meaning of the word 'deva' is 'one who shines'. There are no five 'gods' known as 'pañca deva', just as 'two gods' stand for the 'Āśvins' and '33 gods' stand for twelve Adityas and other deities.

The word 'pañcādeva' occurs also at another place (10.55.3) of the Rākṣaṇ Samhitā. Hence, the word can be rendered as five planets. It has, already been stated above that "nākṣatras are homes of gods". This statement also lends support to my view, and these very quotations show that the people had some knowledge of planets in the Vedic age.

In these days people of all ages very well recognize the planets Jupiter and Venus and particularly Venus. It appears in the east continuously for some days early morning and then in the west in the evening. It appears in the morning in the east for about 9 months in every span of 20 months. It seems hardly possible that such a bright object as Venus which is visible in the east for about nine months out of twenty and which is bound to attract the attention of all, failed to be a source of joy and wonder to the ancient Rṣis who used to awake up and bathe early before dawn and start their sacrificial rites; and that the Rṣis failed to note that it had a motion of its own, quite different from that of other stars—that it was a planet in astronomical parlance.

They had really noticed this fact at the very time when the most ancient Vedic hymns were composed and had accordingly invested Jupiter and Venus with divinity. We are inclined to think that the conception of Āśvins as twin gods probably owes its origin to the two planets Jupiter and Venus. Venus appears in the east early morning for about 9 months out of every 20; and almost on every such occasion Jupiter is seen near it for about 2 to 3 months, and in these months it is seen very close to Venus for a few days. Later on, Venus being the faster of the two, Jupiter is seen lagging behind to its west, and is seen rising earlier than Venus every day, and this continues till Jupiter is found to be on the point of setting in the west just when Venus is rising in the east; Jupiter is thus seen to have traversed the whole sky. It was perhaps sometime when Jupiter and Venus were seen together that Āśvinhood was fancifully conferred on them. Again, when it was seen that Venus for ever remains close to the sun while Jupiter is wandering through the sky the observation must have found expression in the following couplets*.

ईन्द्र्यायुधे भुजास्वरूपं रक्षकं येमधृ: । पर्यंत्या नाहुष्य युग्म मध्यं राज्यित दीययः ॥

*The following note was added at the time when this part of the book was first written on 30th December 1887.
(See next page)
“Oh Aśvins! You have kept one lustrous wheel of your chariot near the sun for adorning him and you revolve round the world by the second wheel.”

Of these remarks, the first one viz., ‘you have kept the lustrous wheel near the sun’ very fittingly applies to Venus and the second viz., ‘you revolve round the world by the second wheel’ applied to Jupiter equally fittingly.

The Nirukta includes Aśvins in the list of celestial deities. The time prescribed for offering prayers to them was after midnight. The dawn (Ūṣā) was always associated with the Aśvins in some way or the other in the hymns addressed to them in the Rigveda. Habitually rising with the lark, our ancient Rṣis were bound to feel the attraction of the sky.

These facts lend support to our surmise and all things considered, we feel convinced that the “Twin Aśvins” were originally none else than the planets Jupiter and Venus.

We come across an independent reference showing that Jupiter was known to be a planet.

बृहस्पति: प्रथम जायसानो महो ज्योतिष: परमे भोजनः ॥

जसं सं ५. ६०. ४. अस्य सं २० यश. ४.

“Jupiter was first born in the highest heaven of shining light.”

This sentence occurs also in Taittiriya Brāhmaṇa (2.8.2). The idea conveyed therein seems to be that Jupiter is a god in the form of a star. The Taittiriya Brāhmaṇa further says:

बृहस्पति: प्रथम जायसान: ॥ तिथयं नक्षत्रमभिसम्भवेऽः ॥

तै. भृ. ३. १. १.

“Jupiter when born was first visible near the star Tiśya (Puṣya).”

The maximum latitude of Jupiter is 1° 30’. Hence, there are only 6 out of 27 nakṣatras viz., Puṣya, Maghā, Viśākhā (Alpha Libra), Anurādhā, Satabhiṣak and Revati with whom Jupiter can form a close conjunction. Sometimes Jupiter and the star Puṣya are so closely conjoined that they together appear to be one body. The idea of Jupiter having been born near Puṣya star might have arisen when Jupiter was seen emerging from such occultations. Evidently this would call for the knowledge of Jupiter’s motion, that is to say, the knowledge that Jupiter was a ‘wandering star’ or planet. The presiding deity of Tiśya is Brhaspati. Even now the conjunction of Jupiter and Puṣya is regarded as the most auspicious.

Contd. from previous page

Venus rose heliacally in the east on 26th September and Jupiter rose in the east on 21st November. The two, therefore, began to be seen in the eastern sky before dawn from 21st November. Now they are being seen very near together for the last 2 or 3 days. They will come nearest to each other after about two days, i.e., on 2nd January 1888, that is to say they will be in conjunction. About 1st of June, while Venus will still be seen rising in the east, Jupiter will be seen on the point of setting in the west, and after a few days Venus will disappear in the east. A gentleman who had no knowledge of astronomy, pointed out to me, of his own accord, early in the morning that two planets were situated near each other. It is not, therefore, possible that the attention of our ancient sages was not drawn to Jupiter and Venus in the same way when they joined. —The Author
The hymn "this Vena has risen etc." is sung in honour of the deity known as *Vena*. The description in this hymn naturally suggests that it refers to some bright celestial body, that is, to a star or planet; and descriptions found elsewhere in the Vedas further show that it refers to Venus. The vessels used for storing Soma juice during a sacrifice are called *grahas*. They are so called because they "take in" i.e., store the Soma juice. When the sacrifice is in progress the juice is first placed in the graha and then oblations are offered thereof which are called *grahas*. Two planets, Venus and 'Manthi' are referred to in the Agni-Soma sacrifice. The *Satapatha Brähmana* makes observations about them as below:

चक्रूणी ह्वा अय शुक्रांविनिः।
तदा एव एव शुक्रो एव सर्वसंतीति तद देव एततपति
तेनेवस्कल्पंत्रम एव संस्कृती॥ १ ॥

.....इसाद्वृहः हृदे शुक्रय शुरुचि कःविति।
अय वेनसीयाः
शुक्रांविनिः ज्योतिजरायू रजसो विद्यमान इतिवेतस्य रूपं कृमो एव तपतिति इदाह्योतिजरायूति॥ २ ॥

意志. व्रातः. ३. १. १.

"Śukra (Venus) and Manthi are his eyes. The bright shining body is the same as Śukra. He is called 'śukra' because he shines. The Moon herself is Manthi. Some recite the Rca "Ayam Venaşcodayat" in the beginning while offering prayers to Śukra. The 'jyoti' is said to be 'jarāyu'.

Its appearance may be described by the words 'he who burns'.

These lines show that Vena and Venus (Śukra) are the same; here the moon is called the *manthin*; but there is also a convention of taking Manthin to mean Saturn.

Śukra is called Venus in Latin. Kupros is the Greek form of Śukra. The Greeks regarded Venus as female deity and hence, the word took the form 'Kupris' and its corresponding Latin form is Cypris; thus Venus and Kupris or Cypris are equivalents; and they resemble the words 'Venah' and 'Śukhā' in form*.

It appears from this that Venus was known to the Aryans from the time the Greeks and other European Aryans and the Indian Aryans were living together.

世界संस्कृति राष्ठ्रास्तितिस्वदिष्ट्यसति शुक्रास्ति चंद्रास्ति बृहस्पतिस्वदिष्ट्य सुन्ते राघवु

तेष सं. १. २. ५.

"Oh Soma Krayāni! You are Vēṣyī (i.e. Vēṣu and other deities); you are Rudrā, Aditi and Ādityā; you are Śukrā and Candra. May Brahma bestow happiness upon you in this region."

This is addressed to the Cow who is given away in exchange of Soma juice. Adityā is one related to Ādityā; this is used in feminine gender because it qualifies the cow. Śukrā and Candrā are similar feminine forms; here also the word Śukrā appears to refer to Venus.

*This resemblance was suggested to the author by Mr. Bal Gangadhar Tilak.
From this it is clear that at the time of the composition of Atharva Veda the term graha has come to be applied to some celestial bodies. The words “May the cāndramasa graha and Aditya graha along with Rāhu prove auspicious to you” seem to refer to the planets eclipsing the sun and moon; and the additional remark “May the planets moving in the sky bring happiness to you” appears to have been made with reference to planets such as Venus.

The German Professor Weber* who is of opinion that the Hindus have borrowed even the nakṣatras from the Babylonians declares that it appears from the names of planets that the Hindus discovered them independently.

On the whole, we feel that the Indian people had the knowledge of the planets Venus and Jupiter in the Vedic age; and if this be true, it is not improbable that they might have had some knowledge also of Mars who sometimes appears as bright as Jupiter, or of Mercury who always remains near the Sun, and of the slow moving planet Saturn.

METEORS AND COMETS

The quotations from Atharva Samhitā (19.9) given above contain the words Ulkā (Meteors) and Dhūmaketu (Comets). Varāhamihira has extensively dealt with the results of a meteor striking against a star.

AUSPICIOUS TIME

Even in the Vedic age people believed that an auspicious time is necessary for doing anything.

“Vipra (intelligent) [Varuṇa] established the reciter of hymns in an auspicious day, after expending the passing days and nights”.

The Taittirīya Śruti contains good many instructions for performing the agnyādhan and other rites on particular nakṣatras and some of them have already been given above in some context or other. Some more are given below:—

“On the rise of nakṣatras he breaks his silence saying ‘perform a particular rite’.

It is well known that the works on Dharmāstra abound in instructions regarding certain rites to be performed till the rise of nakṣatras and in beliefs that certain persons become purified at the sight of nakṣatras.

*See Weber’s History of the Indian Literature, Page 251.
THE VEDIC PERIOD

II. कामयेत चालकामे ने प्रजा: स्युंरिति। स पूर्वमै: फलपुष्पिरिनिमाधवयी।
अर्नं वा एतंख्यं। यथूवे पल्लुंगी। अवर्मेरितं तमाहृयं द्वारित। वानकामा अस्मं
प्रजामयेति।

वृ. भ्र. १. १. २.

याओ बेमनकारण। तेसु कुर्यसन जनकारस्वात। पुष्पां एव कथते।

वृ. भ्र. १. ५. २.

यां कामयेत दुहितर प्रवास्वारित। तां मन्द्वयां द्वात। प्रवेष्तबित।

वृ. भ्र. १. ५. २.

(i) "He who is desirous that his progeny should be generous, should commence a sacrifice on the Pūrva Phalguni day; because, the Pūrva Phalguni nakṣatra belongs to aryamā (sun). He who gives away on this nakṣatra comes to be known as 'aryamā'. His progeny has a charitable disposition."

(ii) "Whatever good rites you have to perform, do them on divine nakṣatra days, because they are auspicious days."

(iii) "If you wish that your daughter should be dear to her husband, marry her on the 'Niṣṭyā' (i.e., Śvāti) nakṣatra day."

पीषन्त ध्वस्यान। मंत्राण कृत्तत। वाष्णव विप्रवाता आसते। क्षेत्रप्रत्येक पाठ्यते।

आदिष्येन नादवते।

वृ. भ्र. १. ८. ४.

It appears from the remark 'aśīla nāmaṇīcitre' (on page 50) that just as people had certain notions about the auspicious character of stars, so also they had their notions about the character of days considered apart from the nakṣatras; these lines further show that the nakṣatras were distinguished as evil or good from their names, etc. The principle by which the day was adjusted to be good or evil is, however, not understood. It seems that the nakṣatras received their names from their luminosity, form, and the malefic or benefic nature attributed to them through fancy or experience. To some extent this involves the fallacy or arguing in a circle. But even in the post-Vedic works on astrology we find many a rule framed simply in the light of the significance of names. Thus, for instance, one may be advised to settle a marriage between the bride and bridegroom if they are born, say, under the signs Aries and Leo respectively on the assumption that the ram (Aries) yields easily to the lion (Leo).

COMMENCEMENT OF THE YEAR

Let us now consider as to when the year used to begin in Vedic times. Nowhere in Rk Samhitā do we find the names of all the seasons mentioned together; only the words Sarad and Hemanta occur in many places in the sense of year. As for the other Vedas whenever all the seasons are mentioned, the list invariably begins with Spring. In both the branches of Yajurveda, Spring has been specifically mentioned as the 'mouth of the year' (The quotation have already been given before). The months are named according to the Madhu-Mādhava series, and Madhu and Mādhava are mentioned as the two months of Spring. It is, therefore, proved
beyond doubt that during the Yajurveda Saṃhitā age and during all the Vedic times later, the year used to commence from the month of Madhu and with Spring. The people then might have been occasionally commencing the year from some other season for civil purposes: but as a rule the year used to commence from Spring. Now the months were lunar and the seasons depend upon solar year; and if a particular solar year began with the beginning of a lunar year, there being difference of 11 days in the two units of time, the beginning of Spring will not invariably coincide with the beginning of the lunar year and Spring used to set in invariably in the month of Madhu; there is no doubt that the system of commencing the year with the month of Madhu was in use in the Yajurveda Saṃhitā age and even in later periods.

Some other astronomical features of the Vedic age will be dealt with in the conclusion of Part I.

ASTRONOMY

It seems that the science of astronomy had assumed a tangible shape in the Vedic period. The Vaiṣṇavey Saṃhitā contains the following lines:

प्रज्ञानन्य नक्षत्रदर्शनं || वर. सं. ३०. २०.
एकं गणकं || वर. सं. ३०. २०.

(i) “(Go to) an observer of stars for special knowledge” and
(ii) “a calculator for Yadasa…”

The first of these quotations occurs even in Taittirīya Brāhmaṇa (3. 4. 1). The words gaṇaka and nakṣatra darśa occur here. The Taittirīya Brāhmaṇa (3. 4. 1) mentions also the names of certain sages who were proficient in these sciences. It is stated at one place that a certain sage named Mātśya got some rite performed on an auspicious nakṣatra and it proved beneficial (1.5.2). The anuvāk which contains the names etc. of the month in a year, the days and nights of the month, and muhūrtas and pratimuhūrtas which has already quoted above has the following lines at the end:

जनको हृ बैठकः || असोहरवः समाजाय || ता होकः || को जा अस्मानः वेष ||
विज्ञानीयामानिषेत || ६ || अतिस्वर्ग लोकं जनति || अही नाहाहवस्चत्यः || सारवित्र विद्वान-चकार || १० || ग हुहुसो…सूत्वा || स्वर्ग लोकमयाय || वेषभागी हृ शोचवः || सारवित्र विद्वान-चकार || ११ || ……सूत्रो हृ वात्सल्य: अविद्येय समाजाय ||
ते ब्रा. ३. ३०. ६.

“The Vaideha Janaka went with ‘days and nights’. They told that he who knows them becomes sinless and ascends to heaven. Ahīna, the son of Aśvattha learnt the science of Sāvitra; he became a swan and ascended heaven. Śrautarṣa Devabhāga learnt the science of Sāvitra. The Vārṣneya Śuṣa became united with Āditya.”

This appears to be partly related to Vedānta philosophy; but the context shows that it has also some bearing on astronomy. On the whole we are led to conclude that astronomy had grown into an independent science in the Vedic period.

In the above discussion all the Vedic quotations have been considered together. That does not mean, however, that they were all composed and
made known to the people at one and the same time. Hence, it follows that it was not that the astronomical facts embodied in those quotations were all known to them at one time. It is obvious that the astronomical knowledge must have gradually developed as time rolled on.

It would not be correct to infer whatever has not been mentioned in the Vedas was not at all known to the people of Vedic times. The Rk Śāṁhitā, for instance, refers to eclipse but does not mention all the names of stars. The Taittiriya Śruti, on the other hand, contains references to the nakṣatras by hundreds, but does not refer to eclipses at all. But it would be absurd to presume on this ground that the people then knew nothing of eclipses. Other matters also should receive such judicious consideration.

THE DIVINE DAY

An important sentence may be cited before the close of this chapter.

एकं वा एतं वानामहः ॥ यत्संवल्सरः ॥

ते व्र. ३. ६. २२.

"The year is equivalent to a day of the gods."

Gods dwell on the Meru mountain at the North Pole of the Earth, and in the polar regions the day lasts for six months and the night for six months. Hence, the year is known to be equivalent to a 'divine day' in the post-Vedic works on astronomy. Who knows whether this remark emanated from a knowledge of the durations of day and night at the poles or not? Be that as it may, the rationale of the Yuga-measure, as expressed in terms of years in the post-Vedic works, is to a certain extent implicit in this sentence. The next Part will treat this question at a greater length.
SECTION II
THE VEDĀNGA PERIOD
CHAPTER I—VEDĀNGAS
1. ASTRONOMY

“Śikṣā, Kalpa, Vyākaraṇa, Nirukta, Jyotiṣa and Chandas” are regarded as the six parts (Aṅgas) of the Vedas. At present a separate Sūtra (Kalpa) for each Veda is available and it is recited generally by the Vaidic Brahmins belonging to each branch (Śākhā); as regards other parts, the Vedas cannot possibly have separate ones. The remaining five parts, which are at present available, are recited by Rigvedi Brahmins only and not by those belonging to other Vedas. The Vedāṅga Jyotiṣa (astronomy) which we hear was recited by Vaidic Brahmins, consists of 36 verses; but there is another work known as Vedāṅga Jyotiṣa and which is commented upon by Somākara. The commentary by Somākara gives the remark “Yajurvedāṅga Jyotiṣa by Śeṣa” at its end. This portion is not at all different from the one recited by the Rigvedi Brahmins. There is also another work known as Atharva Jyotiṣa. It cannot be said for certain that the three Vedas had originally different “astronomical works” (Vedāṅga Jyotiṣa); it will, therefore, be convenient to call them by different names for a clear understanding of the same. Let us call the astronomical work recited by Rigvedi Brahmins as “Rigveda Jyotiṣa” and that which bears the commentary by Somākara as “Yajurveda Jyotiṣa”. The Atharva Jyotiṣa is quite a different one. The first two are similar in many respects; out of 36 verses belonging to Rg-Jyotiṣa, 30 are found in the Yajurveda Jyotiṣa also, which has 13 different verses. The total number of verses on astronomy and belonging to the two sections together amount to 49. It is also interesting to note, that of the 30 common verses, one verse is similar in meaning but different in words and metre.

No information regarding Somākara’s date, etc. is available and in no other work or commentary is his name found. His commentary is found to be of two kinds. One is an extensive commentary in which Somākara mentions his name in the beginning and adds at the end the remark “The Vedāṅga Jyotiṣa by Śeṣa ends.” The second kind is an abbreviation of the first one. It does not mention either Somākara’s name or the word “compiled by Śeṣa”, etc. Those verses which are very easy to understand or those which deal with mathematics, are left aside; there is no harm if one thinks that Somākara did not understand the work at all. Even none of other astronomers appears to have attempted to explain the mathematical side of the Vedāṅga Jyotiṣa; and because it has very little in common with other astronomical works, we seldom find its references in them, and those very few references will be dealt with in subsequent pages. This work is a very ancient one and as such occupies an important place in the history of astronomy. It should, therefore, be fully considered.

In 1879 A.D. Prof. Thibbaut published a small booklet on the translation of Yajurveda Jyotiṣa, which shows that he could succeed in explaining 6 verses more than what Somākara could do. In 1881 A.D. the author attempted to translate as many verses of Yajurveda Jyotiṣa as he could understand. Late Krishna Shastri Goḍbole had attempted to explain the work but
he could not explain more number of verses than what Prof. Thibaut could. In 1885 late Janardan Balaji Modak, B. A. published a Marathi translation of Rg-Jyotisā and Yajur-Jyotisā, from which it can be said that he could explain 2 or 3 verses more. He explained only 28 verses out of 49. The author is at present in a position to explain 36 verses out of 49.

At present only the Rg-Jyotisā is recited by Brahmans. It is not known if Brahmans in any part of India now recite the Yajurveda Jyotisā or ever used to do so in the past. There is an interesting thing about the text of Rg-Jyotisā which is widely in recitation among the Vaidic Brahmans. It is worth noting that a number of verses contains words giving erroneous meaning. The words are incorrect; still it is interesting to see that these are recited throughout India in this form.

It is no wonder that people regard the text with the same veneration as the Vedas, and hence, a suggestion to the reciter to replace the incorrect form by a correct one would become unacceptable. It is obvious that the astronomical work would not have been erroneous originally; and hence, the research as to when and how these errors have crept in, would be found very important in the study of the history of the Vedas and Vedāṅgas. It seems that the original Vedāṅga Jyotisā must have disappeared some time in the past, and later on some pandit, not understanding the text, must have introduced the recitation of the text from an illegible or incorrectly written edition available to him. This is not the condition of other works connected with Vedic literature and hence the above can become a subject of research for the historians of Sanskrit literature. The author has written later on his findings about some of the verses. Of the six Vedāṅgas, Pāṇinī wrote Vyākaraṇa (grammar); Piṅgalā is the author of Chandaśāstra (metre), and so were Lagadha of Rigveda Jyotisā. The second verse of this astronomical work is written, “I am giving the knowledge of time as described by Lagadha.”

This is somewhat like the recitation of two verses (devoted to the salutation of Pāṇinī) before commencing the recital of Aṣṭādhyāyī. It is just possible that Lagadha was not the author of the whole work; some one might have recast it later on in accordance with Lagadha’s suggestions. “लाग” is expressed by the Europeans as ‘Lagad’ or ‘Lagadh’. This confusion seems to be due to the fact that the letter ल cannot be properly expressed in roman character, and it is on account of this that Prof. Weber has expressed a doubt that if Lagad be the same person as Laat, he must have lived in the 5th century A. D. But the Sanskrit texts mention the name as ‘Lagadhu’ beyond doubt.*

In what follows, the translation of more important verses common to both the Vedāṅga Jyotisās is given first. In the beginning, the Rg-Jyotisā has been taken up and the text is written exactly in the form in which it is actually recited. If the same verse happens to belong to the Yajurveda, but with a different version given by Somākara and giving a better sense, it is also given later on. These are followed by those verses from the Yajurveda which are not found in Rg- Jyotisā. Then useful suggestions and criticism are given

* Dr. Kern has published the Aryanhatīva. He has in its introduction given some quotations from the original commentary “Bhataprakāśika” in the Malayalam character. The commentator has, at one place, quoted two verses from Vedāṅga Jyotisā as “being written by Lagadācārya”. In this he writes the name as “Lagad”. The mistake might have been committed because of the similarity of D & DH in the Malayalam character. It is worth seeing if the Brahmans of this province while reciting the Rg- Jyotisā pronounce the name as “Lagad”.

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with the verses themselves wherever it was possible to do so. Attempt has been made to retain the originality of the text in the form in which it is recited by Vaidic Brahmins.

For the sake of convenient comparison and contrast, the verse numbers belonging to one of the Vedângas are given in the first column and the corresponding verses belonging to the second Vedânga are given in the next column. The first two columns are the analysis of verses belonging to Rigveda Jyotisa and the last 3 columns are that of verses belonging to Yajurveda Jyotisa.

<table>
<thead>
<tr>
<th>Analysis of Rg-Jyotisa</th>
<th>Analysis of Yajur-Jyotisa</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Y</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
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<td>2</td>
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<td>3</td>
<td>2</td>
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<td>7</td>
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<td>8</td>
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<td>9</td>
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<td>10</td>
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<td>17</td>
</tr>
<tr>
<td>16</td>
<td>38</td>
</tr>
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<td>17</td>
<td>24</td>
</tr>
<tr>
<td>18</td>
<td>39</td>
</tr>
</tbody>
</table>

(I) RIGVEDA JYOTIȘA

पञ्चांशर्ताणां युगाधिकृतं प्रजापतिः ॥ बिनेकवंनमासां ग्रणम् शस्रस् शुचि: ॥ १ ॥
प्रणम्य शस्रसा कालमभव्य सरस्वती ॥ कालजान्य प्रवक्ष्यामि समधस्य महातमः ॥ २ ॥

"After saluting Prajâpati who is the lord of the five-year Yuga (which consists of the day, the season, the ayana and the month as its parts) I become
purified and then after saluting the god of time and also the goddess of learning (Sarasvati) I describe the knowledge of time as propounded by the great sage Lagadha”.

It is a bit surprising to note that the names of the 5 years comprising the Pańca-Samvatsara-Yuga (five-year-period) are not found in the Vedāṅga Jyotiṣa. But Somākara has quoted some verses belonging to Garga to which the author has referred in his note on the 8th verse. Those verses give a description of Pańca-Samvatsara-Yuga similar to that given by the Vedāṅga Jyotiṣa and they mention names for the five years. The Brhat Saṃhitā by Varāhamihira gives the names of years and their Lords. (See Brhat Saṃhitā 8-10); some of these Lords are different from those mentioned by Garga. A line from Taittirīya Brāhmaṇa has already been quoted on page 15 which gives the names of Lords of years; but they are only four and different in certain respects. These are given below:

<table>
<thead>
<tr>
<th>Name of the year</th>
<th>Tai. Brāhm</th>
<th>Garga</th>
<th>Varāha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Samvatsara</td>
<td>Agni</td>
<td>Agni</td>
<td>Agni</td>
</tr>
<tr>
<td>2. Parivatsara</td>
<td>Āditya</td>
<td>Āditya</td>
<td>Āditya</td>
</tr>
<tr>
<td>3. Idvatsara</td>
<td>Candramā</td>
<td>Vāyu</td>
<td>Candra</td>
</tr>
<tr>
<td>4. Anuvatsara</td>
<td>Vāyu</td>
<td>Candramā</td>
<td>Prajāpti</td>
</tr>
<tr>
<td>5. Idvatsara</td>
<td>Mṛtyu</td>
<td></td>
<td>Rudra</td>
</tr>
</tbody>
</table>

If the words “Dvādaśāhyastam” and “Samyutam” from Yajur-Jyotiṣa be substituted for “Dvādaśārdhābdam” and “Saṃjñikam” from Ṛg-Jyotiṣa; the above verse can be translated sensibly as follows:

“Reduce the current year number (out of the 5 year cycle) by one. Multiply the result by 12. Add number of months elapsed. Double the sum. Add 2 for every sixty. The resulting sum is called Parva Rāśi”.

Example.—Find the Parva-number (i) in the beginning of the second year of the cycle and (ii) at the end of the 7th month of the 3rd year.

Solution.—(i) Current year number minus one=2−1=1. 1×12×2 gives 24. (ii) Current year number−1=3−1=2. (2×12+7)×2+2=64.

This is just like calculating the number of days elapsed from the epoch. This shows that one intercalary month is reckoned after 60 Parvas i.e., after every 30 lunar months. Some verses from Rigveda-version suggest this; but verse number 37 from Yajur Jyotiṣa definitely mentions the rule.

स्वराष्ट्रमेव सोमाकाः यथा साधं सवासवी || स्त्रालवसायुः माघस्तप: सुऽको दिनंश्याः || ५ ॥

यजुःपाठः:

स्वराष्ट्रमेव सोमाकाः यथा साधं सवासवी || स्त्रालवसायुः माघस्तप: सुऽको लोकोऽवहुतकः ॥

“When the sun and the moon while moving in the sky, come to Vāsava (Dhanisthā, 3-Delphini) star together, then the Yuga, the Māgha (month), the Tapas (season), the light half of the month, and the winter solstice, all commence together.”
Note:—The Yajur-version “Candramasa” is correct and not the version “Cândramasa.”

“The sun and the moon turn towards North in the beginning of Dhanișṭhās and towards South in the middle of Āśleṣā. The sun always does this respectively in the months of Māgha and Srāvaṇa.”

The time when the ayanas were possible in Māgha and Srāvaṇa can be calculated; this point has been explained at length in the end.

“During the sun’s northward journey the day increases by one Prastha-measure of water and the night becomes short. During the southward journey, the conditions reverse. The increase (of time) during an ayan is equal to six mūhūrtas.”

An increase of one Prastha is equivalent to 4/61 nāḍikā. In this connection, verse no. 17 may also be seen. At the end of this topic, it is fully discussed as to where an increase of six mūhūrtas is possible.

(The Yajur-version should be accepted for rational meaning).

“The Ayanas commence twice on the Pratipadā, Saptami, Trayodaśi, Caturthi and Daśamī. They are respectively the commencing tithis of both the ayanas which can occur even in dark half of a month.”

The 1st, 7th and 13th of the light half and the 4th and 10th of the dark half are these very 5 tithis occurring again, form the 10 beginning tithis of 10 ayanas occurring in the 5 years; and because the ayanas take place in Māgha and Srāvaṇa, the tithis alternately belong to the two ayanas and hence to the months of Māgha and Srāvaṇa.

That the above verse is to be rendered in this very particular way is supported by the quotations of Garga given with reference to this portion of Vedāṅga Jyotiṣa.

In this verse, the words ‘first, seventh, etc.’ are used in neuter gender, while the word ‘tithi’ is used in feminine or sometimes in masculine and not in neuter gender; this no doubt creates a difficulty. The author has, therefore, taken them to be adjectives qualifying the word ‘day’ (Dinam). They are to be regarded as tithis and not civil days of a civil month, since no such specific mention is made, nor does it agree with the Vedāṅga Jyotiṣa system.

“Vasu, Tvasta, Bhava, Aja, Mitra, Sarpa, the two Aśvinas, Jala, Dhātā and Brahmā are the Lords of the nakṣatras (viz. Dhaniṣṭhā, Citrā, Ārdrā, Pūrva Bhādrapadā, Anurādhā, Āśreṣā, Aśvayuja, Pūrvāṣādhā, Utara Phalguni and Rohini) with which the ayanas begin; one Rtu (season) is equivalent to 4½ nakṣatras.”
Vedanga Period

The first ayana in the 5th year commences on Uttara Phalguni and its Lord, according to Vedāṅga Jyotiṣa, is Aryamā and hence the word Dhātā will have to be translated as Aryamā (this is a difficulty). The nakṣatras alluded to in the verse are lunar mansions.

The meaning of the above two verses will be clear from the 'Garga-quotations' given by Somākara in the following verses.

The gist of the "Garga-quotations" and the two verses (8 and 9) is explained in the form of a table given below. :—

<table>
<thead>
<tr>
<th>Year</th>
<th>Commencement of Winter Solstice</th>
<th>Commencement of Summer Solstice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tithi</td>
<td>Sun’s Nakṣatra</td>
</tr>
<tr>
<td>Samvatsara</td>
<td>Māgha S 1</td>
<td>Dhaniṣṭhā</td>
</tr>
<tr>
<td>Parivatsara</td>
<td>„ 13</td>
<td>„</td>
</tr>
<tr>
<td>Idāvatsara</td>
<td>„ K 10</td>
<td>„</td>
</tr>
<tr>
<td>Anuvatsara</td>
<td>„ S 7</td>
<td>„</td>
</tr>
<tr>
<td>Idvatsara</td>
<td>„ K 4</td>
<td>„ U. Phalguni</td>
</tr>
</tbody>
</table>
This verse should be read as

which is the Yajurveda version and a correct one. In this verse 27 nakṣatras have been indicated by symbolic letters as follows:

1. Jau—Aśvayujau for Aśvini
2. Drā for Ādrā
3. Gaḥ—Bhagah for P. Phalguni
4. Khe for Viśākhē
5. Śve—Viśve (Devā) for U. Aṣādhā
6. Hīḥ—Ahirbuddhnyā for U. Bhadrpadā
7. Rō for Rohiṇī
8. Śā for Aśreṣā
9. Cīt for Cīrā
10. Mū for Mūla
11. Śak for Śatabhiṣak
12. Nyāḥ for Bharanyāḥ
13. Sū for Punarvasū
14. Mā—Aryāmā for U. Phalgunī
15. Dhä for Anurādhā
16. Naḥ for Śravaṇaḥ
17. Re for Revati
18. Mr for Mrgasārṣa
19. Ghā for Magha
20. Svā for Svātī
21. Pah—Āpah for P. Aṣādhā
22. Ajah—Aja Eka Pād for P. Bhadrpadā
23. Kṛ for Kṛttikā
24. Śyaḥ for Puṣyaḥ
25. Ha for Hasta
26. Jye for Jyeṣṭhā
27. Śṭā for Śraviṣṭhā

The list contains the nakṣatras beginning with Aśvini and then every 6th nakṣatra from it. The symbols are either the beginning letters or the ending letters of nakṣatra names or those of controlling deities.

The theory underlying this is as follows:— It appears from the above* verse and from the 25 verses of Yajur Jyotiṣa that 1 yuga contains 124 parvas and hence one nakṣatra division is supposed to be divided into 124 parts. One yuga contains 1860 tithis and the Sun revolves through the nakṣatras 5 times during a mahāyuga (see Yajur Jyo, verses 28 and 31). Hence the Sun moves through $\frac{9 \times 27 \times 124}{1860}$ i.e. 9 parts during one tithi. The following table gives the part (or degree) of a particular nakṣatra which the Sun occupies at the end of each Parva. From this it can be seen that the Sun will be found on the part number which is the ordinal number of nakṣatra in the list. For example: Aśvini is the first and Ādrā is the second nakṣatra; whenever the sun would come to Aśvini (i.e. at the end of 5th, 30th, 55th, 79th and 104th parva) the sun would be found to occupy the first part or a multiple of 27 plus one part and when it would come to Ādrā it would occupy the second part or multiple of 27 plus 2 parts and so on. In the last column of the table is noted the balance which remains after dividing the number of parts of a nakṣatra by 27. Each nakṣatra occupies that place in the list which is indicated by that number. The scheme or the system cited above can not be rightly understood, as the meanings of all the verses are not clear. It is just possible that originally there might have been verses explaining the system, but those verses are now lost for us.

*A nakṣatra is supposed to consist of 610 Kalās (minutes), as given in verses 18 and 21 of Rk-version. This number refers to the Moon’s motion.
### Vedāṅga Period

The Sun’s position at the end of each Parva in the 5 years of a Yuga.

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<td>Bhādraṇāda</td>
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<td>16</td>
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<td>U. Phalguni</td>
</tr>
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</table>
It seems, while writing out this chapter, he must have had before his mind this very verse from Vedāṅga Jyotiṣa. But although he has made use of the term ‘drona’ in the next verse, he does not mention any relation between ‘āḍhaka’ and ‘drona’. It may be, he did not find any suitable place wherein to mention this relation, because the four ‘quarters’ of the verse were already composed. Also, the commentator Bhāṭotpala says, “because 50 palas are said to make one āḍhaka, and four āḍhakas make one drona”. These parts of a verse so much agree with the 2nd and 3rd quarters of 17th verse of Vedāṅga Jyotiṣa, that Bhāṭotpala appears to have taken the quotation, without doubt, from Vedāṅga Jyotiṣa. Bhāskarācārya and the others have also mentioned ‘drona’ as equivalent to 4 ‘āḍhakas’ and the real verse of Vedāṅga Jyotiṣa ought to run as follows and it will then remain in agreement with the context:—

‘One muhurtas = two nāḍikās; 50 palas = 1 āḍhaka; 4 āḍhakas = 1 drona — this being larger than one nāḍikā by 3 kuḍavas’.
Here we have to take for granted the words "Than one nāḍikā". This word occurs in the first quarter and we can take it without much difficulty. The sense which we thus get tallies with the clear meaning of the verse given by the Yajur-Jyotiṣa, which runs thus:

"The vessel known as 'āḍhaka' holds 50 palas of water. Measure one drona of water with it. Throw away from it water equal to 3 kuḍavas in volume. Then the time needed for the remaining water (to trickle away) is known as one nāḍikā".

The measure of the unit Kuṭapa (Kuḍava) which occurs in the verse needs understanding. Similarly another unit 'Prastha' denoting some measure of time has occurred before in verse No. 7. Vedāṅga Jyotiṣa does not give any relation between Prastha and Nāḍikā. Let us try to understand it. Bhāskaracārya says,


Loṭāvarti.

Meaning:—4 kuḍavas=1 prastha
4 prasthas=1 āḍhaka
4 āḍhakas=1 drona

and according to Vedāṅga Jyotiṣa, 50 palas make one āḍhaka. Hence, the following units can be interrelated as

1 drona=200 palas=64 kuḍavas. 1 prastha=12 1/2 palas.
1 āḍhaka=50 palas. 1 kuḍava= 3 1/2 palas.

Also according to Vedāṅga Jyotiṣa, 1 nāḍikā=1 drona minus 3 kuḍavas. Hence, 1 nāḍikā=61 kuḍavas=(200–3×3 1/2) palas=190 1/2 palas and 1 prastha=12 1/2 palas,

therefore, 1 prastha= \( \frac{12 \frac{1}{2}}{190 \frac{1}{2}} = \frac{4}{61} \) nāḍikās.

It has been said in the 7th verse above that the day-light increases by 1 prastha per day, and it has been now proved that 1 prastha=4/61 nāḍikās, and this agrees with the theory underlying the method of calculating 'measure of day' (Dinamāna) described in 22nd verse. This shows that we have correctly established the relation between prastha, nāḍikā and other units. It has been proved that 'nāḍikā' stands for that measure of time during which 190 1/2 palas volume of water would trickle away; but no rule is given as to how to regulate the size of the hole to ensure the correctness of time for a definite volume of water to flow out. It appears that it was considered unnecessary to dilate upon this as the ghaṭikā vessel had come into common use since a long time. According to Amarkoṣa, Lilāvatī and other works, one pala=4 karṣa=4 tolaś of water; or 190 1/2 palas×4=762 1/2 tolaś; which amounts to a volume greater than 9 seers of water. The ghaṭikā-vessels which are found in use at present can hold 1 1/2 seers of water at the most. The bigger the vessel in size the greater is the accuracy of time and hence big vesseles are always desirable.
The unit of time known as ‘pala’ appears to have been derived from the
time which 1 pala (spoon) full of water takes to trickle out. The pala, there-
fore, is a unit of volume and of time also. In astronomy the word ‘pañiyapala’
is found in use to indicate a ‘pala-unit’ (see Siddhānta Siromani). According
to Vedāṅga Jyotiṣa, a gaṇṭikā was not considered to be equivalent to 60 palas
but equal to 190½ paṇiyapalas. This measure is inconvenient for calcu-
lations. However, the work does mention ‘a day = 60 nādikās’ and it appears
that the identity (1 nādikā = 60 palas) might have come into use; and just as
in Vedāṅga Jyotisa, the measure of one nādikā has been described as the
time for 190½ palas of water to trickle out, so the future generations may
begin to define a nādikā as the time for 60 palas of water to pass out. It
does not matter as to the number of palas which a nādikā would consist of;
since, one nādikā has always to remain equivalent to 1/60th part of a day,
it is constant in value. The relation “1 nādikā = 60 palas” can be maintained
if the size of aperture in the vessel of capacity 60 palas be so adjusted that the
water in it would pass out exactly in 1 nādikā time. Even at present, people
do not care to know as to how much water their “gaṇṭikā pātra” (nādikā vessel)
should hold. They take care to see that the bore is sufficiently small so that
the water oozes out exactly in 1 gaṇṭikā time. The measure of a nādikā as
adopted in Vedāṅga Jyotiṣa period no doubt appears very inconvenient,
but it will be shown later on that it is really a convenient one.

There will be very little change if the word ‘Syaṇa’ in the first quarter of
the Rk-verse be replaced by ‘Śyena’.

“The moon remains in a nakṣatra for a period of 1 civil day + 7 (kalās).
The Sun remains there for 13½ days. 5 letters are equal to 1 kāśṭhā”.

A solar year consists of 366 and one Yuga contains (366 × 5) = 1830 civil
days (see Yajurveda-verse No. 28); and the moon moves through the nakṣatras
67 times during one Yuga (see Yajurveda-verse No. 31). The moon, there-
fore, moves through $67 	imes 27$ nakṣatras in one yuga. One day consists of
503 kalās. Hence, one yuga contains 1830 × 603 kalās. The moon, there-
fore, requires $\frac{1830}{27} \times \frac{603}{67} = 610$ Kalā-time ($= 1$ day 3 kalās) to pass through
one nakṣatra. The sun takes 366 days to move through 27 nakṣatras; hence,
it requires $\frac{366}{27} = 13\frac{1}{2}$ days to pass through a nakṣatra.

(First half is unintelligible. Translation of second half) — “Multiply the
solar month by six, the result will be lunar seasons”.

Sun’s complete revolution through stars is known as a year and 6 seasons
occur in this period, so the six lunar seasons will occur in moon’s one revolu-
tion through the Zodiac. But the moon’s one revolution is equal to one solar
month. Hence number of solar months multiplied by six will give the period
for the moon’s seasons. This is an approximate result. According to Vedāṅga
Jyotiṣa the moon makes 67 revolutions in 60 solar months, and therefore,
one solar month gives rise to $\frac{6}{67} \times 60 = 5\frac{5}{3}$ lunar seasons.

Ya: Pāṇiṣadakaśṭrātād saptādhaḥ tīrthī. 21
“To obtain ‘Ādāna Kalā’ (i.e. Bhogyo or elapsable number of kalās) at the end of the day falling on a parva, add seven times tithi to the Ādāna Kalā (elapsable kalās) of the nakṣatra(=Bha) on the parva-day in question”.

One civil day contains 603 kalās and a nakṣatra is equivalent to 610 kalās. Hence, the moon after passing through 603 kalās in one civil day, still leaves 7 kalās more to be passed over next day; it thus leaves 14 kalās more after 2 days and so on. The above rule is based on this theory. The tithi here stands for a “civil day”.

यदुर्स्याकेयन्त्यन्ति स्थानानां तु यद्विश्वासातीत्यन्ति ॥
तदेव बद्यत्र हि चर्च विभवं विभवं स्ह्रव्यज्ञयस्माताः ॥ २२ ॥

यजुःपाठ—

यदुर्स्यायन्ती गतं ना्खादं तथा दक्षिणायन्ती ॥
तदेव बद्यत्र हि चर्च विभवं विभवं स्ह्रव्यज्ञयस्माताः ॥

(The work ‘Tadevaśaṣṭya’ in both these versions must be replaced by ‘Tadekaśaṣṭya’ to give a sensible meaning).

“Find the number of days elapsed after Uttarāśaṇa or number of days yet to go for the Daksīṇāyana; multiply the number by 2 and divide the product by 61. Add 12 to the quotient getting the measure of a day in “muhūrtes”.

One can understand the theory underlying the above method from the fact that one year consists of 366 days, one ayana contains 183 and the total increase during this period is 6 muhūrtes. Therefore daily increase over 12 muhūrtes would be \(\frac{1}{12} \) of \(\frac{1}{61} \) muhūrtes or \(\frac{1}{61} \) nāḍīkās.

Example.—Find the “length of the day” on the day just after Uttarāśaṇa commences. The increase \(=\frac{1}{5} \) of muhūrtes. Therefore the “dinamāṇa” or length of the day will be \(\frac{1}{61} \) muhūrtes or \(\frac{1}{61} \) nāḍīkās.

In verse 7 it has been already stated that the day increases by a prastha, and it was proved in 17th verse that a prastha was equal to \(\frac{1}{61} \) nāḍīkās. The relation of 61 kuḍāvas equal to one nāḍīkā is a convenient adoption to avoid lengthy multiplications and divisions.

तदवर्ष विनाभानां तथा पर्वित्ति पर्वित्ति। अवस्योऽस्तु सहिष्ठात्व सर्वाय सहुर्विभयां अ। २३ ॥

यजुःपाठ—यद्विश्वासातानां...। क्षणु।...सर्वाय...॥

(Yadardham has been taken as the correct word).

“Ritu-śeṣa (balance of a Ritu) is obtained by the sum of balances in all parvas; at the end of each parva a balance of a half-tithi remains”.

The time between two parvas is equal to a “half-lunar month”. A Yuga contains 1830 civil days, 120 half-solar months and 124 parvas; hence, a half-lunar month = \(\frac{1830}{120} = 15 \frac{1}{2} \) civil days; a half-solar month = \(\frac{1830}{24} = 15 \frac{3}{4} \) civil days. The balance per parva is, therefore, \(15 \frac{3}{4} - 14 \frac{1}{2} = \frac{5}{4} \) civil days = half-tithi. The seasons depend upon solar months; hence, this is the balance in half-lunar month. This is termed “Adbhimāsa śeṣa” in books on astronomy. The balance in 30 lunar months comes to \(=\frac{5}{4} \times 30 = \frac{152}{3} \) civil months which is equal to one lunar month. Hence, one month is reckoned as intercalary after every 30 lunar months. The theory about the intercalary month and the meaning of the above verse will thus be clear.

अभिन: प्रकाषारिति: सोमो ख्रिहितितिबहुस्पति।।
सप्तदश विद्यतिधेङ्व महतैवायमार च। २५ ॥
These verses give the names of controlling deities of 27 nakṣatras. The names of nakṣatras are not given, but the order definitely begins from Kṛttikā. The commencing part of 27th verse reads “Viṣṇur-Varuṇo-Vasavo”. From this, deities of Śravīṣṭhā and Satabhiṣak become respectively Varuṇa and Vasu; but the Taittirīya Śruti and all astronomical works give names in reverse order. The Yajurveda-version of this part is “Viṣṇur-Vasavo-Varuṇo”; this must be the correct reading and should be accepted.

The nakṣatras and their deities are as follows:

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Comming from</th>
<th>Name</th>
<th>Deity</th>
</tr>
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<tbody>
<tr>
<td>8</td>
<td>1 Kṛttikā</td>
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<td>Agni</td>
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<td>9</td>
<td>2 Rohini</td>
<td></td>
<td>Prājāpati</td>
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<td>10</td>
<td>3 Mrgaśīra</td>
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<td>11</td>
<td>4 Ārdra</td>
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<td>12</td>
<td>5 Punarvasu</td>
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<td>13</td>
<td>6 Puṣya</td>
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<td>14</td>
<td>7 Āstreṣa</td>
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<td>8 Magha</td>
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<td>16</td>
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<td>10 U. Phalgunī</td>
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<td>18 P. Asādhā</td>
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<td>Āpah</td>
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<td>19 U. Asādhā</td>
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<td></td>
<td>Bharani</td>
<td>Yama</td>
</tr>
</tbody>
</table>

"These are the deities of nakṣatras. The holy preceptors (Śastrañās) ordain that the sacrificer should adopt a name based on the nakṣatra (at birth)."

(Note.—Other astronomical works give a method by which persons are given names according to the nakṣatra-quarter at birth, and the same is still in vogue).

"[To find the tithis and parvas elapsed when a certain equinox (after the 1st one) would fall. Subtract 1 from the number of equinoxes under question. Multiply the remainder by 2 and by 1. Multiply each product by 5. The first product gives the number of parvas elapsed and the second product tithis."

**Example.**—To find when the 10th equinox would fall.

Method .—

\[10 - 1 = 9\]

\[9 \times 2 \times 6 = 108 \text{ parvas} \]

\[9 \times 1 \times 6 = 54 \text{ tithis} \]

\[108 \text{ parvas} + 54 \text{ tithis} = 111 \text{ parvas} + 9 \text{ tithis} \]

Adding to this, period elapsed for 1st equinox from the beginning of Yuga, i.e., 6 parvas + 3 tithis

\[= 117 \text{ parvas} + 12 \text{ tithis} \]

The 10th equinox would, therefore, fall after 117 parvas and 12 tithis would pass, i.e. at the end of Kṛṣṇa Dvādaśi (12th tithi of dark half of Kārtika) in the 5th year of the Yuga.

The Yajurveda-version for this formula runs thus:

This verse can directly and easily be rendered as follows:—“Subtract 1 from the equinox-number and multiply the difference by 2. Multiply the result by 6 giving ‘pākṣas’. The half of this pākṣa-number would be the tithi at the equinox time.”
Replacing the word 'Pravṛtta' from Rṣk-version by the word 'Prapanna'
the Yajur-Jyotiṣa reading would be translated thus:

"The knowledge of time concerning the 5 year-cycle (yuga) which com-

mences with the light half of Māgha and ends with the dark half of Pauṣa

is being described now".

"The equinox occurs on the 3rd, 9th, 15th, 6th and 12th tithis (and again

on these very tithis in the same order)".

It has been shown before, that the equinox day was known in Vedic times.
The first equinox occurred 3 solar months after the winter solstice and the
second one 6 solar months after the first. According to Vedāṅga Jyotiṣa three
solar months are equivalent to 93 tithis; and because the Yuga commenced
from the first tithi of Māgha, the first equinox must fall on the 3rd tithi of
light half of Vaiśākha. After six solar months, that is after 6 lunar months
and 6 tithis, the next equinox must occur. Hence, we get the 9th tithi in the
formula. All the equinoxes occurring in a Yuga are given together in a table
later on.

The term 'Trayodaśi' is not clear; otherwise, the verse must be translated
as above.

The verse is understandable if the 9th letter "thah" is omitted.

"The sun and the moon come nearer to one another on the 14th tithi
(of dark half). The moon is so positioned that when it rises, the day dawns.
It conjuncts with the sun on the 1st tithi of light half of Māgha in the day
time and also with the Śrāvaṇa asterism. Similar is its position (at the end
of the first parva) before the commencement of rainy season."

The moon rises when the day has begun, that is, just after sunrise. This is
possible on the 1st tithi of light half of Māgha (on the junction of New Moon
and 1st tithi). The sun and the moon always conjunct on each New Moon
day. The object of mentioning only two New-moon days is that it is only on
two occasions during a Yuga that the Udagayana or Dakṣināyana commence
on New-moon days, the first one being the Uttarāyana on the commencing
tithi of Māgha in the beginning of the first year and the second one being the
Dakṣināyana in the beginning of Śrāvaṇa in the third year.

(2) YAJURVEDA JYOTIṢA

"The later Rtu commences after every alternate day and alternate month
from the former Rtu."

Two solar months make a season; and the dates of commencement of these
seasons during five years are given in a table later on. It will be seen that the
term 'Ekāntareṇhi' (i.e. alternatively) applies to tithis.

"Multiply the number of parvas elapsed by 11; add to this the product of
number of tithis by 9. Divide the sum by 124, and add the parva-number
to the quotient, which gives the solar nakṣatra (on the desired tithi)".
Because a yuga contains 124 parvas, the word yuga has been used to mean 124 in this verse. A nakṣatra is supposed to be divided into 124 parts. Some other verses also lead one to the same view. The sun crosses such 9 parts during one tithi.

Example:—(i) To find the solar nakṣatra at the end of Full-moon in the month of Māgha in the 1st year of the cycle. Solution:—

(Tithis) i.e. \(15 \times 9 = 135\). \(135 / 124 = 1 + \frac{11}{124}\). Here the quotient is 1 and the parva number elapsed is zero. The sun has therefore crossed 11 parts of the 2nd nakṣatra.

(ii) To find the solar nakṣatra at the end of 3rd parva. Because three parvas have elapsed, \(3 \times 11 / 124 + 3 = \frac{33}{124}\). This shows that the sun has crossed 33 parts of the fourth nakṣatra.

There are 366 days, 6 seasons, 2 ayanas (and) 12 solar months in a year. A yuga is five times such.

The sun (Vāsava) rises five times the number of days in a year of the yuga (i.e. 1830). The moonrises (Ṛṣi) are 62 less.

A civil day is the time between two consecutive sunrises. Hence the number of civil days in a year is equal to number of sunrises during the period. Hence, 5 times the number of civil days (366) is the number of sunrises. If the sun would have been a fixed body like other stars, the number of sunrises would have been equal to those of the stars; but because it moves through the stars a short distance towards East every day, it rises a little later than the star with which it had conjuncted the previous day. Thus, it makes a complete revolution through the stars; and it is, therefore, obvious that the number of rises of a star is 367, i.e. more than 366 by one, in one year, and hence they are 5 more than those of the sun in one Yuga. The moon revolves through the asterisms 67 times in one yuga (See verse 31, below); hence, the number of moonrises is less than those of stars by 67 and less than sunrises by 62 in one yuga. The fourth quarter of the verse is illegible. It appears, they must have originally contained words meaning something like 'the number of stellar-rises is greater than sunrises by five'.

"(In one yuga) the lunar ayanas occur 134 times and lunar parvas 124. One kalā is equivalent to 124 kāṣṭhā."

The word "Pauṣṇaṁ" in the original verse does not appear to fit in; but looking to the general sense, any other word is not possible. The moon revolves 67 times during a yuga; hence, \(67 \times 2 = 134\) must be the number of 'lunar ayanas'. The word 'pāda' indicates the number 31 according to verse 12; hence, "chatuspadī" would stand for 124.

"A yuga consists of 61 civil months, 62 lunar months and 67 sidereal months. One civil month consists of 30 days, and the solar month of 30\(\frac{1}{2}\) days. The sidereal month is the time taken by the moon to make a complete revolution through the asterisms."
Vedanga Period

One year consists of 12 solar months (See Yajur-version 28) hence, one yuga contains 60 solar months and 1830 civil days.

Hence, one civil month = 1830 civil days ÷ 61 civil months = 30 days.

Similarly, a solar month = $\frac{1830}{60} = 30\frac{1}{2}$ days.

The stars, Ārdrā, Citrā, Viśākhā, Śrāvana and Aśvayuj are awe-inspiring (Ugra) while Maghā, Svātī, Jyeṣṭhā, Mūla and that of Yama (i.e. Bharaṇī) are of cruel nature.

Our present-day books on ‘Muhūrta’ take the awe-inspiring stars as cruel also, but they include only Maghā and Bharaṇī. According to them Ārdrā, Jyeṣṭhā and Mūla are horrifying or sharp-natured stars; but these can also be regarded as cruel-natured. Of the remaining stars, Citrā is at present regarded as soft-natured, Viśākhā as having a mixed nature, Śrāvana and Svātī as having varying (Calā) nature and Aśvini as stars of trifling importance.

This can be rendered as “when the 62nd part of a civil day is subtracted from it we get a lunar day (or tithi) and if 60th part be added to it we get a solar day; because of this (viz. that the lunar day is shorter than the solar day) the intercalary month comes in the middle and at the end of a yuga”.

Somākara has given some quotations from Garga; his commentary describes completely the 5-year-yuga system of Vedāṅga Jyotiṣa. He has introduced a new time unit — ‘Lava’ — which is a part of a day. This helps an easy understanding of the Garga-quotations.

- No. of civil days in a yuga = 1830
- No. of lunar months in a yuga = 62
- Therefore, 1 tithi = $\frac{1830}{62} \times \frac{1}{30}$ civil days = $\frac{30}{3}$ civil days = $1 + \frac{1}{30}$ civil days.
- Therefore, 1 solar month = $\frac{30}{30}$ civil days = $\frac{30}{30}$ civil days = $1 + \frac{1}{30}$ civil days.


STUDY OF RGYAJUR-VEDĀNGA-JYOTIṢA

The Composition period

Let us now consider the problem of the “time of Vedāṅga Jyotiṣa”. It has been told in the 6th verse of Rg-Jyotiṣa that the winter solstice commences from the beginning of Śrāvīṣṭhā and the summer solstice from the middle of Āśresā. At present the sun turns towards north when the sun and the moon conjoin near the Pūrvaśāṅkā constellation. The solsticial point is thus seen to be gradually receding. This phenomenon is termed “Ayana Calana”. The equinoctial motion is very accurately known in our time and with its help can be found the time when the luni-solar phenomena described in Vedāṅga Jyotiṣa had occurred.

European scholars like Colebrooke have found out the time of Vedāṅga Jyotiṣa, basing their calculations on the assumption that in those times the sun and the moon conjuncted on the winter solstice day with the beginning point of the Dhaniṣṭhā division, the zodiacal divisions being supposed to begin from the Revatī star. It amounts to supposing the Alpha-Delphini star as the beginning point of Dhaniṣṭhā division, which is not the case, the fact being that the star Alpha is in advance of the beginning point by 4° 11' and hence, the time calculated by them is mistaken by an amount of time (viz. 300 years) which is necessary for the equinoctial point to recede by 4° 11'. What does the statement “winter solstice began at the beginning of Dhaniṣṭhās” mean? How can we say that the winter solstice commenced when the sun and the moon come near that imaginary point which is the beginning of an imaginary Dhaniṣṭhā division? And it is a fact that the beginning point of the Dhaniṣṭhā division (which is one of the nakṣatra divisions belonging to Aśvinyaḍī system) is an imaginary point.

* There is some misprint in the reading. It ought to give 1800 as the meaning.
The next important point to remember is that, whatever be the period of composition of Vedāṅga Jyotiṣa, the fact remains that the Aśvinyādi system of nakṣatra division had not come into vogue and hence, the beginning point of Dhanisthā division belonging to this system was also unknown. The mathematicians will, therefore, agree that the time calculated on the assumption of the sun and the moon’s coincidence with this beginning point of Dhanisthā as the moment of Udagayana, was no doubt mistaken.

The verses should clearly be taken to mean that the Uttarāyaṇa commenced when the sun and the moon came near the cluster of 4 or 5 visible stars. At the moment of winter solstice, the tropical longitudes of both the sun and the moon must be 270° or 9 rāsīs; and because it took place at the beginning of Dhanisthā, it is evident that the longitude of Dhanisthā also used to be 9 rāsīs. Keropant regarded Alpha-Delphini as the junction star of Dhanisthā; Colebrooke also regards the same. The author has calculated the tropical longitude of this star in 1887 A.D. as being 10° 15° 48’ 29” i.e., in excess over 270° by 45°-48’. Taking 50’ as annual precessional motion of equinoxes, the time for this excess comes to be 3297 years. Subtracting this figure from 1887, we get 1410 B.C. as the year when the longitude of Dhanisthā could be 9 signs i.e. when the winter solstice used to take place near the Dhanisthā stars. This comes to be the time of Vedāṅga Jyotiṣa. If we regard Beta-Delphini as the junction-star as supposed by Prof. Whitney, the time would be 72 years earlier, and since all the stars in this asterism lie within a degree, the time of the ‘Jyotiṣa work’ will not much vary. On an average 1400 B.C. should be regarded as the time. Colebrooke and others calculate the time as follows:

The equinox used to occur near the Zeta-Piscium star near about the year 572 A.D. In those days the winter solstice used to take place at the end of the first quarter of the Uttarāśādha nakṣatra division instead of in the beginning of Dhanisthā, as described by Vedāṅga Jyotiṣa. A shifting of $\frac{1}{4}$ nakṣatras i.e. 23° 20’ had then taken place. The time for this shift at the rate of 50’ per year comes to be 1680 years. Hence, the winter solstice used to occur near the beginning of Dhanisthās about the year (1680-572) or 1108 B.C. The figure is shorter by 300 years because of the supposition that Udagayana used to take place “in the beginning of the Dhanisthā division”. It has already been pointed out above that the time should be calculated on the basis that winter solstice took place near a star of Delphini group.*

The time of composition of Vedāṅga Jyotiṣa as astronomically calculated by the author is quite correct beyond doubt; but some European scholars on philological grounds believe it to be “not so old”. They attempt to bring the times of our ancient works as later as possible. Max Müller writes that it was composed in the 3rd century B.C. Prof. Weber even suspects it to have been written in the 5th century A.D. Let us, therefore, examine this point more critically.

*The precessional motion is gradually increasing at a very slow rate. It might have been a bit smaller than 50’ in 1400 B.C. Taking 48’ as the motion, the above calculated time would come to be smaller by about 135 years. The time calculated by Colebrooke and others differs from the one viz. 1108 B.C. etc. calculated by me because of the assumption of different precessional motions and of different years for the conjunction of equinoctial point with the Zeta-Piscium star.
Varāhamihira says:

The whole trend of the description shows that in his time (near about Śaka year 427) the Vedāṅga Jyotiṣa had come to be regarded as "very old". He has, in his Pitāmaha Siddhānta (which was a part of Paṇca Siddhāntikā) given some mathematical formulae, which had been out of use in his time as being very old; and the author has shown in 'Part Two', that the formulae resembled with those given by Vedāṅga Jyotiṣa.

Brahmagupta says,

This shows that at the time of Brahmagupta and Varāhamihira the Pitāmaha Siddhānta was being regarded as having been written very many years ago.

A good many quotations from Garga have been given before; it appears that Vedāṅga Jyotiṣa occupied an important place in his time. Even Parāśara says:

This gives the same solar position for winter solstice as given by Vedāṅga Jyotiṣa. This shows that it must have been composed long before these two seers lived. Although the Saṃhitās composed by Garga and Parāśara do describe the Vedāṅga Jyotiṣa, the circumstances for a winter solstice to occur at the commencement of Dhaniṣṭhā had no doubt altered. While commenting on the portion 'Aprāptamakara' in Chapter 3, Brh. Saṃ., Bhaṭotpala has quoted the following verse:

Parāśara's verse also has been quoted above. These verses show that Vedāṅga Jyotiṣa was composed long before the times of Garga and Parāśara; but it is very difficult to fix up their times. Garga has been a very famous astrologer in India (See Gadāparva, Chap. 8, verses 14 and 15). The name of Garga has occurred a number of times in Pātanjal-Mahābhāṣya; and one comes across the names of Parāśara and Garga even in Pāṇini (See 4-3-110, 4-10-105, etc.). The two, therefore, must have lived before Pāṇini and Vedāṅga Jyotiṣa was composed long before them. According to Dr. Bhandarkar,
Pāṇini’s time comes to be the beginning of 7th century B.C. and according to late V. Kunte it was the beginning of 9th century B.C. The words “Sām-vatsara, Parivatsara etc.” occur in Pāṇini (See 5-1-92) and the measures of Ādhaka and Khāṛī etc., as described by Vedāṅga Jyotiṣa were in use in Pāṇini’s time (See 5-1-53). These support the view that Vedāṅga Jyotiṣa existed long before Pāṇini. Another important consideration leads one to believe that it was composed in those times when the Vedic methods of performing sacrifices were well known and perfectly set up in society, as can be seen from the fact that Vedāṅga Jyotiṣa has specially described the method of calculating the “Viṣuvāṇ” day correctly, this day being regarded as the most important one by Aitareya and Taittirīya Brāhmaṇa. Now, although some philological evidences like the words “Yathā Śikha Mayūrāṇī” might appear to be modern, it can not be said so about all other verses. Dr. Martin Haug says (in his lecture on the Vedas) “the word ‘Gharna’ has been used by Vedāṅga Jyotiṣa to mean a ‘day’. (See verse 7 Rk-reading). The use of the word in this sense had become out of use long before Yāska who lived before Pāṇini.

The Vedāṅga Jyotiṣa must, therefore, have been written near about the times of composition of ‘Śravata and Śāmātī sūtras’ i.e. between 1200 and 600 B.C. There are no evidences of the nature of astronomical terms, that Vedāṅga Jyotiṣa belonged to an earlier period. It used a terminology different from the one in which number are indicated by words, e.g. the number ‘four’ is denoted by the word Veda. Prof. Weber says that the names of nakṣatras given by Vedāṅga Jyotiṣa are like those found in modern books and that it contains Rāsi-names also. The author has already translated the verse in which the term Rāsi occurs. He maintains that not only Vedāṅga Jyotiṣa does not give Rāsi-names, but also it does not give nakṣatra-names which are current in modern times. Of the list of nakṣatras, the Rk-version clearly gives the name of only one star, and that too as Śravisthā and not as Dhanisthā of the modern times. The verse No. 36 of Yajurveda version gives names of 9 stars, and the list gives Aśvayuk as the ancient name and not as Aśvini for one of them, while others are modern names. Similarly, verse No. 14 of Rk-version gives a list of symbolic names of stars which can help one in differentiating ancient names from modern ones, e.g. Aśvayuk and Śatabhiṣak which are ancient names. It no doubt contains a name, Śravana, which appears to be modern, yet it is not similar to the name “Śrōṇaḥ” of the Taittirīya Brāhmaṇa. The star used to be called as Śravana even in the times of Atharva Samhitā (See pp. 47-48) and of Pāṇini (see Pāṇini, 4. 2.5; 4.2.23). Prof. Weber’s arguments do not, therefore, deserve consideration. All the above considerations will support the author’s view that we must accept that time for the composition of Vedāṅga Jyotiṣa which one gets on grounds of astronomical calculation.

The Place of Composition.

Let us attempt to find out the place of its composition on the basis of statements about length of the day as given by Vedāṅga Jyotiṣa. The verse No. 7 & 22 (Rk-version) say that the daily increase in the length of day is /61 nāḍīs and that the lengths on solstitial days are 24 and 36 ghaṭīs respectively. The “Dinārdha” i.e. length of half-day comes to be respectively 12 and 18 ghaṭīs, and the correction for ascensional difference is 3 ghaṭīs. The sun acquires maximum declination on the two occasions. The value of Sun’s maximum declination about the year 1400 B.C. used to be 23° 53°*. Our

*See pages 48-50 of planetary tables by Keropant.
astronomical works give it to be $24^\circ$. Let us try to find by the following method the stations where both the values can be true:—

Formula:—$\sin (A.D.) \times \cot (\text{declin}) = \tan (\text{lat. of place})$. Here, $A.D. = 3$ ghaṭis $= 18^\circ$.

(i) $\sin 18^\circ = 9.489982$
(ii) $\sin 18^\circ = 9.489982$

L cot $24^\circ = 10.351417$
L cot $23^\circ 53' = 10.353801$

Therefore $\tan (\text{lat.}) = 9.841399$
$:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\:\\line

This shows that the place of composition must be a place whose latitude is either $34^\circ 46'$ or $34^\circ 55'$. The work gives $4/61$ nādi as the daily increase in length. The fact is that the increase is never constant. It is minimum when the sun goes to solstices and is maximum when it comes to equinoxes. At a place on latitude $35^\circ$, the increase in length of day would be found to be only $1/61$ ghaṭi (at the most) in two days near about solsticial days and about $5\frac{1}{2}/61$ ghaṭis per day on or about equinoctial days.

**Ayana Calana (Shifting of Equinoxes)**

The Vedaṅga Jyotiṣa mentions the commencement of a Yuga as coincident with that of the winter solstice and also that of Dhaniṣṭhā. It is clear from this that they had no idea of shifting of equinoxes in those times.

**Detailed information about length of a year etc. in the Vedaṅga Jyotiṣa Period**

<table>
<thead>
<tr>
<th>Number in a Yuga</th>
<th>No. of days in a year</th>
<th>Dates of equinoxes</th>
<th>Dates of commencement of seasons</th>
<th>Omitted (Kṣaya) Tithis</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Solar months</td>
<td>60</td>
<td>Samvatsara 355</td>
<td>(i) Vaiśākha S. 3</td>
<td>Māgha S. 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(ii) Kārtika S. 9</td>
<td>Caitra S. 3</td>
</tr>
<tr>
<td>(2) Lunar months</td>
<td>62</td>
<td>Samvatsara 355</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Intercalary months</td>
<td>2</td>
<td>Parivatsara 354</td>
<td>(i) Vaiśākha S. 15</td>
<td>Māgha S. 13</td>
</tr>
<tr>
<td>(4) Civil days</td>
<td>1830</td>
<td></td>
<td>(ii) Kārtika K. 6</td>
<td>Caitra S. 15</td>
</tr>
<tr>
<td>(5) Tithis</td>
<td>1860</td>
<td></td>
<td></td>
<td>Jyeṣṭha S. 2</td>
</tr>
<tr>
<td>(6) Kṣaya tithis</td>
<td>30</td>
<td></td>
<td></td>
<td>Śrāvaṇa S. 4</td>
</tr>
<tr>
<td>(7) Sidereal months</td>
<td>67</td>
<td>Idāvatsara 384</td>
<td>(i) Vaiśākha K. 12</td>
<td>Māgha K. 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(ii) Kārtika S. 3</td>
<td>Caitra K. 12</td>
</tr>
<tr>
<td>(8) Nakṣatras 1809</td>
<td></td>
<td></td>
<td></td>
<td>JyeṣṭhaK.14</td>
</tr>
<tr>
<td>(9) Vṛddhi nakṣatras 21</td>
<td></td>
<td></td>
<td></td>
<td>Śrāvaṇa S. 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Āśvina S. 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mārgaśirṣa S. 5</td>
</tr>
</tbody>
</table>

|                  |                       |                    |                                  | Mārgaśirṣa K. 9        |
The dates on which the ayanas in a Yuga begin are already given on p. 71. The dates of commencement of seasons are given in the above table. It should be noted that (i) between each pair of these dates, one more solar month falls. These two lists together would give 60 dates of month-beginnings. (ii) The first intercalary month is inserted between Aṣāṅga and Śrāvana of the 3rd year (after 30 lunar months have elapsed after Yuga), and the second is inserted after 30 more lunar months, that is, after Pauṣa of the 5th year. Thus Śrāvana and Māgha always happen to be intercalary months in each Yuga. (iii) Because one Yuga consists of 1830 civil days and 1860 tithis, the number of ‘Lapsed tithis’ comes out to be 30. (iv) Similarly, because the moon revolves 67 times during the period, the number of nakṣatras through which it passes would be $67 \times 27 = 1809$ and hence, in 1830 civil days the increase in their number becomes 21. The nakṣatra cycle begins from Śraviṣṭhās (See verses 25 to 27, Rk-version). Under Vedāṅga Jyotiṣa system the moon and the sun are supposed to move by a uniform motion, which is termed as “mean motion” in astronomical works; and because a mean tithi is shorter than a mean civil day, a tithi-vṛddhi can never occur; so also a “lapsed nakṣatra” can never occur because the mean length of a nakṣatra is greater than a civil day.

### The Pañcāṅga

The above discussion will make it clear that once a 5-yearly calendar is compiled, it would serve the purpose for all yugas to come. The detailed panchang can not be given here for its being very extensive; its salient features are, of course, described above.
Let us now examine the correctness of the lengths of the year and of other units of time.

<table>
<thead>
<tr>
<th>Number of civil days in a yuga.</th>
<th>Vedāṅga Jyotiṣa</th>
<th>Sūrya Siddhānta</th>
<th>Modern European</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830</td>
<td>1826.2938</td>
<td></td>
<td>1826.2319 (Sidereal)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of days in 62 lunar months</th>
<th>1830</th>
<th>1830.8961</th>
<th>1830.8964</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. of civil days in 95 years</th>
<th>34770</th>
<th>34699.58</th>
<th>34699.36 (Sidereal Yr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of days in 1178 lunar months</td>
<td>34770</td>
<td>34787.03</td>
<td>34787.03</td>
</tr>
</tbody>
</table>

This shows that while the error in the measure of a lunar month is very small, that in the solar year is big**. The result is that if the first ‘ayana’ would take place on a Māgha Śukla 1 of a certain Yuga, it will not take place on the same tithi of the next yuga but 4 days earlier; similarly, after 95 years it will take place some 72 days earlier and so on. The error in the measure of a lunar month is very small; yet, because the cumulative error would amount to 54 ghatis in 5 years, there will be an error of about one day in 5 years, even if we reckon full moons and new moons according to the Vedāṅga Jyotiṣa system. But, although the error in the case of ayanas is not easily detectable, that in the case of Pūrṇimā and Amāvasyā can be readily found. From this, it seems that they must have taken 1830 as the round figure for the number of civil days in a yuga, while reckoned by actual observations of the positions of the moon on full-moon days, it must have been coming to about 1831 days; and because the number of lunar months in 95 years (including 38 intercalary months) being taken to be 1178, the number of civil days in 19 yugas or 95 years would actually come to be 34787 or (according to Vedāṅga Jyotiṣa) 34770, and the next Māgha Śukla 1 would again be so after 95 years and would be the first tithi of the 96th year. But the fact remains that 95 solar years would consist of 34698 days, which shows that the winter solstice (coming in the 96th year) would fall 89 days (or at least 72 days) earlier than the Māgha S. 1. of that year, which amounts to a difference of 2½ to 3 lunar months. To avoid this the number of intercalary months should not be taken as 38 (as per Vedāṅga Jyotiṣa system), but only 35; otherwise a difference of 3 seasons would occur in 200 years. This is too much to be neglected.

*This is calculated from the length of a solar year in 1400 B. C.

**Shri Visāji Raghunath Lele observes that the measure of the length of the solar year is gradually and slowly decreasing and the European scholars also maintain the same view. It is, therefore, probable that Vedāṅga Jyotiṣa was composed in a period in the previous cycle of equinoxes i. e. 28000 years ago, when the length of a year might have been actually 366 days.
Such a wrong system could not have remained in vogue all over the country for a long time; and we cannot but believe that the Vedânga Jyotîśa system was not in practice for a very long time. The intercalary months, decayed this and excess nakṣatras recur in the same order and these things have much religious importance. The intercalary month is regarded as 'Censurable' even in the Vedas. If, therefore, the Vedâṅga Jyotiṣa system had been in use in all provinces and for a long time we would have come across their references in 'Sūtra' works. This shows that it must have remained in use, if at all, in only some provinces. The rate of increase in the length of day (as given by Vedâṅga Jyotiṣa) is applicable only to a place on latitude 34° N. But this does not in any manner stand in the way of our supposing 1400 B.C. as the probable date of that work. The Taittiriya Śrutis gives 4 names for the years, sometimes 5 or even 6. The reason for this, the author believes, must be that the '5-year-cycle' system of Vedâṅga Jyotiṣa did not come into vogue fully then. It was perhaps found that the 'āyanas' repeat with respect to lunar months in a cycle of 5 years, and this must have led them to adopt either 4 years or 6 years for the cycle. It may be that there might not have been any fixed cycle in use and then the author of Vedâṅga Jyotiṣa might have calculated 366 days as the average length of a year and introduced a fixed system of a 5-year-cycle. It is even probable that people must have either discarded the system as wrong or allowed it to continue, adjusting the insertion of intercalary months in their proper place, viz. 35 in place of 38 during a period of 95 years. Almost all our religious rites are performed on the proper lunar positions since time immemorial, and they have found it convenient to adjust the calculation to a correct solar time by adjusting the insertion of intercalary months. The author has already observed in Section 1 that in his opinion, this was the system in vogue even in the Vedic times. It requires 1000 years to pass for changing the position of winter solstice with respect to a nakṣatra; and they could have controlled the occurrence of winter solstice in Dhaniṣṭhā in the beginning of Magha and retention of 5 names for the 5 years, by careful adjustment of intercalary months in their proper place, and could have continued the system for some centuries. In short, it can be said that, even if the Vedāṅga Jyotiṣa system would have been out of use in its original form, it must have continued in some other form and that is why we get references about it in astronomical works by Garga and others. It will be shown in a discussion in Part Two, that the Jovian sixty-year cycle owed its origin to this "5 year-cycle" system. That this system has got a place in the list of Vedāṅgas (parts of the Vedas) is itself something very important. It cannot be said for certain as to when it obtained that elevated position, but the author believes that it must have received that importance within 200 years of its origin, i.e. before the time when it was found useless in its original form for religious purposes. Varāhamihira does not call it a 'Vedāṅga', but it was definitely so at his time. Brahmagupta (Śaka 550) at one place says:—

युगांशः पंचाश्च रविविशिष्टोऽस्पदानीयानि कालार्ये।
अधिसाक्षरतमोऽस्पदानोऽस्पदानविशिष्टसदस्वत्। || 211

The word 'Aṅga' occurring in this appears to be used to denote Vedāṅga Jyotiṣa. At present it is regarded a part of the Vedas (Vedāṅga).

Apapātha (Deformed Readings)

It can not be said for certain as to when the incorrectness entered in the readings of Ṛg-Jyotiṣa; but the quotation of Varāha viz. "Paṅcāṣatpala-
History of Indian Astronomy

mādhakām” and that of Bhaṭotpalā viz. “Caturbhīrāḍhakāirdroṇaḥ” show that these did not enter till Śaka 427 and 888 respectively. Bhaṭotpalā has taken latter half of verse No. 32 (Rk-reading) in his commentary on the penultimate verse of chapter 8 of Brhaṭ Saṃhitā. The author finds the same in a manuscript copy of the book in his possession. It runs thus,

युगत्व पंचमस्येह कालकान निषिद्धत

Here the word ‘Paṇcamasya’ seems to be a misprint. It ought to be “Paṇcavarṣasya”. Similarly, the Vaidikas read “Pracāṣate” in place of “Nibodhata”. Hence, if ‘Nibodhata’ be the original reading by Bhaṭotpalā, it can be said for certain that the incorrectness did not enter into the readings till Śaka 888; still, this conjecture can not be said to be a final word on it for want of further evidences.

Pradhāna Pāṭha (The Principal Readings)

The 24th verse of Yajur-Jyotiṣa is similar in meaning to, but different in words from, the 17th verse of Rk-version and quoted by Varāhamihira and Bhaṭotpalā.

This shows that the Vaidic Brahmins in the times of Varāhamihira and Bhaṭotpalā used to recite the Rk-reading (and not the Yajur one) in its correct form; it can be said that the people at least paid greater importance to the Rigveda-reading. The commentator of Aryabhaṭiya, named SuryadevaJayajan has taken two verses* from Vedāṅga Jyotiṣa in his commentary. These happen to be the last two verses, viz. 35th & 36th of the Rigveda-version and are given in this very order, and not in the order of Yajurveda-version—there they stand respectively 4th and 3rd—and looking to the context of the commentary it seems that the taking of first or last verses at that place was quite reasonable. This shows that even at the time of Sūrya Deva, the Rk-reading was considered as more important. The time of Suryadevajayan is not known, but he appears to have lived later than Bhaṭotpalā.

In the latter half of 35th verse (See Suryadeva’s commentary) is found the word “Tathā” in place of “Tadvat”. The word “Tathā” is not found in any of the two Vedic Jyotisha works. If, therefore, the word is Suryadeva’s replacement, it seems that the current Vaidic reading did not come in use in final form at least in his province.

It cannot be said for certain, if the Yajurveda reading was at all known to Varāhamihira, Bhaṭotpalā and Suryadevajayan; but the Yajur-reading also appears to be an ancient one; because only six verses from Rk-version are not found in it, and of these six only three important ones viz. 13th, 19th, 33rd are missing. It contains 13 verses more than Rg-Jyotiṣa. These can definitely be seen to belong to the period when Vedāṅga-Jyotiṣa was in vogue and might have been composed by Lagadha himself. Also, the list of cruel and horrifying nakṣatras given in the 36th verse of Yajur-Jyotiṣa does not tally with that given by other astronomical works.

This shows that the Yajur-Jyotiṣa belonged to a comparatively later period. But the 24th verse is quite different in words and the 21st is partially different from similar verses in Rg-Jyotisa, and those of the verses (from both the works) which are illegible, some may be similar and others might be opposite in meaning. This leads one to believe that some verses not composed by Lagadha were later on interpolated in the Yajur-Jyotiṣa. The sequence of verses in

*See “Introduction to Aryabhaṭiya” by Dr. Kern.
both the readings is not logical; if an attempt be made to re-write them in the logical order of topics, the order of verses will change much; and this shows that the present order of verses is a result of an attempt at composition by a later writer and in so doing, some of the original verses must have been lost for ever. For instance, the units of Kāṣṭhā and Aksara have been mentioned in the same verse, although they bear no relation to other units and they are not seen to have been used anywhere in the text; but the words could not have come in without any reason. These support the author's belief that some original verses must have been lost.

**Planetary motions.**

VEDĀNGA Jyotiṣa has given the motions of the Sun and the Moon only. It mentions nothing about other planets. Although some verses are found illegible, the author can say for certain that they do not give any other important information.

**Mean motions of planets**

The motions of the Sun and the Moon as given by VEDĀNGA Jyotiṣa are mean motions, but since these motions change every moment, the sun’s true place differs from the mean place by about 2 degrees* and that of the moon by about 8 degrees. It cannot be said for certain if they in VEDĀNGA Jyotiṣa’s time knew how to calculate the difference between true and mean place of a planet, the term now being known to us as “Equation of centre”. Brahmagupta, however, remarks in his couplet given on page 93 that astronomers of these times did not have any knowledge of planets’ true places.

One will not be able to detect the difference between the true and mean motions and positions of the sun and the moon unless one observes their places and motions regularly and studies them. This difference would come to one’s notice at the time of eclipses if one knew that eclipses take place near the ending moments of Full Moon or New Moon. It is nevertheless a matter of pride to us that they in VEDĀNGA Jyotiṣa’s time had at least the knowledge of sun’s and moon’s motions, if not of their true places. The daily mean motion and the time for their complete revolution can not be found unless one actually records and calculates the time that the sun and the moon take in a finite number of revolutions, and it is clear that people had obtained this much knowledge before the compilation of VEDĀNGA Jyotiṣa. The measure of a solar year appears to have been mistaken because of the fact that the nakṣatras near about the sun are never visible.

The adoption of mean motions (to the sun and the moon) by VEDĀNGA Jyotiṣa brought the solstices and equinoxes at the distance of 183 days from one another and the distance of one solstice from the next equinox comes to be 91 1/2 days. But their actual relative distances before the year 1400 B.C. used to be as given below:

<table>
<thead>
<tr>
<th>Distance</th>
<th>Days</th>
<th>Ghaṭis</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Winter Solstice to Vernal Equinox</td>
<td></td>
<td>91 5</td>
</tr>
<tr>
<td>, Vernal Equinox to Summer Solstice</td>
<td></td>
<td>94 5</td>
</tr>
<tr>
<td>, Summer Solstice to Autumnal Equinox</td>
<td></td>
<td>91 30</td>
</tr>
<tr>
<td>, Autumnal Equinox to Winter Solstice</td>
<td></td>
<td>88 35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>365 15</td>
</tr>
</tbody>
</table>

* One degree being 360th part of a full circular measure.
The Year

The words ‘Varṣa’ and ‘Samvatsara’ are found used in Rg-Jyotiṣa to denote a year. The Yajur-Jyotiṣa gives an additional word Abda for it (See 28th verse). The words ‘Varṣa’ and ‘Abda’ occur only in Satapatha Brāhmaṇa of the Vedic literature.

The Month

The months ended with New Moon in this system.

The First Nakṣatra

The first nakṣatra according to Vedāṅga Jyotiṣa is Dhaniṣṭhā. The list of controlling deities of nakṣatras as given in Rk verses 25, 26 and 27 begins, as in the Vedas from Kṛttikās. One comes across a reference of the Dhaniṣṭhādi system in the Mahābhārata. The sixty-year cycle and 12-year Jovian cycle begin from Dhaniṣṭhās.

Arithmetic

People in Vedāṅga Jyotiṣa time knew four fundamental rules and the rule of three. Not only this, but one can say from verses 7, 14, 16, 17, 18 and 22 of Rk-reading and 37th verse of Yajur-reading that they had knowledge of these rules about fractions also. Also the use of shortcuts like Apavarta (simplification) etc. shows that they had taken much pains over the mastery of arithmetic.

The Ascendant (Lagna)

The line “Sraviṣṭḥabhhyām” etc. in verse 19 of Rk-reading suggests that they had the idea of Lagna i.e. ascendant. The astronomical works define Lagna as the point of the ecliptic in contact with the horizon. The above verse should be regarded as very important if it means to say something like the definition.

Meṣa and other signs

It does not mention any Rāśis (signs) nor was then the system of stating a planet’s place with respect to 12 divisions of the ecliptic. The positions of the sun and the moon are given with respect to nakṣatras.

Solar Months

Although no mention of Meṣa and other signs is made, the solar months are stated. The word Suryamāsa actually occurs, and the relation between the solar and lunar months is given in clear terms at good many places. A season is mentioned to consist of 2 solar months or of 4½ solar-nakṣatras and the lunar months with the tithis on which the seasons commence are also specifically mentioned. Again, it contains a method somewhat similar to the one of calculating ‘Adhimāsaśeṣa’ with respect to the solar and lunar months and described by Sūrya-Siddhānta and similar other works (See verse 23, Rk-version). No solar month had any independent (special) names. These were perhaps named as Caitra, Vaśākha, etc., as we find with regard to solar months in Bengal.

Parvagaṇa (i.e. number of lunations)

This work describes a method of calculating the “parvagaṇa” or number of parvas or lunations elapsed from the commencement of Yuga, much on the lines of calculating ‘Aḥargagaṇa’ as described by Sūrya Siddhānta and others.
Vedanga Period

Identical divisions for time and space

Discussion of this topic will be completed after recording a more important thing. It is the identical division system for both time and space, which came into existence from the time Vedāṅga Jyotiṣa was compiled. In astronomical works like Śrūya-Siddhānta we find exact similarity in the divisions and subdivisions of time and space as described below:

<table>
<thead>
<tr>
<th>Division</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 Palas</td>
<td>= 1 Ghaṭikā</td>
</tr>
<tr>
<td>60 Ghaṭikās</td>
<td>= 1 Day</td>
</tr>
<tr>
<td>30 Days</td>
<td>= 1 Month</td>
</tr>
<tr>
<td>12 Months</td>
<td>= 1 Year</td>
</tr>
<tr>
<td>360 Days</td>
<td>or 360 Aṃśas</td>
</tr>
<tr>
<td></td>
<td>or 12 Rāṣis</td>
</tr>
</tbody>
</table>

Under Vedāṅga Jyotiṣa system the time division and space divisions are identical. The nakṣatra is supposed to be divided into 610 Kalās; and a day is supposed to be divided into 603 parts, because the moon passes over so many parts (i.e. 603 Kalās) of a nakṣatra in 1 day. This subdivision of a day into 603 parts might be found inconvenient for calculation, but this subdivision is convenient when nakṣatras are concerned. The time division is seen to have been suggested by space division. Similarly, the division of 1 yuga into 124 parvas had suggested the division of one nakṣatra into 124 parts or 'Aṃśa'. This is an example of a time division suggesting a space division. Now looking to the fact that the above system was actually in vogue in Vedāṅga Jyotiṣa period and that from Vedic times the relations “1 year=360 days, 1 solar year=12 months, 1 month=30 days and 1 day=60 nādiśkās” have remained in general use, can we not say that these were sufficient enough easily to suggest an Aryan mind that a circular space be divided into 12 parts and each part into 30 subdivisions and that the current space-subdivisions are a result of independent thinking on the part of the Aryans?

(3) Atharva Jyotiṣa

The time units

Let us now turn to the study of Atharva Jyotiṣa. This consists of 14 chapters and 162 verses. This has been told to Kaśyapa by Pitāmaha. The author explains its topics briefly.

The time units are given as follows:

<table>
<thead>
<tr>
<th>Division</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Nimeṣa</td>
<td>= 1 Lava</td>
</tr>
<tr>
<td>30 Lavas</td>
<td>= 1 Kalā</td>
</tr>
<tr>
<td>30 Kalās</td>
<td>= 1 Truṭī</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These are followed by a list of names of 15 Muhūrtas whose measure is compared with the length of a gnomon 12 ‘aṅgulas’ long. The Muhūrtas are:

<table>
<thead>
<tr>
<th>Muhūrta</th>
<th>Shadow length (in aṅgulas)</th>
<th>Muhūrta</th>
<th>Shadow length (in aṅgulas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Raudra</td>
<td>96 (max.)</td>
<td>5. Sāvitra</td>
<td>5</td>
</tr>
<tr>
<td>2. Sveta</td>
<td>60</td>
<td>6. Vairāja</td>
<td>4</td>
</tr>
<tr>
<td>3. Maitra</td>
<td>12</td>
<td>7. Viśvāvasu</td>
<td>3</td>
</tr>
<tr>
<td>4. Sārabhaṭa</td>
<td>6</td>
<td>8. Abhijit</td>
<td></td>
</tr>
</tbody>
</table>
Abhijit has been described as that Muhūrta in which the shadow does not alter in length or direction. The lengths of shadows of Muhūrta coming after noon increase in the reverse order. It cannot be said that the shadow at noon is of zero length, but it must be shorter than 3 añgas. The place where this Jyotiṣa was compiled can be found out from this condition; but because the lengths of shadows are not the same throughout the year and it is not an important problem worthwhile attempting, the author leaves out of consideration the problem of finding the place.

The Karaṇas and Auspicious times

As we proceed further on we come across instructions about the duties to be performed on particular muhūrtae.g. horrorful acts to be done on Raundra (Terrifying) Muhūrta, and friendly acts to be done on Maitra Muhūrta. The fourth chapter gives a list of Karaṇas (of Tithis) with their names which are like those of our present time. Of the stationary Karaṇas “Kimbstuṣha” is substituted by “Kaustubha”. It may be a writer’s error. Further on, we find a classification of Karaṇas responsible for auspicious and inauspicious acts and the ghatikā has been adopted as a time-unit for them. Further on are given, as at present, names of deities controlling the Karaṇas. They include the Dhanāḍhīpa of Kaustubha and Manibhadra of Vānja. The names of remaining deities are those from the Vedas. Next we find a discussion as to which acts, when done on particular tithis, would give auspicious or inauspicious results. This list of tithis includes 5 names like Nandā and Bhadrā—

चतुर्भि: कार्येरकम सिद्धेरतो चक्षु: ॥
तिथिवशशक्तिरणीयतेर्नि नियम: ॥

This verse gives only four “Aṅgas” (i.e. parts) viz. Tithi, Nakṣatra, Kāraṇa and Muhūrta, and not the Yogas.

तिथियस्तुपुनः प्रोक्ता नक्षत्र व चतुर्गुण: ॥ कार्यचायमुग्गुणः प्रोक्तः करण प्रोक्ताविषयं ॥ ६० ॥
हारानिरसूपो योगस्तारा पक्षसम्मिलिता: ॥ चंद्र: शतगुणः प्रोक्तस्तसमाः चंद्रस्तत्वालभलन: ॥ ६१ ॥
सामीयतं चतुर्वचन भावलर्थ यह: प्रवचनवति बुधायुगानि

These verses discuss the auspicious or inauspicious nature of planets depending, of course, on the “strength” of the moon; and the words “Na Kṛṣṇapakṣe śaśiṇaḥ prabhāvaḥ” suggest the moon’s strength varies with the number of its “Kalās”.

Vara or names of days and names of planets

The following verse gives names of seven days in a week calling the planets as ‘Lords of days’.

आविश्य: सोमो भौमस्त तथा बुधवृत्त:ः ॥ भाग्य: ब्राह्मचर्यं एते सत्त दिनाविष्य: ॥ ६२ ॥

Other verses give following more names of planets as being applicable to names of days:—Sūrya, Lohitāṅga, Somasuta, Devaguru, Guru, Bhṛgu, Śukra, Sūryasuta.

Jātaka branch of Astrology

After passing over 100 verses, one comes across the quotation

अलप्राप्य महायाँ च प्रवेशयो भूयोर्मल ॥
which is followed by 62 more verses. This portion contains the seeds of
predictional section of astrology Jātaka and is, therefore, an import-ant
one. Some of the verses are given below:

The nakṣatras are divided into 9 groups:

<table>
<thead>
<tr>
<th>Order</th>
<th>Nakṣatra numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>1 Nakṣatra at birth</td>
</tr>
<tr>
<td>(2)</td>
<td>2</td>
</tr>
<tr>
<td>(3)</td>
<td>3</td>
</tr>
<tr>
<td>(4)</td>
<td>4</td>
</tr>
<tr>
<td>(5)</td>
<td>5</td>
</tr>
<tr>
<td>(6)</td>
<td>6</td>
</tr>
<tr>
<td>(7)</td>
<td>7</td>
</tr>
<tr>
<td>(8)</td>
<td>8</td>
</tr>
<tr>
<td>(9)</td>
<td>9</td>
</tr>
</tbody>
</table>

Each group consists of 3 nakṣatras separated by 9. These are to be reckoned
from the nakṣatra at birth; this is clear from verse No. 104. The next verses
ordain to do or not to do certain acts on these nakṣatras and by the next verse
viz.,

The author describes the fears and horrors which befall when certain nakṣatras
are accompanied by planets, electric charges, meteors etc. It is evident that
by the word ‘graha’ the planets Sun, Moon and others are meant. Further
on something is stated and the discussion is closed by the verses:

No mention is made that the work is to be called Atharva Jyotiṣa; still
that it is so borne by the evidence of the last verse ending with the remark
“Ānnyavidhidarśanāt”.

2 DGO/59
It is clear from its topics that this Jyotiṣa is not so ancient as the Rk or Yajur-Jyotiṣa, still the old consideration of the fact that if the Meṣādirāsī would have been in vogue in the time of the author of this work, they would certainly have occurred in the text, leads one to accept that the Atharva otiṣa is pretty old and because it is so called, the author took it for scussion at this place.

One more important point, worth remembering, is that while no mention is made of 12 rāsīs, the names of days (Vāra) do occur; this point will be considered later on.

This work describes a system of astrology, very akin to and not quite different from, the one which is based on 12 rāsīs and is in use in our country; and no doubt can be entertained about the fact that this system of astrology originated and had been independently developed in our country. It seems probable that although the Hindus are said to have borrowed the 12 rāsīs from foreigners, they developed the Rāsi-Jyotiṣa on the already known lines of astrology related to nakṣatras.

2. KALPA SŪTRAS

Āśvalāyana Sūtra

Names of nakṣatras months are found in Āśvalāyana Sūtra. “Srāvatyāṁ Paurnamāsyaṁ Śravaṇakarma” is an example (See Gṛhya Sūtra 2-1-1). The names of months like Madhu, Mādhava, etc. are also found (Śrauta Sūtra 4-12). At one place, a reference about seasons in the same quotation shows that Spring was regarded as the first season. Although the word tithi does not occur explicitly, the quotations (i) “Mārgaśirṣyaṁ Pratyavarohanaṁ Caturḍaśyāṁ” (Gṛ. S. 2-3-1) (ii) “Hemantaśiśiśirayoścaturnāmaṇaparapekṣā- nānaṣṭamiśiṣyaṣṭiḥ” (Gṛ. S. 2-4-1) (iii) “Adhyāyopākatanam Śravaṇ- asya Paṇcamaṁ” (3-5) etc. show that the words Caturḍaśi, Aṣṭami, Paṇcami stand for tithis. References about Ayana and Viṣuvva occur at good many places. The references about nakṣatras show that some are used in dual form as, ‘Uttarayoh Proṣṭhapadayoḥ’ (Gṛ. S. 2-1) and in masculine gender plural number also as in ‘Uttaraiḥ proṣṭhapadaiḥ’ (Gṛ. S. 2-10-3). In Taittirīya Brāhmaṇas, both these star-names are used in masculine and plural number. The names of Pole star(Dhruva), the Great Bear (Saptarṣi) and Arundhati occur in Gṛ S. 1-7-22 as “Dhruvarundhatiṃ Saptarṣiniḥ drṣṭvā vacam visṛjeta”. Definite instruction for doing certain rites on certain auspicious nakṣatras seems to be given in it; e.g. Fields should be ploughed on the Uttar Pradesh, Phalguni and Rohini nakṣatras, sacrifices should begin on such and such nakṣatras (Gṛ. S. 2-10-3); the thread ceremony should be performed on auspicious nakṣatras; the Simantonnammanam to be performed on ‘masculine’ nakṣatras conjoined with moon (Gṛ. S. 1-4-1, 1-14.) etc. Which nakṣatras were regarded as auspicious and masculine, is not known. The current works on astrology give a list of masculine and feminine nakṣatras; and the kinds of nakṣatras are similar to those shown on page 48-50. People might be following the same kind of grouping in Sūtra period.

Pāraskara Sūtra

Pāraskara Sūtra seems to belong to a period later than the Āśvalāyana Sūtra. It contains almost all topics discussed by Āśvalāyana Sūtra; but it ordains the “Āgrahāyaṇi-karma” to be performed on the full moon day of
Mārgaśīrṣa—no mention of this act is made in the Āśvalāyana Śūtra. It also gives “triṣu triṣu uttarādhi svātatu mṛgaśīrṣi rohīṇyam” as the list of nakṣatras auspicious for marriage. Haradatta defines these as “Uttarā, Hasta, Cittā, Uttarāśādhā, Śravaṇa, Dhanīṣṭhā, Uttarābhādrapadā, Revati and Āśvini”. The current works on Muhūrta do not give Cittā, Śravaṇa, Dhanīṣṭhā and Āśvini as marriage-nakṣatras. Similarly, Jyeṣṭhā has been recommended for ploughing the field (2-16). The list of marriage-nakṣatras given by one Śūtra does not agree with that given by another. This Śūtra (Pāraskara) describes the results, if a child birth takes place on Mūla Nakṣatra e.g. “if born on the first part, the father dies; if on the second, the mother; if it be born on the 3rd, the loss of money and corn results and the whole family suffers if born on the fourth part (1.21)”. It is worth noting that a nakṣatra is divided into 4 parts. If the ecliptic were to be divided into 12 parts, a nakṣatra necessitates a division into 4 parts. Different works express different opinion about birth of children on Mūla nakṣatra. The Taittirīya Śruti, however, appears to carry better opinion regarding birth on Mūla nakṣatra (Tai. Br. 3-1-2). Pāraskara Śūtra describes the inauspicious nature of “Āśresā Stars” (1.21). The topics of intercalary months, tithi vṛddhi and nakṣatra vṛddhi do not occur in either Āśvalāyana or Pāraskara Śūtra. The names of seven days (7 vāras), the rāsis, yogas and karaṇas also are not found in either of them.

Other Śūtras

The Hīranyakṣi and Āpasambha Śūtras contain almost all the subjects discussed by the Pāraskara and Āśvalāyana Śūtras. The rāsis and names of days do not occur in these śūtras also. All these śūtras define a spring season as composed of either Caitra and Vaiśākha or Madhu and Mādhava months. The Baudhāyana Śūtra defines the spring as “Mīna Meṣayōḥ Meṣa Vṛṣabhayōḥ Vasantah” The names of 12 rāsis occur there. The quotation (given on page 21) from Maitreya Śūtra refers to the Sun’s entry into signs and the word “Rāsi” is found used by them. The author feels that much more information regarding astrological subjects could be gathered from the Śūtra works; but he could not get a chance of reading other Śūtras.

3. NIRUKTA

Some astronomical references from Nirukta have already been given in the first part. The terms “Muhūrta” and “Kṣaṇa” have occurred in the 25th section of the 2nd Chapter. One comes across a reference to Saptarṣi in the quotation “Saptarṣīṁi Jyotiṁ” (See 10-26). One comes across some thoughts* of a surprising nature about the terms day, night, light-half and dark-half of a month and winter and summer solstices which occur in them.

अथ वें हिंसामात्मिक विश्वासुपूज्य महत्तत्तिपि रेवरेन्द्र बेदोक्तालि वा कर्मणि कृति ते धूमानिंसंपर्वत धूमावतिर्त राष्ट्रपीयभवमुक्षप्रस्ममहाभिलापिकायया वसिलाध्यात्मितूवलोकः प्रतिविद्यते \* \* अथ वें हिंसामात्मिक विश्वामाधिक्ष्य महत्तत्तिपिरे बानोक्तालि वा कर्मणि कृति

*Verses 8 and 9 from Chapter 14 and quoted below, describes how persons go to higher worlds if they (i) forsake study, commit cruel acts, but ultimately take to doing a penance or (ii) forsake cruel deeds, take up to study and also a penance in the end. The statement “Ākāśagujñah sabdah…………….” from the same chapter is important and worth reading. We come across similar thoughts in Yājñavalkya Smṛti and Bhagabagdītā also.
Yuga and Other Units of Time

The description about these time units is mostly similar to that found in Manusmṛti and astronomical works. The Nirukta defines Brahmā’s one day as the period of 1000 yugas, no clue being given as to the measure of a yuga in years; during this time the creation, maintenance and destruction of the Universe take place. Brahmā’s night also is of the same length (i.e. 1000 yugas) during which time he sleeps; the period of ‘a day plus a night’ is called Brahmā’s “ahorātra”. These repeat continuously infinite number of times. The period of Brahmā’s ‘ahorātra’ is identical with the one known as ‘Kalpa’ to the Sūrya Siddhānta and other astronomical works. The word ‘Kalpa’ does not occur in it. It is needless to say that Nirukta is the most ancient of all works which describe the long period of Yuga and other units. Although nothing is said about the measure of a yuga in terms of solar years, it is certain that it was definitely not so small a measure as five years. However the statements on the whole suggest some larger length for this term.

4. PĀNINI’S GRAMMAR

One comes across words like ‘Varṣa’ (5-1-88, 7-3-15) and ‘Hāyana’ (4-1-27; 5-1-130), occasionally found in the Vedas. One can read about lunar months denoted by Caitra etc. (4-1-21) and the term ‘Muhūrta’ (indicating a part of a day) (3-3-9). Similarly the term ‘Nādi’ denoting a number one or more than one (and not denoting a sinew in the body) occurs in it (5-4-159). This shows that the term ‘Nādi’ was used to indicate some measure of time. The term ‘tithi’ is not found in Pānini; but one should not say from this that the term was unknown to people in Pānini’s time. This grammatical work does not deal with astronomical subjects or religious topics such as the commands to do or not to do certain acts on certain nakṣatras. Hence, we can not say that the astronomical terms which do not occur in this work were unknown in his time. Also, of the names of yuga’s (Kṛta etc.), the term Kali does occur in Pānini, but not in the sense of a yuga; this is not sufficient to prove that the Kṛta and other units of yuga were unknown in Pānini’s time.
The names of nakṣatra’s are found in this work. The names ‘Puṣya’ and ‘Sidhya’ are found used in place of ‘Tiṣya’ (3-1-116). Similarly, ‘Sravaṇa’ used in Atharva-Veda only is found used in place of ‘Srōṇa’ (See 4-2-23). One comes across the statements, “The singular form for Purarvasu (1-2-61) and dual for Viśākhā (1-2-62) are to be accepted according to ‘Chandas’ i.e. Vedas”. but in no Śruti-works read by him the author finds these nakṣatra names used in the singular. He can not say, if they are found so used in Vedic work not known to him. The term ‘Proṣṭhapadā’ is used in dual and plural (1-2-60). Similarly the quotation “Vibhaṣāgrahāh” (3-1-143) leads one to suspect that a planet was taken to be a star.

CHAPTER II—SMṚTI, MAHĀBHĀRATA, ETC.

MANU SMṚTI

The Yuga-system

The Yuga system is described in details in the first chapter of Manusmṛti. The same system is generally given in Purāṇas and astronomical works. The text is, therefore, given below for reference.
# HISTORY OF INDIAN ASTRONOMY

The lengthy units of time, Kṛta and others, as described in the above verses are given in a tabular form below:

<table>
<thead>
<tr>
<th>Yuga name</th>
<th>Years</th>
<th>Transition period</th>
<th>Yuga name</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. KṛTA</td>
<td>400</td>
<td>3. DVĀPARA</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Central period</td>
<td>4000</td>
<td>Central period</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Transition period</td>
<td>400</td>
<td>Transition period</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>2. TRETĀ</td>
<td>300</td>
<td>4. KALI</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Central period</td>
<td>3000</td>
<td>Central period</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Transition period</td>
<td>300</td>
<td>Transition period</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Total of four Yugas = 12,000 years = Divine Yuga. 1000 Divine Yugas = 12,000,000 years = Brahmā’s day. In this scheme, a divine Yuga is considered to be equivalent to 12,000 years; but it is not clear if these years are to be regarded as divine. Now, taking one divine year as equivalent to 360 ‘human’ years, the divine yuga will be equivalent to 360 times 12000, that is, equal to 4320,000 ordinary human years. In the opinion of Whitney*, the years to be divine years is not Manu’s idea, it has been the result of later thought. But this is not correct.

That the divine year is a period far greater than an ordinary year was a well known idea even before Manu. A quotation from Taittirīya Saṁhitā given on page 65, clearly states that the ordinary year (human) which consists of 360 days is equivalent to a ‘divine day’. Hence, following the same analogy, one divine year is equal to 360 human (ordinary) years; and although Manu does not explicitly state 12000 years as divine years, the next unit (Divine yuga) is sufficiently suggestive to mean that the term “years” stands for divine years. The measure, “1 divine yuga = 360 × 12000 = 4320000 years” is doubtless a unit of time well known in Manu’s time; and 1000 such years are said to be Brahmā’s day. This measure is equal to that of Kalpa described by astronomical works, although the word ‘Kalpa’ is not mentioned by Manu. It is the author’s conviction that the units of time, viz., “Kṛta and other yugas, Mahāyugas, and Kalpa”, which are described by astronomical works, were already established as standard unit of time, not only in Manu’s time, but in the time of Yāska, the author of Nirukta, because the ideas given in verses 72 and 73 of Manu Smṛti are identical with those given by Nirukta in the last paragraph. He has clearly stated that a Brahmā’s day consists of 1000 years; although he neither says that these years were divine nor does he mention one yuga to consist of 12000 years, the names of yugas viz. Kṛta and others are found in the Vedas, so they belong to a period older than Nirukta. Also, the term “yuga” according to Nirukta, indicates a unit of time which was something very long; hence it is believed that the standard units of time given by the Śūrya-Siddhānta and others, had been well established in the time of Nirukta; and that it was

*See translation of Śūrya Siddhānta, page 10, by Burgess.*
well set into standard form in Manu’s time is doubtlessly true. The Mahābhārata mentions a yuga system similar to that given by Manu, and it will be described later on. European scholars believe that the Mahābhārata was compiled after Manusmṛti; even if it be supposed that it was compiled earlier, it would lend support to the belief that the standard yuga system was established long before Manu’s time.

The signs of advent of different yugas are given by Manu in terms of prevailing religious conditions; similar conditions are described by the Purāṇas also. The measure of the period known as ‘Manu’ is the same as given by the Sūrya-Siddhānta.

Manu Smṛti does not mention any names of planets or those of Rāśis; it does not give anything else of astronomical importance.

YĀJÑAVALKYA SMṚTI

Names of Week Days

This Smṛti describes a sacrifice in honour of planets, whose names are given in the following lines.

सूर्यः सोमः महीपत्रः सोमपत्री ब्रह्मपतिः ||२६५||
चुंबः शनिवरे राहुः केलुषोत्तेप्रहसः स्मुता: ||

Achalārāhāya.

The names of seven days and their Lords are not explicitly mentioned, but the order of names of planets is given exactly in the order of week days; this shows that the names of seven days of a week were known in the time of Yājñavalkya Smṛti. The Atharva Jyotiṣa mentions seven planets in relation to seven days, but it does not mention Rāhu and Ketu; but Yājñavalkya Smṛti mentions nine planets and the incantations (mantras) to be chanted in their honour* which are found in vogue in the present time. Scholars believe that Yājñavalkya Smṛti belongs to a very later period, later than Manu Smṛti and the references of planets and names of week-days lends a support to this view.

The Yuga-System

This Smṛti does not give the names of ‘Kṛtādi’ yugas and their measures; but a solitary reference viz.,

मन्त्रंचन्द्रेऽप्राप्तया ॐ २.१७२.

shows that the system described by Manu Smṛti was then in vogue.

Twelve Parts of the Ecliptic

The following lines give proper times for performing the ‘Śrāddha’ ceremonies:

अन्नमुद्यस्यार्थका बृहि: कृष्णपतोमित्रहन्तयम् ॥
द्वयं ब्रह्मण्डपतिविषुरसुधयं सर्वसाहं: ॥२॥
श्योत्तिपातो गजनिज्याया प्रहहुं चंद्रसूयंयो: ॥

Achalārāhāya.

* See verses 299-301, Ācārāhāya.
This work gives the word ‘Sūrya Saṃkrama’. It is not, therefore, necessary to infer that the names of Rāśis (Meṣa etc.) were known then. The terms are nowhere found in Yājñavalkya Śrīmti and only at one place we get a reference of nakṣatras names (See ‘Kṛttikādi Bharanyantam’ 1.267). It has already been pointed out that although the Rāśi-terms were not in vogue in the Vedāṅga Jyotiṣa period, the ecliptic was supposed to be divided into 12 parts. It is also said that according to some European scholars the names of seven days and 12 signs have been borrowed by the Hindus, and on the basis of this assumption one would argue that the Sanskrit work which gives names of week days must give names of Rāśis also. But it has been shown on page 100 that Atharva Jyotiṣa does not give Rāśis although it gives names of week days; and it will be shown later on in the study of Mahābhārata that the Indians, long before the introduction of the terms ‘vāra’ and ‘rāśi’, had adopted the division of the ecliptic into 12 parts for the calculation of Sun’s position and motion. The term ‘Saṃkramaṇa’ could be used to denote the crossing of the sun into a part of the ecliptic, no matter if the ecliptic be regarded as divided into 12 parts or in 9 parts according to Atharva Jyotiṣa. The above lines show that the word ‘Saṃkramaḥ’ has come in along with the ‘Ayanas’ (solstices) and ‘Viṣuva’ (equinoxes). It is thus proved that the ecliptic was divided into 12 parts in the times of Yājñavalkya Śrīmti.

Anyway, the study of Atharva Jyotiṣa and Yājñavalkya Śrīmti proves that the names of week-days and 12 rāśis did not come into use simultaneously; the ‘vāras’ came into vogue before the rāśi-names.

Yoga

The word ‘Vṛddhi’ occurs in the lines giving auspicious times for Śrāddha quoted on prepage; it is doubtful if this is one of 27 yogas given by astronomical works. The author thinks that it stands for ‘increase’ of “wealth, brāhmaṇas, money” etc., occurring in the same lines.

Other Matters of Interest

The word ‘Vyātipāta’ also comes in the same sloka. It definitely stands for the astronomical ‘yoga’. At another place (Prāyaścitādhyaśya, verse 171) we come across a quotation “grahasamyogajaiḥ phalaḥ”. This shows that people were attracted by the phenomena of planetary conjunctions and that they had begun to discuss about their probable auspicious (benefic) and inauspicious (malefic) effects. If the time of Yājñavalkya Śrīmti had been decided beyond doubt, it would have been possible to draw some more important inferences; still, the author records his opinion here that the Indians had the knowledge of Rāhu, Ketu, the order of week days, Vyātipāta and the conjunctions of planets.

पितुपालोज्जीवीपाद्याच यदावस्थ्ययो चांतर || तेनाप्रियोनिष्ट्रिणो वद्या शर्मकाम विन्य प्रति || ११८५१।
समालक्षीतिसाहित मुनयो मुहसेविनः || सप्तविनायवीप्रस्थतवसङ्क तमानसितः || ११८५६।
प्रयत्निवर्षपेषाययः।

We find references of Agastya and Saptarṣi in these lines. Similarly, in the Garga Saṃhitā and other works, they are said forming groups or clusters (Vīthi) of nakṣatras, e.g. Aja and Nāga are the names of two vīthis occurring
in them. There are differences of opinion regarding the formation of nakṣatras into groups and their number; some take 9 as the number, others regard it as 3. Bhaṭotpala has given in details the views of Garga, Parāśara and others in the chapter on ‘Sukracāra’ in Bhāṭat Samhitā. People in Yājñavalkya’s time, it seems, used to observe the movements of planets with respect to stars, since the viṭhis referred to in the above lines are clusters of stars such that the planets were actually observed as moving on one side or the other of them.

People thought that the abode of gods lay in the northern hemisphere of the heavens and the abode of pitṛs (fore-fathers) lay in the southern hemisphere. This view is similar to the ideas given by Śatapatha Brāhmaṇa (page 23).

We find in Yājñavalkya Smṛti (Chapter 3, verses 192 to 197) some discussion about ‘āyanas’ similar to that found in the quotations from Nirukta. We come across commands that certain religious rites should be performed when the Moon occupies certain benefic nakṣatras (See 1-180 etc.); they believed that the ominous influence of malefic planets is overcome by worshipping them (See 1-306); mourning was to be observed in the case of Rāhu. The viṭhis and muhūrtas also occur in the Smṛti; it also describes the reverential status of astronomers (See 1-312, 332).

MAHĀBHĀRATA

The astronomical references found in the Mahābhārata are so many in number that it is not possible to enumerate them for want of space. We will consider only those of them which are found very useful from point of view of the present subject matter.

Its Time

Before doing so, it is necessary to consider when the Mahābhārata was compiled; because the importance of the astronomical references will be the more firmly established. It is very difficult to establish without doubt its time; however, it can be found by conjecture. Now looking to the text, because the sage Vyāsa is said to have compiled it and Vaiśampāyana recited it to King Janmejaya, the work may appear to have been written at the time of Pāṇḍavas or soon after. It seems that the Mahābhārata was in existence in the time of Pāṇini. There is a direct reference of the Mahābhārata in the Āśvalāyana Sūtra and that it has already been proved from philological evidences that Āśvalāyana lived before Pāṇini. This definitely shows that the Mahābhārata* is a very ancient work. It may however be possible that a major part of what is known as the Mahābhārata to-day is of a later origin; even from astronomical evidence it can be said that several portions may have belonged to different periods. But an information of an important research about the interpolated portion must be given here.

The belief that the Mahābhārata contains a lac (100000) of verses should not be said to belong to the present time only. Under orders of the Government of India, ancient inscriptions on copper plates and stones are being published in a series of books entitled “Inscriptionum Indicarum”. The third part of the series contains inscriptions of Gupta Kings, which includes an inscription (belonging to Samvat 197) of King Sarvanātha of Uccakalpa (See page

*It is Prof. Kunte’s view that Pāṇini knew the Mahābhārata. See page 448, “Vicissitud yan civilization”.
134 of the said book) which clearly states that the Mahābhārata consists of 1 lac verses. It is established beyond doubt that the samvat quoted in it is Cedi (Kalachuri) (See Indian Antiquary, XIX 227 f; XVII 215). Now 197 Cedi = (197+170) = 367 Saka = 445 A.D. This shows that nothing new was interpolated in the Mahābhārata after 4th century (Saka); and it is also true that at least some portion of it was written in Pāndavas’ time, whatever that time be. The ‘Upākhyaṇas’, subsidiary stories and lengthy descriptions of fights can possibly have been interpolated afterwards. But it is not very probable that the original story about Pāndavas and important references about the position of certain planets near about particular nakṣatras at the time of the Mahābhārata battle have been interpolated by some one of his own accord later on. It can not be said about astronomical references found in the Mahābhārata that they have continued in their original form from Pāndavas’ time. The astronomical condition might have been handed down traditionally and these have been versified by some one later on. In short, what the author means to say is that the most important of the astronomical references must have been actual facts, traditionally handed down right from Pāndavas’ time and the remaining references, if not very old, at least belong to a period as ancient as Āśvalāyana and Pāṇini.

The author has read the whole of the Mahābhārata from point of view of astronomy, and an important thing which he noticed is that we do not get in it any reference of seven week-days and 12 rāsis. It can, therefore, be said beyond doubt* that the astronomical references in it point to a period, prior to the time (whatever that time be) when the week days and rāsis got introduced in our country. According to European scholars, the Hindus have borrowed astronomical knowledge from the Greeks; if they have borrowed it at all, they have not done it from Ptolemy (150 A.D.), but long before him. This fact can be proved easily and the European scholars also admit it. None of them has proved beyond doubt, when the knowledge was gathered; but they mean to hint that it was borrowed from Hipparchus, the famous Greek astronomer (150 B. C.) and hence, even the Europeans agree that the astronomical references found in the Mahābhārata could not have entered it earlier than 150 B. C.

To possess the knowledge of planetary motions and their causes and of finding their true positions is an important thing and so is inventing a system of names for week-days and those for Mēṣa and other Rāsis; but there is a vast difference between the importance of the two.

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*The author is giving below an interesting information about the Mahābhārata Nirṇayāṁṛta, a famous work on Dharmaśāstra, quoting the following lines about Cātumāśya and as taken from the Mahābhārata:—

वायुक्तिकृतान्तरा माहान् न गिरिस्मात्मचित्रेत्।
असंवचे तुलको तृ न्यायां तृ विशेषः।

But he did not find this verse in the Mahābhārata. Similarly, certain passages about ‘ghatikāpātra’ and attributed to have quoted by the Mahābhārata, are not found in it. The same work, Nirṇayāṁṛta, in the chapter on ‘Mahālaya’ in the second part of Nirnaya Sindhu quotes the following verse as taken from the Mahābhārata, but he does not find it anywhere in the work:—

पावलब कम्यांतः कम्यांतः हिविवरणः।
तृतीयं शेषपुरः तवेष्ट्रम् बृक्ष्यकम् यव्यवस्त:।

He has written these lines after actually going through the book printed by Ganapat Krishnaji’s press. A certain Vaman Sastri Islampurkar has published a news that he has found some original chapters of the Mahābhārata which have not been printed and published.
Vedanga Period

The first one is a very important thing; it was not known to anyone in Europe before Hipparchus, the Greek astronomer, and even the European scholars admit it; and if the Indians had required some help from the Greeks in this matter, it must have been very little. The second thing is not so important.

Let us now turn to the study of astronomical references found in the Mahābhārata.

The Yuga-System

The Mahābhārata describes Yuga and other units of time on the same lines as given by Manu Smṛti. (See Bhārata Vanaprava. Chap. 149, 188, Bhagavadgītā, 8.17; Śāntiparava, Chap. 232, 233 etc.). The names of Kṛta and other yugas have occurred at several places in reference to incidents attributed to be happening in those yugas. Similarly, the term ‘Kalpa’ denoting a unit of time has occurred at several places (See Śāntiparva, Chap. 183 etc.).

The System of Vedāṅga Jyotiṣa

We come across references about 5-year cycle or the system of 5-year yugs, at some places. The five Pāṇḍavas were born, one in each consecutive year. A reference to this is found in the following verse:—

अर्थसंवर्त्तर जाता अः प्रकाश संवर्तित ।
पापेश्वर ब्रह्माध्यक्ष पंच संवर्तित इति ॥२३॥
अर्थसंवर्तम, अ. १२४.

Bhīṣma, while calculating the time elapsed after the Pāṇḍavas went into exile, says to Duryodhana on the occasion of Uttara Gograhaṇa as follows—

तेषां कालांतरंगेण व्योतिष्ठां च व्यशोकम् ।
पंचमे पंचमे वर्षोऽहो मासानुव्रत्यातः ॥३॥
एवामाध्यक्षान नामसः पंच च द्वादश यापाः ॥
क्योंदशायान खण्डान्तमिति हि वनस्ति मनि: ॥४॥
विराजपरम, अ. ५२.

Here we get the reference to the Vedāṅga Jyotiṣa system of inserting two intercalary months in five years.

Under the Vedāṅga Jyotiṣa system, the nakṣatra-cycle begins from Dhaniṣṭhās, which means that Dhaniṣṭhā must be considered to be at the origin while stating a planetary position. The Kṛtikās were once regarded as the first nakṣatra before Dhaniṣṭhās. An interesting story about the Dhaniṣṭhādī system is related in the Mahābhārata as follows:—

अभिमितं स्वर्यसा तु रोहिण्याः कन्यसि स्वस्ता ॥
इश्वरी ज्योतिषां देवी सप्तस्तु वर्न गता ॥५॥
तत्र मूर्षोत्सरम् नक्षत्रं नक्षत्रं गणानां च खृत ॥
कालं स्वयं च ग्रहव बलभद्रं वह चित्वय ॥६॥
वनिष्ठादिको चालो श्राहणं परिकृष्टातः ॥
रोहिण्या ह्रणवनप्रमणां संशया समाबहवत् ॥१०॥
These lines occur in ‘Skandākhyāna’. The general sense of the story is not clear to the author. Various current mythical stories about the stars Abhijit, Dhaniṣṭhā, Rohiṇī, Kṛttikā are jumbled up in this chapter, and hence their mutual relationship is not clear. The Dhaniṣṭhādi system is said to have been introduced by god Brahmā; the theory underlying this is well known. The next sentence is “before it was Rohiṇī”. It is not clear if this refers to the period when Rohiṇī was possibly considered as the first nakṣatra. The important portion of the story is the reference of “star Abhijit’s falling down from heavens”. The celestial latitude of Abhijit (Alpha-Vega) is 61° North. Hence, owing to the precessional motion of the equinox, it is bound to occupy the position of the pole of the celestial equator; and it is shown in a well known book* on astronomy that it will be a polar star 12000 years hence. When Abhijit would come to the position of the pole, it would be seen very low near the horizon and is liable to be observed even in the horizon (i.e. in the lowest position). The author suspects that the myth has originated because of such a position of Abhijit actually observed in the past, and this thing can possibly have happened 13000 years ago. The statement “Kṛttikās have gone up in the sky” does not carry any satisfactory sense.

Winter Solstice And Śravaṇa Star

In the Vedāṅga Jyotiṣa period the Winter Solstice used to take place at the beginning of Dhaniṣṭhā; at present its place is nearabout the commencement of P. Aṣāḍhā and some years ago it used to occur near U. Aṣāḍhā. It must have, therefore, been taking place near Śravaṇa in some age. We come across an important reference about this in the Mahābhārata. While reading an account of how sage Viśvāmitra attempted to create a ‘parallel-world’ we come across verse No. 34, Chap. 71 from Adi parva, which runs thus:

चक्रार्थयं च लोकं ब्रह्मां हस्तत्तरं । प्रतिस्वत्वपूर्वार्थिः नक्षत्राणि चक्रार्थयं । ॥

Similarly, the following lines are also worth reading:

अहं द्वैतं ततो राज्यसतहः शुष्कलाब्ध्यम् समूहः । अभिमानसिद्धिमानं क्षत्रियं अर्जुः सिद्धिरामः । ॥

Although it is not stated in clear words that winter solstice used to take place in the beginning of Śravaṇa nakṣatra, there is no other reason for calling the nakṣatras as Śravaṇādīni commencing from Śravaṇa. Like the Vedāṅga Jyotiṣa system, herein also the nakṣatras are ‘Śuklādi’, that is commencing with light half or ending in New Moons. From this it can, therefore, be inferred that the Vedāṅga Jyotiṣa system continued for few centuries more but in a slight different form. It has already been shown before that the time when winter solstice used to occur near the beginning of Dhaniṣṭhā was about 1400 B. C.; it began to take place in the beginning of Śravaṇa at about 450 B. C.

*Newcomb’s Popular Astronomy has given in a map a list of stars which will become polar stars in different ages.
References about seasons, ayanas, Madhu and other months, and tithis are found at several places. The seasons commenced with ‘Śīśira’, so say the lines. The words “Seasons commencing with spring” also occur at many places. If the year began with W. S., the commencing season must either be Śīśira or Hemanta. The following lines support the view that “Caitra and Vaiśākha constitute the Spring season” was the popularly known relation in those times.

We meet with two lists of names of months in Chap. 106 and 109 of Aśvaśāsana Parva, in both of which the first month is stated to be Mārgaśīrṣa. Even when the verse concerning Śravaṇa nakṣatra states new moon ending month-system, we come across a statement showing that full moon ending month-system was also in vogue. e.g. see verse No. 96.

The following verses contain references about parts and sub-parts of a day. The line from verse No. 21, Chapter 7 from Śanṭi parva viz.,

quotes the time-units viz. Kalā, Kaśṭhā, Muhūrta and Lava. Similarly the line

from verse 14, Chap. 36 of Śanṭi parva gives ‘Kṣaṇa’ as another unit; but their mutual relationship is nowhere to be found. The term ‘muhūrta’ occurs at hundreds of places e.g.

quotes the Jaya muhūrta. The Atharva Jyotiṣa gives Vijaya as the name of the 11th muhūrta. The following verse contains the names of Abhijit, the 8th muhūrta, and the term Tithi (but in masculine form).

The 8th muhūrta, Abhijit, is famous in the Atharva Jyotiṣa and other astronomical works. The units, ghāṭi and pāla are not to be found anywhere in the Mahābhārata; but the author is not certain about this, since he did not read the work with particular attention to these units.
Week-days

No reference is to be found about 7 days in a week in the Mahābhārata but the author came across a solitary instance in which the word ‘Vāra’ occurs in the verse No. 7, Chap. 160, Adiparva. The Pāndavas used to live with a certain Brahmin in the Eka Cakra Nagari, before Draupadi’s ‘Swamvara’ was held. In that city there lived a demon and it was agreed between him and the citizens that they should send one man every day for his meals. One day, it was the turn of that Brahmin to send a man to the demon. It is in this connection that the verse is written.

एकेकरसाथि पुत्रसत्तप्रयज्जति मोजन || स वारो बुद्धिम बर्षेबंधसुकृरो नर्वः ||

अविनर्व, अ. १६०.

The word ‘Vāra’ has been used to denote the turn (of a day). It has already been pointed out that the word ‘Vāsara’ occurs in the Rigveda. It shows that the term ‘Vāsara’ or ‘Vāra’ used to be applied to a day to show a ‘turn’, before the names of seven days of a week came into vogue.

Nakṣatras

A complete list of 27 nakṣatras is found given at two places (see Chap. 64 and 89, Anuśāsana Parva) but the list begins with Krūttikā; names of nakṣatras are found at several places. It is not necessary to quote all the concerning verses here; but the author gives below only those few sentences which are worth noting.

The references about Mṛgasīras comes at some places in stories about god Rudra chasing the Mṛga (the star-deer) e.g. (See verse 20, Chap. 278, Vana Parva).

अविनर्व, अ. २०४.

The story of Rudra chasing the deer (Mṛgasīras) is found in many Sanskrit works and in Sauptik Parva and also in Chap. 283 on ‘Mokṣadharma’, in Śanti Parva. For this, read

तत: तत् यद्य विवाच रोक्षण हुल्लि राज्या ॥
तत: प्रवर्तकस्ततो यज्ञ भूषण स पावक: ॥
सः सूर्य: राज्य दिव्य व्याप्ति व्यराजत: ॥
अन्तःलिङ्को रोक्षण दुरावर्तित नभास्वले ॥

अविनर्व, अ. १४.

In the following verses are to be found references about the Punarvasu stars in which the beauty of the twin stars on both sides of the moon is described.

ताज्यो वर्षराजस्य मूर्तिः परिपार्ष्ठत: ॥
राष्टिसाध्रो वक्षितोत्वो चन्द्रस्य पुल्लबसु ॥

कर्णपर्व, अ. ४५.

A reference to star Hasta composed of 5 stars occurs in

पञ्चविष्योत्वम्: पार्ष्ट्रोग्न: परिपार्ष्ठो भव: ॥
पञ्चतारेय संयुक्त: सावर्चेष्व चंद्रम: ॥

वानपर्व, अ. १३५.
The Viśākhā* is said to have two stars.
A reference is found in the following lines.

Other Stars

A reference to dog star Sirius has already come along with Mrga. The names of stars other than 27 standard ones are also found in the Mahābhārata e.g. in the following lines one gets a reference to Agastyā (Canopus) and Saptarṣi with Arundhati (Great Bear).

Yogas, Karaṇas and Names of 12 Rāṣis

Nowhere in the Mahābhārata is found a single reference to Yoga, Karaṇa, or Rāṣi. Haḍ Rāṣi been in vogue at any stage of the Mahābhārata’s compilation, they would certainly have come in the text. This definitely shows that the terms Aries (Meṣa), Taurus (Vṛṣabha) etc. were not current in the age when the Mahābhārata was compiled. In the same way it was not the system to mention a planet’s position with reference to a part after dividing the ecliptic into 12 parts. Everywhere in the Mahābhārata we find the position of the moon and other planets with reference to stars.

Solar Months

The sun’s position in the ecliptic does not appear to have been given anywhere in the Mahābhārata, still it can be said that like Vedāṅga Jyotisa, the solar months were known to the Mahābhārata also; not only that, we also get references of 8 ‘saṃkrānts’ in the following verse in which their importance as being very auspicious for charity are stated.

The terms ‘two ayanas’ occurring in it are known in astronomical works as Makara and Karka Saṃkrāntis, and the ‘Viśuvas’ are termed Meṣa and Tula Saṃkrāntis.

* Some books on astronomy describe Viśākhā as a cluster of 4 stars. Of these, the star Alpha and Beta Libra are very luminous; but even these stars fade when the full moon comes in between them. If however, the moon happens to come in between these stars any day prior to the 5th tithi of light half or after the 10th tithi of dark half, the scene is very a scintating. (See P. 37, second edition, Jyotirvīḷāsā.)
The term ‘Ṣaḍaśti’ in the Sūrya-Siddhānta applies for the four signs, Gemini, Virgo, Sagittarius and Pisces. This term is used in the plural and therefore, the author feels that it signifies the above mentioned four signs. This consideration leads one to infer that so far as stating the sun’s position was considered, the ecliptic was divided into 12 portions at the time of the Mahābhārata.

**Eclipses**

Ordinary references of solar and lunar eclipses are found at many places. We find the description of fruitfulness of performing Śrāddha ceremonies, at the times of eclipses (particularly at the time of solar eclipses) and of giving away of lands and other articles in charity. Similarly, we get references of occasions when eclipses took place. For instance, a solar eclipse occurred when the Pāṇḍavas started for exile.

> राहुप्रसदस्वदधिवर्यमपविविलापेऽप्रभु ।
> समाख्ययः अः ॥
> श्रीमपवः भः ॥
>
> चतुर्विंशीं पंचदशीं भूतपूर्वी ।
> घोषभ्यं तु ताभिजायते मामातायां ज्योतिः ॥
> चतुर्विंशीं प्रस्ताविक्षप्ताः ज्योतिः ॥ ॥
> श्रीमपवः भः ॥
>
> These lines and the previous context show that a lunar eclipse had taken place on the Kārtika-full moon and a solar eclipse had fallen on the next new-moon day. The falling of two eclipses in the same month is a common experience; but those two are rarely seen at the same one place; and that is why this is regarded as an ominous incident. This phenomenon is considered at length by Bhaṭṭotpala (in Śaka 888) in his commentary on Bṛhat Samhitā (see Chapter on ‘Rāhucāra’).

**Viśvaghasra Pakṣa**

The above lines contain a reference of a ‘Pakṣa’* consisting of 13 days having occurred at the time of the Bhārata battle. The occurrence of a “half-month” consisting of 13 civil days is a rarity; and hence it is regarded as an ominous incident. This is called a Kṣaya Pakṣa or a missing half. If calculations are done with the formulae given by the Sūrya Siddhānta and other astronomical works and if true positions of the sun and the moon are taken into account, we do sometimes get a 13-day half-month; but we can never get it by either adopting the mean motions given by the Vedāṅga Jyotiṣa or even by the mean motions given by modern astronomy; because the measure of

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*The literal meaning of the word is ‘wing’ or ‘side’. A lunar month is said to have sides or halves viz. the light half and the dark half. This word should not be translated as a “fortnight”.

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a half-month according to Vedāṅga Jyotiṣa comes to be 14d. 45gh. $29\frac{1}{31}$ p. and that according to S. S. and European astronomical works it comes to 14d. 45gh. $55\frac{3}{50}$ p. The 13-day half-month is possible when its mean value would be less than 14 days. This is never possible if mean values are taken for the motions of the sun and the moon; but it is possible if true positions are reckoned. For example, the dark half of Phālguna, Śaka 1793 and the light half of Jyaistha, Śaka 1800 were 13-day half-months. On both these occasions the Grahalaghava almanac and the Keropant’s almanac (which took figures from English Nautical Almanac) gave a half-month a measure which was less than 14 days by a few ghātis. The occasions when the half-month’s measure would be less than 14 days are very few and it is not necessary that a 13-day half-month would emerge on all these occasions. For example, suppose that on the first day of a month (Meṣa) or on the 1st date of an English Calendar month the new moon or full moon takes place at 4 ghātis after sunrise and suppose that by reckoning the true motion, the actual measure of half-month came to be 13 days 55 gh.; then the next lunation will take place (i.e. the full moon or the new moon would take place) at the end of 59th ghāti on the 14th day. Now, because first Parva-end occurred on the 1st day of the solar or civil month, after sunrise, that civil day would be included in the previous half-month and hence, only 13 days would be left to be reckoned in the next half-month. Taking the same example, if we suppose that the first lunation occurred after 10 ghātis after sunrise on the 1st date, the second lunation will occur on the 15th day at 5 ghātis after sunrise; hence, the half-month will consist of 14 civil days and not 13. It is therefore quite clear that a 13-day half-month is never possible if mean motions are adopted and the fact that reference of such a half-month occurs in the above lines, leads one to infer that the Indians knew how to calculate true positions of planets even so early as in the Mahābhārata age; and this is a very important thing to note. Some one is likely to raise a doubt that the reference of a 13-day half-month in the Mahābhārata is an actual phenomenon recorded by actually counting the number of civil days elapsed between one lunation to the other after seeing the moon’s position in the sky every night and not as a result of calculations based on mean or true motions of planets. This is simply an impossibility. A 13-day half-month is possible (as is shown above) only when the ending moments of new or full moons are about a few ghātis before or after sunrise. The moon is never visible on a new moon day, and it is doubtful if it is visible when the ending moments occur near about sunrise. A calm consideration of the problem will convince one that the possibility of such a missing half-month is noticeable not by observation of moon’s position by actual mathematical calculation. It is difficult to explain the thing more clearly and in shorter terms.

The above references show that the lunar eclipse had fallen on the Kārtikī full moon day and solar eclipse on the next following new moon day. Now, when a 13-day half-month is the light half of a month, the beginning eclipse must be solar and the ending one a lunar as can be seen from such a half-month viz. Vaiśākha Śukla paśa of current year (i.e. Śaka 1817). But, if a 13-day half-month is to be taken as a dark half of a month, the falling of a lunar eclipse in the beginning and that of a solar eclipse at the end is an impossibility. One will not find such an example in any of the past almanacs. Even if it be supposed that such a half-month did occur, maximum length of it would be 13 days 30 ghātis; but the max-length of actual ‘any 13 consecutive civil days’ can never be less than 13 days 50 ghātis. According to modern accurate
elements, it is not possible to get a 13-day half-month which has a lunar
eclipse in the beginning and a solar eclipse at the end; but we do get such a
reference in the Mahābhārata; and one cannot get the occurrence of this
phenomenon by adopting mean motions of the luminaries. We are, therefore,
led to believe that in the days of ‘Pāṇḍava’s the Indians had, no doubt, acquired
the knowledge of calculating true places of planets, but their calculations
were different from (i.e. less accurate than) what are done in the present times.
The Mahābhārata relates the occurrence of a solar eclipse when Duryodhana was killed.

राहुरूपिणांत्वप्रसर्वर्योपवधिः विषाणि ॥ १०॥ गदाधर. अ. २७.

A solar eclipse had already occurred one month before the commence-
ment of the battle. Another solar eclipse could not have, therefore, fallen imme-
diately after a month. This appears to be an exaggeration*. It is definitely
stated at least in this verse that eclipse had fallen even when it was not a
‘parva-day’.

It is probable that occurrence of a 13-day half-month and that of a solar
eclipse are exaggerations. Even then we can not say that the phenomenon
of the occurrence of a 13-day half-month was not known to people in those
times, and the above discussion does not come in the way of our inference.

Planets

Now let us see what references we get about planets in the Mahābhārata.
One comes across the following lines in a passage describing the god
Sun:

तौसो कुर्मविद्वात् शुचिः कुर्मोमारुपे एक एक ॥ १७॥ इंद्रो विवश्चनां द्वीतियाः। शुचिः थोरिः। शमेश्वर: ॥

वनभर्ष. अ. ३.

In this we read of names of Mercury and other 4 planets. The following
verse appears to state that the sun had five planets:

ते तु कुड़ा महेश्वरस त्रौपवेष्ट: प्रहारिणः ॥ राशिं बुधवः सब्यू लोके पंच रंगे यथा ॥ १३॥

भीतपर्वः. अ. १००.

Similarly the verses

प्रजासंहरणे जाति सौम सप्त प्रहा इव ॥ १२॥ ब्रमणवर्ष. अ. २७.

निं सरंतो व्यवुद्धत सुभर्षस्य महाप्रहाः ॥ १४॥ कर्षणवर्ष. अ. २७.

refer to 7 planets ‘afflicting’ the moon. The number seven must, therefore,
be including Rāhu and Ketu which are not visible. This shows that our
astronomers had developed a knowledge of Rāhu and Ketu with reference to
the moon’s latitude or the eclipses and that they understood the theory under-
lying these phenomena.

*The same line occurs at another place as “Rahunarko grasisah............etc.”. The incident
of Duryodhana’s death is given in a poetic and figurative way by the writer. He means to
say that it was not the death of King Duryodhana but the ‘devouring’ of the god Sun by
Rāhu, on a day (to-day) which is not a parva day. Eclipse is never possible on a non-lunation
day. But the poet compares the event of Duryodhana’s death with the occurrence of a solar
eclipse even when the day was a non-parva day.

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Many people try to suggest that the current names of some planets which occur in Indian astronomy are not originally Indian but of foreign origin, but their names as given by the Mahābhārata are strictly of Sanskrit in origin.

Retrograde Motion of Planets

References about planets’ retrograde motion occur at good many places; e.g. see the following verses.

विषयज्ञपती विमार्शयन्त भ्रातविचित्र ॥ ॥
कर्णपर्व ० १८ ॥

वायुक्तिके पुनात्युपस्तृते संस्कृत्कार्ये वहने ॥ वक्तकिदन्तमनोकायागारके इह प्रह ॥ ॥
कर्णपर्व ० २० ॥

अंत इतिदोषों संधो तदा वंशविविधमात ॥ ॥
कर्णपर्व ० २१ ॥

Planetary Conjunctions

We come across references of planets’ mutual fights i.e. their conjunctions at many places; e.g. see the verses.

तत्त: समनविच्छूद्धरुपविच्छूद्धरुप: ॥ विषयज्ञपती विमार्शयन्त ॥ ॥
कर्णपर्व ० १८ ॥

भृगुस्वातोधरुप: शास्त्राचिन्तेन समन्विताऽ ॥ ॥
शताप्रव ० १९ ॥

Positions of Planets at the Time of Bhārata Battle

The author gives below the positions of planets as described by the Mahābhārata. These refer to a period two months prior to the commencement of the battle or even the fighting period. When Lord Kṛṣṇa, who had gone to Kauravas on or about Kārtika Sukla 12 for mediation, returned from his mission, on the 7th day before next new moon, he was met by Karna who says to him:

प्रारंभात्रं हि नन्द: प्रहस्तीयायमः शायत: ॥ शरीचर: पीड्यति पीड्यत: प्राणितदेव: ॥ ॥
कृत्यान्तरावभारतस्वं ज्ञायते मथयुतं ॥ अनुरोदान्त शायत: प्रायत्ते संस्त: संसार्यनिव ॥ ॥
विशेषो हि वायुयायतं च चतुर्तावत: पीड्यते प्रह: ॥ ॥
समस्त्य लक्ष्म: व्यापूर्तं राहुर्युपपरित: च ॥
उद्गोपव ० १४३ ॥

These verses describe Karna’s views about indications of bad omens and loss of general life on a large scale. Similarly, sage Vyāsa is describing in Chapter 3 of Bhīṣma Parva, planetary positions which give indications of wholesale destruction of public life. See verses 12 to 18 and 27.
Knowledge About Planets

It has already been shown on page 108 that the position of planets described by Vyasa in a dialogue between Karna and Krsna is a record of observed phenomena in Pndavas' time, the information having been handed down from generation to generation till it was incorporated in the Mahabharata. This shows that people in Pndavas' time, whatever that time be, were well acquainted with the planets and their movements and that the planetary positions used to be stated with reference to nakshatras.

Pndavas' Time

Let us now take for consideration the problem of finding the time when Pndavas lived.

We come across some lines in the Mahabharata which suggest that Pndavas lived in the 'transition' period between Dvapara and Kali.

Similarly, MAruti says to Bhima,

or Yudhishtira observes while in exile,

or Sri Krsna says to Balarama after Duryodhana was killed,

We also come across a description of time units given in Chap. 188 of Vana-parva, in which are foretold a number of things to happen in (future) Kali. All these references unanimously mean today that according to the Mahabhara the Pndavas flourished in the period transiting between Dvapara and Kali. In the opinion of all astronomical works the Kaliyuga commenced 3179 years before Saka era; this shows that in the current year Saka 1817, the number of Kali years elapsed is equal to 3179+1817=4996. This means that about 5000 years have passed since Pndavas lived. All astronomical works unanimously agree to when Kaliyuga set in; and all these works have been written 2600 years after. But we do not find any reliable references in the several works compiled during the Vedic and Vedanta Jyotisa period, on the basis of which we could fix up the time of Kali-beginning. European scholars however think that the moment of commencement of Kali has been arbitrarily decided by the astronomical works on the basis of certain planetary positions and this view is worth consideration and will be considered later on. If the time of starting Kali era be a correct one and if the Pndavas really flourished between Dvapara and Kali, they must have lived about 3200 years before Saka.
Famous astronomer Āryabhaṭa (Saka 421) has stated in definite terms that
the Bhārata battle was fought in the ending period of Dvāpara (See descrip-
tion of Āryabhaṭa, Part II) and it can be proved from his work that 3179 years
of Kali had elapsed at the beginning of Śaka era.

Varāhamihira (Śaka 427) says,

असंभवधतु मुनयः सातति पृथ्वी युधिष्ठिरे नृपति ॥

वद्धिकपण्डित्य (२५२६) युतः आकारलस्त्तप्य राजद� ॥

बुधसंहिता, सत्तविजार.

"The sages (i.e. Saptarṣi stars) occupied the Maghā constellation when
the King Yudhiṣṭhira ruled the earth; the year of his reign can be obtained
by adding 2526 years to the number of Śaka years elapsed."

This shows that according to Varāhamihira, Pāṇḍavas lived 2526 years
before Śaka era i.e. after 653 Kali-years had elapsed; and he has described the
movement of Saptarṣi according to Vṛddha Garga’s opinion.

The sage Vṛddha Garga also appears to hold the same view. The history
of Kashmir, by name Rāja Tarāṅgini, has been written by Kalhaṇa, who lived
700 years after Varāhamihira. He has also given in the first chapter (Ullāsa)
the time of Pāṇḍavas as 653 Kali-elapsed.

This time quoted by Garga and Varāha is simply an imaginary one. Varāha
has stated in the chapter on Saptarṣicāra that these seven stars have motion
and they stay in each nakṣatra for 100 years, and the Pāṇḍavas’ time has been
calculated on this basis; but it is a fact that the Great Bear is almost stationary
and is still on the meridian passing through Maghās just as it did in Yudhiṣṭhira’s
time. Hence if, the supposition that the 7-stars remain in each nakṣatra
for 100 years be regarded as true, then Yudhiṣṭhira will have to be taken as
having lived 2700 years or 5400 years (or some other multiple of 2700 years)
ago from now. But, the stars have no motion, and hence the time calculated
on this assumption has no meaning and so also the time given by Garga and
Varāha is meaningless. This sage Garga flourished a century or two after
Śaka era started. He noticed the Great Bear to be on a meridian passing near
about the constellation of Maghā and hence he must have decided that 2526
years before Śaka elapsed after Yudhiṣṭhira lived. This big constellation
occupies an extensive region of the sky and the stars could be said to be on a
meridian passing through any of the constellations, Maghā to Citrā. The
same was their position in Garga-Varāha’s time. (If some would tell the
author that the Saptarṣis were formerly seen in the ‘lune’ occupying Maghās
and if he thinks them to be in a ‘lune’ occupying Pūrvā, he would naturally be
led to believe that the Saptarṣis have got motion). Varāhamihira lived only
a few centuries (two or three hundred years) after Garga; hence he also believed
as true what Garga stated. In any case the time is imaginary.

The Mahābhārata states that Pāṇḍavas lived at the end of Dvāparayuga,
and this view was considered as correct even up to Varāha’s time. Āryabhaṭa I
who lived before Varāha (or was just his contemporary) accepts this view,
but astronomers like Varāha and Garga do not; this leads one to feel that the
Mahābhārata’s statement is unreliable.

Shri Visaji Raghunath Lele has published in a newspaper in Śaka 180
his findings about Pāṇḍavas’ time based on the planetary positions given in
the Mahābhārata. Let us examine the case.
The summary of what Mr. Lele means to say is as follows:—

The dialogue between Karna and Vyasa shows some planets to be positioned on two nakṣatras each. Moon also is stated to be seen with two nakṣatras. The moon's position on the first day of fight is stated in the following verse.

When Balarāma returned from pilgrimage, it was the 18th day of the battle. He remarked

This shows that the nakṣatra on the first day of the battle must have been either Rohini or Mrga. Thus according to the Mahābhārata, the planetary positions were observed on two different nakṣatras as given below:—

Moon: situated in (i) Rohini or Mrga and (ii) Magha
Mars: (i) Magha and (ii) Anurādhā or Jyeṣṭha
Jupiter: situated near (i) Viśākhā and in (ii) Śravaṇa

This shows that one nakṣatra seems to be 'divisional and Sāyana' and another one a 'stellar and nirayaṇa.' These two nakṣatras, in each case differ by 7 or 8 nakṣatras. Calculating the possible age when so much difference in Sāyana and Nirayaṇa nakṣatras could have happened, we get 5306th year before Śaka era (or 2127th year before Kali era). The battle appears to have been fought in the Sāyana month of Mārgaśīrṣa of that year. The planetary position described in the dialogue of Karna and Vyasa refers to the period of 22 days before this. The author calculated planets' places on the Kārtika new moon day by Keropant's planetary tables. This book has accepted the Sūrya Siddhānta's measure for a year. The moment of equinox according to this measure comes to be 12th 27° after mean sunrise on Saturday, the eleventh tithi of Caitra Śukla pakṣa of that year. The tropical true longitude of the sun comes to be 8° 25° 1° which shows that the Caitra is actually the Sāyana-Pauṣa; and the ayanāṃśa for that year was 3° 4° 59°. Adding this to Sāyana longitude of the planet we get its Nirayaṇa place. The new moon of Nirayaṇa Māgha is found to occur 313 days after the vernal equinox in that year. The Sāyana positions of planets, at 12th 27° after mean sunrise at Bombay, come to be as given below:—

<table>
<thead>
<tr>
<th>Planet</th>
<th>Trop. long.</th>
<th>Sāyana Nakṣatra</th>
<th>Nirayaṇa Nakṣatra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>7 3 16</td>
<td>Viśākhā</td>
<td>Śatadhaśak</td>
</tr>
<tr>
<td>Moon</td>
<td>7 3 27</td>
<td>Anurādhā</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>7 1 8</td>
<td>Viśākhā</td>
<td>Dhaniṣṭha</td>
</tr>
<tr>
<td>Venus</td>
<td>7 21 1</td>
<td>Jyeṣṭha</td>
<td>P. Bhādrapadā</td>
</tr>
<tr>
<td>Mars</td>
<td>4 6 34</td>
<td>Magha</td>
<td>Anurādhā</td>
</tr>
<tr>
<td>Jupiter</td>
<td>6 17 47</td>
<td>Śvāti</td>
<td>Śravaṇa</td>
</tr>
<tr>
<td>Saturn</td>
<td>5 1 8</td>
<td>Citrā</td>
<td>U. Bhādrapadā</td>
</tr>
<tr>
<td>Rāhu</td>
<td>7 10 43</td>
<td>Anurādhā</td>
<td>Śatadhaśak</td>
</tr>
</tbody>
</table>

The moon's approx. long. (on next full moon day) 1 18

P. Phalguna
Mars is said to be in Maghā; by calculation it appears to be Sāyana Maghā. Jupiter and Saturn are stated to be near about Visākhā; and calculation shows Jupiter to be in Sāyana Svātī and Saturn in Sāyana Cīrā. The nirayaṇa system was not at all in vogue in Pāṇḍavas’ time. The position of a planet used to be given as “situated in such and such Sāyana division and near such and such star”; and according to this system Mars was given to be near the fixed star Jyeṣṭhā (Alpha Antares). The fixed stars were and even now are situated somewhere near about the nirayaṇa divisional nakṣatras of that name. According to that system, the star Jyeṣṭhā was situated in the nirayaṇa Anurādhā division and Mars conjoined with the star. The statement “āṅgaraṇaṃ jyeṣṭhāyām vakram kṛtvā” of the verse should not be interpreted as the retrograde motion of Mars, but its motion “away from” the star Jyeṣṭhā as far as the latitude was concerned. Jupiter has been said to be near Śrāvana, so we find it near Śrāvana star by calculation. The moon has been given to be near Rohini and so we find her position by calculation. Its position near Maghā is confirmed by calculation which shows her to have been near Maghā-star in the nirayaṇa Pūrva-Phalgunī division. Venus proves to be near P. Bhādrapāḍa as told by the Mahābhārata. The words “Rāhuḥ arkaṃ upati” meaning “Rāhu comes near the Sun” is found to be true by calculation. In short, the planetary positions described by the Mahābhārata appear to be given in terms of Sāyana divisional nakṣatras and actual stars, and the year of battle comes to be 5306th year before Śaka era. This is the gist of what Mr. Lele has published. The following are some serious objections against his statement:

(1) Mr. Lele states that the planetary positions given by the Mahābhārata are Sāyana; but they are not so. The zodiac in the present time is taken to commence from Aśvinī; following the same principle, Mr. Lele has converted the positions of all planets with regard to the equinox, taking first nakṣatra from this as Aśvinī. But whence does he get the rule of regarding first nakṣatra from equinox as Aśvinī? Sāyana-Aśvinī-nakṣatra is not a visible star. It is quite obvious that originally the divisional nakṣatras began to be known by the names of some visible stars; and hence, the sāyana nakṣatra in which the equinox used to take place in the time of Pāṇḍavas must have got the name of that star which was actually situated in the division. But Mr. Lele says that the nakṣatras in the time of the Mahābhārata were sāyana and commenced from Aśvinī. These arguments would lead one to infer that the system of reckoning sāyana Aśvinī as the first nakṣatra must have come into vogue at a time when the equinox used to occur near about Aśvinī star. By calculation we find that the equinox used to take place near a star of Arietis group in between Śaka 500 to 800 but the Pāṇḍavas lived long before this period. Hence, according to Mr. Lele’s view, the Sāyana-Aśvinīyādi system was in vogue about 26000 (or an integral multiple of 26000) years before Śaka era. But we do not come across names of nakṣatras as begun from Aśvinī; we get references of the nakṣatra cycle beginning from Kṛttikās or from Dhanisthā or even from Śrāvana. Not only this, but in the Vedas we do not get a single reference of ‘Aśvinīyādi’ system, even in the Vedāṇga-Jyotiṣa we do not read of Aśvinīyādi’ system, but of Dhanisthā; and the list of controlling deities begins with Kṛttikās. In the Rigveda we do not doubt get a solitary reference of Aśvinī being the first nakṣatra, but it has been shown on page 72 that the

*The Nirayaṇa divisional nakṣatras, shown in the above table are not given by Mr. Lele; it is the author who has noted them for a clear understanding of what he wanted to say by stating that such and such planet was near a particular star.
reason is quite a different one. Aśvinī was never the first nakṣatra before 500 years before Śaka (i.e. about 2300 years from now). The current astronomical works do treat of the Aśvinīyādi system, and those of the works which describe them are not older than 2300 years. This will be proved later on. In no works belonging to the Vedic or the Vedāṅga Jyotiṣa period, do we find either any reference of Meṣa and other Rāśis nor of ‘Aśvinīyādi nakṣatras’.

(2) If any one says that the sāyana system of planetary reckoning commenced when the equinox was in Kṛttikās and that the time when Pāṇḍavas lived could be found, by supposing that the astronomical references given by the Mahābhārata are sāyana and the sāyana-divisional Kṛttikā nakṣatra commenced from the equinoctial point, then his suggestion can be accepted. The dual position of planets given by the Mahābhārata refers to two nakṣatras which are separated by seven or eight nakṣatras. Hence, adopting the Aśvinīyādi system we get position of equinox in Punarvasu in Pāṇḍavas’ time; and such was the equinoctial position in the 5306th year before Śaka era. If we start with the assumption that in the time of Pāṇḍavas the system was Kṛttikādi, even then the references of planetary positions can be shown to be true; only the Pāṇḍavas’ time would prove to be 2000 years earlier i.e. about 7300 years before Śaka. The equinox occurred in Kṛttikās about 2400 years before Śaka. The Pāṇḍavas lived before this date. Hence, Mr. Lele will have to say that “The Kṛttikādi-system of nakṣatra reckoning started 26000 years before Śaka” i.e. about 28000 years before Śaka and therefore, also that it continued for 21000 years up to Pāṇḍavas’ time.”

But acceptance of the statement that the sāyana system of calculation began 26 or 28 thousand years before Śaka era involves the responsibility of proving that our astronomers were well-versed in the knowledge of huge astronomical figures involved in necessary calculations for almanac-making. Only the almanac makers can understand the implications of such assumptions and it cannot be agreed to. Mr. Lele observes that our people possessed up-to-date knowledge of astronomy since 26000 years before Śaka or even before that date, they could record correct observations and that the works written in those old ages are now lost*. How could the system which continued for 25000 years suddenly lapse? How could all the works written in this period be lost and the whole knowledge of astronomy be forgotten? The history of hundreds of books on astronomy written during the last 2000 years are traceable from one to the other correctly. (This will be shown in the next part.) Under such circumstances, how is it that not a single work of the old period is available and no trace of the previous mathematics obtainable. Books written 500 years before Śaka are available but none of them contain any trace of the accurate astronomical calculations. Mr. Lele will have to accept that the Vedic and the Vedāṅga Jyotiṣa literature belonged to the pre-Pāṇḍava-period. It is, therefore, impossible to solve the puzzle how the astronomical works and astronomical knowledge possessed by the people in the intermediate period were lost when the works written in the Pāṇḍava and the Vedic periods are still available.

Mr. Lele has taken the Aśvinī as the first nakṣatra; it is not so mentioned in any of the Vedic works; and it is most improbable that people of that time completely understood the delicate implications of the conception of sāyana and nirayaṇa systems to be followed in astronomical calculations.

*The ideas expressed by the author in the above 2 or 3 paragraphs are the views expressed by Mr. Lele to him privately in a letter dated 21st May, 1895.
This stand could be proved as unjustified from many evidences. The positions of planets given by the Mahābhārata are, therefore, not sāyana and hence, the time calculated on the basis of that assumption is also not correct.

In addition to the two major objections raised against the assumption viz. that the planetary positions described by the Mahābhārata are sāyana some more minor objections could be brought against it:—

(3) The Mahābhārata states that Jupiter and Saturn were seen near “Viśākhā”. Mr. Lele, after interpreting Viśākhā as a “sāyana-divisional nakṣattra” has shown by calculation that Jupiter had occupied the sāyana Svātī division and Saturn the sāyana Cīrā division and on that account they could be said to be near Viśākhā. Now, sāyana Viśākhā is not a star but a division; where, then, was the need of saying that “Jupiter and Saturn were found to be near Viśākhā”, when they were respectively in the Svātī and Cīrā divisions? They could have been stated to be in these starry divisions in clear words.

(4) The planetary position when Karna was killed is given in verse No. 6:

बृहस्पति संतरियार्य रोहिनी बृहस्पति संतरियार्य रोहिनी बृहस्पति संतरियार्य रोहिनी बृहस्पति संतरियार्य रोहिनी बृहस्पति संतरियार्य रोहिनी बृहस्पति संतरियार्य रोहिनी बृहस्पति संतरिया योगदानो बिजावते \| 6 \|

In this Jupiter has been stated to be stationary near Rohini which does not move. (i.e. Rohini is not regarded as sāyana).

(5) Saturn is stated to be ‘afflicting’ Rohini and also the Bhaga (i.e. Phalguni) nakṣatra. Mr. Lele has not considered these statements. This reference can be interpreted as one planet while conjoining with one nakṣatra ‘afflicts’ another, and ‘Srīyarduputra’ can for the sake of satisfaction, be interpreted, not as Saturn, but as one of the comets in the solar system.

(6) Mr. Lele has not been able satisfactorily to explain how Mars (Pāvakaprabhā-lōhitaṅga stated in the verse Vākrānumyakram) was ‘retrograde and then direct’. He is required to interpret it, not as Mars but as some comet. In short, the position of some planets stated to be on more than two nakṣatras can not be satisfactorily explained by regarding the nakṣatras as sāyana divisions.

(7) The nakṣatras, referred to in the verse “Mahāśravanagaṇa āvakraḥ Śrāvane ca Bhṛgaspatiḥ” must both be of the same one system; but Mr. Lele regards Magha as sāyana and Śrāvana as nirayaṇa. It is also interesting to note that ‘Magha’ has been used in plural. How can a sāyana division be expressed in plural form?

(8) The planetary positions in the early morning of the day on which Śalya was killed are described in the line

शुस्तरस्तुराश्रयोधरवक्षेत्रं समस्वतीं \| 15 \|

This verse states that Venus, Mars and Mercury were together on that day. Mr. Lele’s calculations do not explain and support the statement.

(9) Mars is stated to be ‘offering prayers’ to Anurādhā after ‘turning round Jyeṣṭhā’. The retrograde motion of Mars is clearly shown here. As the calculations did not prove the motion of Mars as retrograde, Mr. Lele was required to interpret the word ‘vakra’ as otherwise.

(10) Accepting Mr. Lele’s ayanāṁśas as true, if we convert the tropical longitudes of planets into nirayaṇa nakṣatras, we get the moon’s position to be in P. Phalguni and not ‘near Magha’ as stated in the Mahābhārata; Mars
is found to be in nirayaṇa Anurādhā; and Mr. Lele regards it to be ‘near Jyeṣṭhā’ as stated by the Mahābhārata. He also states that in the Mahābhārata age the planetary positions were not given in terms of nirayaṇa nakṣatras but near some stars. Let us, therefore, find out the stars near which the planets in the year 5306 before Śaka, actually were. If accepting the annual precessional motion to be 50° the tropical longitudes of stars for the abovementioned year be calculated we get the longitude of the junction star of P. Bhādrapadās as 8° 13° 5′. Venus was 22° to its west i.e. even west of star śatābhīṣak. Would it look well if we say that it was near P. Bhādrapadā?

The longitude of Jyeṣṭhā was 4° 29° 22′ and Mars was 23° to its west that is near the star Viśākhā; how can it be said to be near Jyeṣṭhā? Even taking for granted that the actual precessional motion was somewhat different from 50°, and that the stars also have got some motion and that the planetary positions were not given in terms of celestial longitudes but in right ascensions, it will still be found that the actual positions of these two planets do not tally with those given by the Mahābhārata.

It is possible to find some other time which is a bit later or earlier than that suggested by Mr. Lele and then one will not be able to raise the last 2 or 3 objections against it; still other objections do stand. On the whole it can be said that the planetary positions described by the Mahābhārata are not given with reference to a dual (sāyana and nirayaṇa) system, and that the time suggested by Mr. Lele is not correct*

Late Shri Venkatesha Bapuji Ketkar interpreted the verse about Saptarṣis that the Yudhiṣṭhira era was in vogue for 2526 years before Vikrama Śaka and hence, he considered that the Pāṇḍavas lived 2526 + 135 = 2661 years before Śālavāhana Śaka. On this supposition he maintained that the Mahābhārata battle was fought in the months of Mārgaśīrṣa and Pauṣa of the 2662nd year before Śaka i.e. in the year 2585 B.C. from Nov. 8 to Nov. 25 of that year. Taking 1° 13° 57′ as the ayanāṃśa he calculated nirayaṇa positions of planets true for the morning of Thursday, Kārtika new moon day, with the help of Keropant’s planetary tables, which are given below:

<table>
<thead>
<tr>
<th>Planet</th>
<th>Position</th>
<th>Nakṣatra</th>
<th>Planet</th>
<th>Position</th>
<th>Nakṣatra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>5</td>
<td>0</td>
<td>Venus</td>
<td>6</td>
<td>0 33</td>
</tr>
<tr>
<td>Mars</td>
<td>7 24</td>
<td>0</td>
<td>Saturn</td>
<td>6</td>
<td>39 51</td>
</tr>
<tr>
<td>Jupiter</td>
<td>7 24 48</td>
<td>Jyeṣṭhā</td>
<td>Rāhu</td>
<td>8</td>
<td>19 39</td>
</tr>
</tbody>
</table>

Moon has been calculated for Friday, the Mārgaśīrṣa full moon day. It is found to occupy the Mṛga nakṣatra, the longitude being 1° 27° 30′.

He says that the position of Venus as described by the Mahābhārata in the line “śvēto grahāḥ praṇavātī jyeṣṭhēmākramya tiṣṭhāti” is seen to be true by his calculated result. After showing-by calculation that there were eclipses in the beginning and at the end of Mārgaṇīrṣa, Mr. Ketkar says that Jayadratha was killed at the time of the second eclipse. This event and the planetary positions do not tally with those given in the Mahābhārata**.

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*This should not be taken to mean that the sāyana-system is not acceptable to the author. He wants only to say that the planetary positions given by the Mahābhārata are not sāyana. That the sāyana system of position-reckoning was acceptable to the Vedas will be shown in detail later on.

**For objections against Mr. Ketkar’s calculations readers are requested to see the May and June 1884 issues of ‘Indu Prakṣa’ and ‘Poone Vaibhava’ papers.
Pāṇḍavas’ time has not been found beyond doubt as yet on the basis of planetary positions given by the Mahābhārata; but this does not mean that these positions were incorrect. The author believes that the references found in the dialogue between Karna and Vyāsa indicate factual position of the planets and that they have been incorporated in the Mahābhārata on the basis of the information handed down direct from Pāṇḍavas’ time. It can at most be said that we are unable to establish the agreement. He has seen how one gentleman, Janardan Hari Athalye, has attempted to disprove Mr. Lele’s theory and to establish the agreement with the help of nirayaṇa system of astrology. He does not think that Lele has succeeded in his attempt even to some extent. He does not know who will be able to explain the validity of the references of planetary positions.

The names of months, Caitra etc., were in vogue in Pāṇḍavas’ time and they could not have belonged to a period earlier than 4000 B.S. (i.e. before Śaka*); (this will be proved later on). This shows that Pāṇḍavas’ time cannot be taken to be earlier than 4000 B.S.

By the by, the author notes down the Pāṇḍavas’ time as can be established from the historical references found in the Viṣṇu Purāṇa and the Śrimadbhāgavata:—

These verses describe in a ‘future form’ the number of years of reign by kings of different dynasties, e.g. 1015 years elapsed between the king Parikṣit (grand son of Yudhiṣṭhira) and the crowning of Nanda. After him 9 Nandas ruled for 100 years, and after them the Emperor Candragupta Maurya (the disciple of Cāṇakya) came to throne. The same story is related in chapters 1 and 2 of 12th section of the Bhāgavata, with the difference that the word ‘Sātām’ is found substituted for ‘Jīeyaṃ’ which means that from Parikṣit to Nanda as many as 1115 years passed. When Alexander the Great came to India, Candragupta had gone to see him. He (Candragupta) came to throne at Patna in the year 316 B.C. At the time of Seleucus who was a very strong general of Alexander, Candragupta was known to be a very great king. His grandson was Asoka and these were well known facts of history beyond controversy.

If the description given by the Viṣṇupurāṇa and the Bhāgavata about the years of reign (viz. 1015 or 1115 years) of kings from Parikṣit to Nanda be correct, we will have to take for Pāṇḍavas’ time a year near about 1431 or 1531 B.C. and almost all European scholars accept this time as correct.

*The Śaka era differs from Christian era by only 78 years. The time established by astronomy as being some year before Śaka era is likely to err by 78 years on account of so many reasons. Hence a date given by the author as B.S. may, for practical purposes, be taken even as so many years B.C.
In the author’s opinion, the Pāṇḍavas must have lived between 1500 to 3000 B.S. and not earlier than this.

Knowledge of Planetary Motions

When the Mahābhārata was compiled people were possessing reasonable amount of knowledge of planets’ motion. The following verse is worth reading.

\[ \text{क्षण संख्यारूप राशि प्रति तथा || ४६ || पक्षपत्य तथा दृष्ट्वा विवस्ताना \}
\[ \text{च संख्यम् ||} \]

शास्तिपर्व, अ. ३०१, मोक्षपर्व.

In this we find references of lapse of a year, a month, a half-month and of a day. The term ‘lapse of a day’ occurs in Vedāṅga Jyotiṣa. The lapse of a half-month occurs in the Mahābhārata at a second place, discussed about in pp. 114-115. In addition to these two, we get a reference of a lapse of a month and lapse of a year. A lapse of one year occurs after every 85 years. (See the Udaya-system and mean-Rāśi-system under ‘examination of the topic of Samvatsara in Part II’; but this presupposes the system of describing Jupiter’s motion in relation to signs. The Mahābhārata does not contain either Rāśi-terms or the system of indicating planets’ place with reference to a 12-part system of an ecliptic. From this it appears that the system of fixing a name to a year from Jupiter’s place found by mean-Rāśi motion was not in vogue in the Mahābhārata’s time. The 12-year cycle system is more ancient than this. It depends upon the heliacal rise and set of Jupiter. By following it the lapse of a Samvatsara occurs often. This might have been in vogue in the Mahābhārata’s time. If it be supposed that the mean-Rāśi system was then in vogue we will have to accept that people had accurate knowledge of Jupiter’s mean motion. The ‘lapsed month’ which occurs in our time can not be accurately found without knowing exact true positions of the sun and the moon. The system of naming months after nakṣatras has been described in Part Two and according to it the lapse of a month does take place; this shows that the system was known in the Mahābhārata period. From the discussion on ‘lapse of a half-month’ made before, it will be seen that they did not have accurate knowledge of true motions of the sun and the moon; but if the rule of making a month, a half-month and a day missing be the same as at present, then we shall have to believe that people in the Mahābhārata time had complete accurate knowledge of the true motions of and of corrections to be applied to the sun and the moon as at present.

Miracles of Nature

In the Mahābhārata we find at many places descriptions about comets and meteors. The following description of the sun as causing rain is worth noting:

\[ \text{वष्णुवायांशुमित्रस्मी तन्नद्वे सर्वे \स्वभिन्नम् || ४६ || सर्वोषधिरस्ताना \च निपववत्सु मुचल्लि} \]

यन्वर्जन, अ. ३.

At some places we find the moon associated with the tides of ocean; we get allusions to show their conviction that the earth is round. The following
verse will show that people had observed that the other side of the moon is never visible:

यथा हिमस्वतः पदर्व पृथ्व चंद्रमसो यथा || न दुष्टपूर्वः मनुष्यः
शास्तिपूर्वः अध्ययः २०३ सौस्कर्यम्.

These references show that we find among the people a curiosity of finding causes of natural phenomena after observing the miracles on the earth and in the sky.

The Samhita Section

In the Mahabharata we come across many references about suggestions to do or not to do certain things as per Muhurtta section of Samhitaa branch of astronomy. It has already been shown above that the planetary positions have been given in the Mahabharata with a view to describing the probable effects of such positions.

यथा वायुपयः सूर्यमयः शुक्लततो जयः || २० || एवं संविश्य यो यति तिथिवतः
पूर्जतः || २५ || विजयं लभति निम्नं सेनां सम्मक्षः प्रवीणयत् ||
शास्तिपूर्वः अ. १००.

This has been addressed to Dharma by Bhishma. The starting for expedition on Pushya nakshatra has been described at many places as being very auspicious. At one place we find mention of a ‘Bhaga’ nakshatra as auspicious for marriage. In the Vedas alone we find ‘Bhaga’ as the deity controlling Uttara Phalguni; otherwise we find her as controlling Purva Phalguni. But P. Phalguni has not been included in the list of nakshatras devoted to celebration of marriages. The following line refers to Draupadi’s marriage with Dharmaraja.

अश्वीष्य योगमुर्भिः चंद्रमः पार्श्वं कृष्णांतपस्वम् (परमराज) मूहावधिक पूर्वं || ५ ||
आदिपूर्वः अ. १६५.

Because Pushya is not regarded as a marriage-nakshatra, Caturdhara, the commentator, defends the acceptance of this nakshatra saying “By the word ‘Pausya’ is to be understood that nakshatra which causes nourishment and not the Pushya nakshatra”. The author does not agree with the explanation. The next description will show that Draupadi was married to five Pandavas on five consecutive days; but in our present day list of marriage-nakshatras we do not find any five nakshatras which are consecutive in order.

Summary

Matters of astronomical interest occurring in the Mahabharata have been so far discussed, some of which are of much importance. Even though the terms, Meșā, Vṛṣa, etc. and the names of week-days are not found in the Mahabharata, it need not be suspected that these have been borrowed from the Greeks. The author reiterates them as follows:—(1) People had knowledge about planets at the time of Pandavas, whatever that time may be. No one thinks it was later than 1500 B.S. In any case, it was the time before names of 7 days and names of signs came into use, that is, before our astronomy came in contact with the Greek system. (2) The ecliptic was divided into 12 parts with respect to the sun’s position. (3) The reference of a 13-day half-month shows that people had a working knowledge of finding the true positions of
the sun and the moon. (4) If the method of reckoning a missing day, half-
month, month and a year was similar to that in the present time, it must be
accepted that people in those times had accurate knowledge of the sun’s and
the moon’s true positions and motions and that of mean motions of Jupiter
and other planets. (5) People used to observe and think over not only the
miracles of the sky, but some planetary phenomena like the rise and set,
(both diurnal and heliacal) of planets and their eight-fold motions like direct,
retrograde etc.

One can not make definite statements about the above matters from refer-
ences in the Purânas just as have been made from those in the Mahâbharata
because one can not say with certainty anything about their time; and to
read through all Purânas is a matter of time and hence, the author does not
make any observations about them. He has not considered anything about
even the Râmâyana since it does not contain terms like Meṣa etc. It is, how-
ever, clear that some of its portions must be belonging to period later than the
Vedic or Vedânga Jyotiśa age and some of it must have been written earlier
than the Mahâbhârata’s compilation; but it is very difficult to make a definite
selection of the two portions.

SUMMARY OF PART ONE

The Time of Śatapatha Brâhmaṇa

This part will be summarised after stating some important facts and in-
ferrences worth mentioning at this place.

Following lines are found in Śatapatha Brâhmaṇa:—

एकं दूसरी चतुर्विंशिति वा अन्यायी नवाष्ट्राष्ट्रे एवं भूस्थि कोशकृत्तिकांतुप्पर्षतुप्पर्षतुप्पर्षतु तत्त्वात्तकृत्तिकास्वाधीन।

"Kr̥ttikās alone consist of many stars, other asterisms (consisting of)
one, two, three, or only four stars. (He who performs the agnyâdha ceremony
on this nakṣatra) gets plentifulness (or abundance) of this star; that is
why “fire should be lit” on Kr̥ttikās. These are the only stars which do not
‘deviate’ from the east while all others do. He who does the ceremony on this
nakṣatra gets two of his ‘agnis’ i.e. fires firmly established in the east, and that
is why fire should first be lit on Kr̥ttikās.”

The statement “Kr̥ttikās never deviate from the east” implies that these
stars always rise in the east, that is, they are situated on the Equator or that
their declination is zero. At present they do not appear to rise exactly in the
east but at a point north of east; this happens because of precessional motion
of the equinox. Assuming 50” as annual motion, the time when the junction
star of the Kr̥ttikās had zero declination, comes to be 3068 years before
Saka and even 150 years earlier, i.e. the approximate time of commencement
of Kali era, if 48” be adopted as the precessional annual motion. Calculating
the declination of some other stars in this age, we find that the northernmost
star of Rohini group, the southern three of Hasta group, two from Anurâdhā,
one from Jyeṣṭhā and one from Âsvini were situated near the Equator; only
some one star from Hasta group (if at all) could possibly have been situated
exactly on the Equator, otherwise none.
The statement about Kṛttikā’s rising in the east is made in the present tense and they can not always do so because of precessional motion of equinoxes. In our time we find them rising to the north of east and they used to rise to its south in 3100 B.S. From this it can be inferred that the concerning portion in Śatapatha Brāhmaṇa was written about 3100 years before Saka era.

The Time of Kṛttikādi system

The list of nakṣatras mentioned in the Vedas begins with Kṛttikās. The equinox used to occur in the 4th quarter of Bharani division in the Vedāṅga-Jyotiṣa age. It must have been in Kṛttikās before that time; and assuming that the nakṣatra-list commenced from Kṛttikās, Bentely and other European scholars have found 15th century B.C. as the time when the equinox used to take place in Kṛttikās; but this is erroneous. The mistake which was committed in the case of Vedāṅga Jyotiṣa has been committed in this case also. The tropical longitude of Kṛttikās must have been zero in the age when equinox used to coincide with this asterism. Its sāyana longitude in 1850 A.D. was 57° 54'. Hence, the time of equinox being in Kṛttikās comes to be (57° 54' x 72) i.e. 4170 yrs—1850=2320 B.C. The scholar Bayo has found out the time of Kṛttikādi system as prevailing amongst the Chinese to be about 2357 B.C.* and he must have found the time by adopting the same system of calculation as followed by the author. He has not read Bayo’s original articles; but it is surprising to see that Bayo has not followed the system in the case of Hindus which he has done in the case of the Chinese-nakṣatra system.

According to Weber, the time of Kṛttikā being first nakṣatra comes to be somewhere between 2780 to 1820 B.C. Dr. Thibaut has a fairly good knowledge of Indian astronomy. His opinion about this point has recently been published. The gist of his arguments is as follows:—There is no support to show that Kṛttikās were regarded as the first nakṣatra because equinox used to occur in that nakṣatra. We do not come across any description in the Vedic literature about planetary positions signifying a time prior to the one given by the solstitial positions described by Vedāṅga Jyotiṣa. The statement of winter solstice occurring in the beginning of Dhanisthā nakṣatra is very ambiguous; because the stars in the nakṣatra division** occupied by the sun is never visible; it can not be said with certainty at which point of the ecliptic the sun must have been for the occurrence of the winter solstice given by Vedāṅga Jyotiṣa. Hence, the time calculated by the above method is liable to be mistaken even by 1000 years.

The Europeans have not even now understood the quotation from Śatapatha Brāhmaṇa given above. The Pleiades are seen above the horizon for about 10 or 11 months during the year; and when they used to rise exactly in the east, this eastern rise could be seen from any place on the earth then; and there is nothing to be doubted about this. If there would have been an error of 1 degree in ascertaining the exact astronomical east, that in the calculated time would not be more than 200 years. In short, the reason why Kṛttikās used to be reckoned as the 1st nakṣatra was their rising in the exact East. The time for this event was about 3000 B.S. without doubt.

The Vedic Age

The Taittirīya Śaṁhitā which is more ancient than Śatapatha Brāhmaṇa also mentions Kṛttikās as the first nakṣatra. Hence, this part of the Śaṁhitā

*See translation of S.S. by Burgess.
**See the 1895, April issue of Indian Antiquary XXIV.
must have been compiled either in 3000 B.S. or a century or two before. The statement about Kṛttikās being first is unequivocally given in Śatapatha Brāhmaṇa and hence its time is definitely 3000 B.S. or a century or two later. It can be said without doubt that all those sections of the Vedas which quote Kṛttikās as the first nakṣatras must have been compiled a century or two earlier or later than 3000 B.S. The Rigveda Śamhitā does not mention the Kṛttikādi nakṣatra system; hence, it must belong to a time earlier than 3000 B.S.

Who was the Originator of the Nakṣatra System?

Some Europeans maintain that the Vedic nakṣatra system does not belong to the Indians originally. The author thinks there is no country in the world the people of which (however savage they might be) never observed any association of the moon with the stars or have not given any names to them.

If no other evidence can be given to show that the Vedic nakṣatra system belongs to Indians, at least some of the Vedic stories, like the Moon’s love to Rohini, can be taken as sufficient evidences. The time when, according to some Europeans, the Hindus appear to have borrowed this system from the Chinese, the Babylonians or other unknown countries, could not have been earlier than 2780 B.C.; but it has already been shown above that nakṣatras were known to Hindus earlier than 3000 B.C. and that these are mentioned in the Vedic literature even before this time. From this it will appear that the argument, that nakṣatras have been borrowed by Hindus from foreigners, does not stand. If Chinese have established their system independently, then the Hindus also have done the same independently and any impartial thinker will agree with this.

Caitra and Other Names

It has been observed that names of months, Caitra and others are nowhere found in the Vedas; but they are found in later works of the Brāhmaṇic period. We come across the following line in Śatapatha Brāhmaṇa.

योऽसो वेषवस्थमावस्था तत्यांतद्वितीये...आयुं वेषवस्थमावस्थायेन प्रतिमात्तिष्ठति II

“śr. ब्रा. १२। १। १। ७।”

Śatapatha Brāhmaṇa consists of two parts comprising 14 sections in all. The first part, known as Purva Śatapatha, contains 10 sections (=66 chapters) and the second part, Uttara Śatapatha consists of 4 sections (=34 chapters). The above line occurs in the 11th section; just before this line we get the line

तत्समाच्य नक्षत्र आद्येये II

“śr. ब्रा. १२। १। १। ३।”

which means “do not lit fire on the nakṣatra”, and it has been ordained in the first part that ‘ādhāna’ should take place specifically on the nakṣatra. We get a reference of the term ‘Vedānta’ at two or three places in the same portion of the 11th section in which the above line occurs and in which the portion of the Vedic literature known as ‘Vedānta’ containing Upaniṣads also occurs and the 14th section of Śatapatha Brāhmaṇa is devoted to the theory of Vedānta itself; that it is known as Brhadāraṇyaka is also well known. It can easily be seen from this that the second part of Śatapatha Brāhmaṇa belongs to a
much later period than the first one; and no objection can be raised if we say that the names, Caitra etc. came into vogue in the latter part of the Brāhmaṇic period. The Kauśitakī Brāhmaṇa gives the line

तैस्यमावधाय एकाह उपरिस्थाहादेवत्स माघाय वेदाधिका ।

कौ. भा. १६. २. ॥

“One should commence a sacrifice after the passing of ‘ekāha’ of the new moon of Pauṣa’;

in which we get the terms Taiṣa (i.e., Pauṣa) and Māgha. This very line has at its end a sentence which means that winter solstice occurs in the beginning of Māgha. This shows that the time of this Brāhmaṇa (K. Br.) must have been the same (viz. 1500 B.S.) as that of Vedāṅga Jyotiṣa. The Pañca Viṃśa Brāhmaṇa gives the following line :—

मुख वा एतत्सनिनवसरस्य यज्ञालमणः ।

पञ्चविंश भा. ४. ६. ॥

“The month known as Phālguna is the ‘month’ (i.e. the commencing month) of the year”.

This refers to the month Phālguna. The whole consideration shows that the names of months, Caitra and others, were never in vogue in the Vedic times, but had come into use, at the end of the Brāhmaṇic period.

The Time when these Terms (Caitra etc.) came into vogue.

Let us consider the problem of finding the time when these names came into use. The sidereal year exceeds the solar year by about 50 palas. Seasons depend upon solar year. The season which would seem to occur to-day when the sun would come to equinox, would seem to occur even after thousands of years when the sun comes to equinox; but seasons will not be the same for all times to come when the sun comes to the same particular nakṣatra; a difference of two months (for the occurrence of the same season) will take place after about 4300 years i.e. of one month after about 2000 years.* Thus, if the Spring season has been observed to be occurring when the sun comes to Aśvinī, the next season Summer (i.e. the Grīṣma) would be found to occur at the sun’s entry into Aśvinī after about 4½ thousand years, and the rainy season after about 8½ thousand years. The time interval between the sun’s two coincidences with Aśvinī star is known as the sidereal year. When the sun is near Aśvinī star, the moon is near about Citrā star on the full moon day, and hence, this lunar month comes to be known as Caitra. Hence, if the spring season is observed to occur in a lunar month known as Caitra (from Moon’s proximity with the star Citrā on full moon day), the spring will be seen to commence some time in Caitra for 2150 years and then some time in Phālguna for another 2150 years and then in Māgha for another 2150 years. (Or in other words, the summer season will be seen to occur in Caitra after about 4½ thousand years after the time when spring season used to occur in Citrā.) In short the month Caitra would maintain its position as the first month of spring for about 2000 years only.

* A detailed discussion of precessional motion and of sāyana system will be found in the second part. The consideration of such matters in this chapter are made on the assumption that the equinoctial point makes a revolution in about 26000 years.
We find the identity ‘Caitra + Vaiśākha = Vasanta (spring) season’ in almost all works. The moment of commencement of season receded after a long time after the above identity became established in practice, and that is why we come across ‘Mina + Meṣa = Vasanta’ or ‘Phālguna + Caitra = Spring’ in some later works, and some almanac makers follow this identity at present. In our times the spring season is actually found to occur in Māgha and Phālguna, but the definition ‘Caitra + Vaiśākha = Vasanta season’ still persists in popular minds. The names Madhu and Mādhava have association with seasons and not with nakṣatras; still the long usage of the identity ‘Caitra + Vaiśākha = Spring’ has made people wrongly to shift the association of Madhu from that of Spring season to the nakṣatra name and Caitra is now wrongly called as ‘Madhumāsa’. When the time of commencement of spring receded from Caitra to Phālguna, the identity, ‘Phālguna + Caitra = Vasanta’ came into use and we find this definition in some later works. But we do not find the identities ‘Vaiśākha + Jyeṣṭha = Vasanta’ and ‘Caitra as the second month of Siśira’ in any of the older works, when it was a fact that, spring actually began one month earlier than Caitra (say, 2000 years before). This definitely points to the fact that the names Caitra etc. came into vogue in those times when the vernal equinox actually used to take place in Caitra; and this hint can lead one to find the probable time. The spring season commences one month before the sun comes to equinox i.e. when the tropical longitude of the sun is 330°; and in order that the corresponding month should be named as Nīrāyanā* Caitra, the longitude of Spica (Citrā) must be less than this by 6 signs or 180° i.e. = 330°−180° = 150°. The tropical longitude of this star in 1850 A. D. was 6° 21° i.e. 201° or in excess of 150° by 51°. The time for this advance = 51 × 72 = 3672 years. Hence, the time for spring to occur in Caitra must be 3672 − 1850 = 1822 B. C., and it can be inferred that the terms Caitra etc. must have come into vogue in this period. Now taking into consideration the fact that the spring season commences earlier in some provinces and later in others, the time when the terms Caitra etc. came into use will be taken to be earlier than what is found above. In some provinces the spring commences about a month and a half before the sun comes to vernal equinox and not earlier. Adopting the condition of “1½ month earlier than equinoctial day” the time of Caitrādi system would come to be 2900 B.C. Again, the doubt as to when the spring season should be taken as begun, the different longitudinal values of nakṣatras, all these factors lead one to adopt 4000 B. S. as the uppermost limit for the possible year before which the terms Caitra etc. could not have come into vogue. The Vedāṇga Jyotiṣa contains Caitra etc. as the names of months; its time has been shown to be about the year 1400 B. S. The Taittirīya Samhitā does not contain these names and the time of compilation of some of its parts has been shown to be about 3000 B. S. He who has understood the sacrificial procedure given by Taittirīya Samhitā and the units of time like seasons and months, will know that if these terms would have been in use in the time of Taittirīya Samhitā they must have entered the text at some place or the other. This argument will convince the reader that the terms were not current before the time 3000 B. S. There are several big volumes of Brāhmaṇic works (at least 4) which do not mention these terms. It is clear that these are of later date than Taittirīya Samhitā. After weighing all these facts the writer feels that the time when the names Caitra

* For the sake of convenience I call a solar month as sāyana and the sidereal month as nirayaṇa.
etc. came into vogue should be safely taken to be 2000 B.S. Those parts of Kausitaki, Satapatha and Pañcavimśa Brāhmaṇas which mention these terms, must have been compiled between 2000 and 1500 B.S.

Commencement of the Year.

In the Rigveda Saṃhitā no actual statement is made that a particular season should be regarded as the first one, nor do we find any indication about it. The words Sarad, Hemanta and Vasanta (names of seasons) are themselves used in the sense of a 'Year' and hence there are grounds to believe that the year used to commence with these seasons; but the words Grīṣma, Varṣā and Śīrṣa are not found used in the Rigveda Saṃhitā in the sense of a 'year'.

It has already been said (on page 63) before that the year used to commence with Spring season and Madhu month in the age when the Yajurveda Saṃhitā was composed and generally in the Vedic age. There is no clear statement in the Vedic works that the year began in other seasons, and it is the author's opinion that we do not come across any indication to show that the year commenced with winter solstice. This was Prof. Tilak's view and this has been examined later on. In Vedāṅga Jyotiṣa time, the year no doubt commenced with W.S.; however, in the time when Śūtra works and the Mahābharata were compiled; the first season was Spring which consisted of Caitra and Vaisākha together. This shows that both these systems were in vogue after the Vedāṅga times; but the system of beginning the year with spring appears to be more prominently used, since the ‘W. S.-year beginning system’ was prevalent only in Vedāṅga-Jyotiṣa age. Also, we find in later astronomical works (Siddhānta) that they have adopted the system of commencing the year with Caitra and they must have adopted this as the system in vogue just before the compilation of these works.

It has been pointed out before (on page 111) that we get references at two places in the Mahābharata that the list of months begins with Mārgasīrṣa. Al Beruni, a traveller with Mahmud of Ghazni, has recorded that they in Sind and other provinces commence the year with Mārgasīrṣa*. This shows that the system of beginning the year with Mārgasīrṣa must have remained in vogue in some provinces at least for some time. Let us examine the matter in detail.

The Kṛttikādi system came into vogue at about 3000 B.S.; and it seems that the Mārgasīrṣa month used to be regarded as the first month in some provinces soon after. The star Mṛga (Orion) is known as “Āgrahāyaṇi”. It derives this meaning because “The year (‘Hāvana’) stood at the end (agra) of that nakṣatra-night.” In the Vedic literature we do find the following quotation:—“P. Phalguni is the last night of the year and U. Phalguni is the first”.† In the Vedic age, the months were lunar and hence the year clearly started with a lunar month; hence, the above quotation indicates that P. Phalguni formed the last nakṣatra of some lunar month and U. Phalguni the first one of the next month. These are, therefore, the daily nakṣatras (lunar). This shows that the system of commencing a year on the next day of a lunar month which ended with ‘Moon associated with Mṛgaśirṣa’ must have come into vogue and this (last) night came to be known as Āgrahāyaṇi. This must have belonged to the time when Mṛgaśirṣa was regarded

* See p. 8, Biruni, India Vol. II.
† Their references from Tai. Br. 1. 1. 2. are given later on.
as the first nakṣatra; naturally, Kṛttikās took the place of Mrga and became the first nakṣatra. Hence, following the old tradition, people began to commence the year on the next day of the month in which the moon used to be full near Pleides, i.e. in the month of Mārgaśīrṣa, which was a lunar month belonging to Pūrṇimānta-system. Even in these days, we know that the lunar month following a ‘full moon with Kṛttikās’ is known as Mārgaśīrṣa. Following this analogy it may be argued that there must have been a time when the year used to commence on the next day of the night when the moon used to be full with Mṛgaśīrṣa; but a difficulty comes in making this assumption. Such a month would be the lunar Pauṣa; and we do not get any reference to show that a year ever commenced in Pauṣa. We do not see any reason for Mṛgaśīrṣa being regarded as the first nakṣatra, other than the occurrence of vernal equinox in that nakṣatra. The equinox used to occur in the month of Mārgaśīrṣa about 4000 B.S. It has been pointed out that the system of naming months after nakṣatras had not come into vogue then; and that is why this particular month (now known as Mārgaśīrṣa) used to be Agraḥāyaṇa or Agraḥāyaṇi, and the absence of any reference for a year commencing in Pauṣa is thus understandable. The writer sometimes feels, that the system of naming a lunar month commencing on the next day of “full moon with Kṛttikā” as Kārtika, that commencing on the next day of “full moon with Mṛgaśīrṣa” as Mārgaśīrṣa, and so on, might have been in use; but we do not have it so now, nor do we get any indication of such a system being in vogue before. The full moon day is always regarded as the last tithi of the ‘Pūrṇimānta lunar month’ or of the ‘light half-month’ and never used to belong to the latter month or the second half-month, as can be seen from a number of quotations in the Vedic literature; and the same system is followed at present. Hence, the following definition can be proved on the basis of the quotation of Pāṇini (4.2.21) [viz. “Sāṃśinaurṇamāsīti samī- rāyām’]. The lunar month in which the moon becomes full on Kṛttikās to be known as Kārtika, and the month which would commence from the next day as Mārgaśīrṣa, since the moon would be found to be full near Mṛgaśīrṣa in that month. In short, it can be said that the system of commencing the year with Mārgaśīrṣa must have come into vogue in some provinces after the Kṛttikādi system came into use (i.e. after 3000 B.S.).

According to Prof. Tilak*, the month Mārgaśīrṣa got the name ‘Āgraḥāyaṇi’ not because it formed the first month of the year, but because of its association with the star ‘Agraḥāyaṇa’, the derivation of this word being according to him that nakṣatra after which the year follows and the sun coming to which shows the equinox and the year begins. This meaning is of course acceptable to the author; but Prof. Tilak assumes two things (or at least they are so understood), viz. (i) that the system of commencing a year in Mārgaśīrṣa was not in vogue and (ii) that the year never began on the next day of that full moon night on which the moon conjuncted with Mṛgaśīrṣa. Even without these assumptions, his interpretation of the word ‘āgraḥāyaṇa’ can be justified. We come across actual quotations that Mārgaśīrṣa formed the first month of the year and this fact can not be denied. Similarly, it has been shown above, that it was not impossible for the year to have been commencing on the next day of the full moon with Mṛgaśīrṣa and that it actually did.

**The Mārgaśīrṣādi System**

Āgraḥāyaṇi has been given a synonym of Mṛgaśīrṣa nakṣatra in Amarakośa. The same word occurs in Pāṇini at 3 places (4.2.22 ; 4.3.50 ; 5.4.110)

* See Orion, Ch IV.
and the month of Mārgaśiśra derives its name of Āgrahāyaṇi from the word Āgrahāyaṇi. (Pāṇini 4.2.22) According to grammarians, the word Āgrahāyaṇi chiefly stands for the Mārgaśiśra full moon; and even with this meaning, because ‘Āgrahāyaṇi’ is the meaning of Mārgaśiśra, the Mṛgāśiśra nakṣatra must be associated with the moon on the Āgrahāyaṇi full moon day, and ‘Āgrahāyaṇi’ has begun to be understood as that full moon day or the next day of which the year commenced. This shows that there was a system of commencing the year on the next day of the Mārgaśiśra Pūrṇimā, having the full moon near Āgrahāyaṇi (i.e., Mṛgāśiśra) star. Such a month bears the name ‘Pauṣa’ by present astronomical system and by Pāṇini’s system also. It has been shown above that the system of year beginning in Mārgaśiśra came into vogue after 3000 B.S. Hence, the system of commencing a year on Pauṣa must be prior to this system i.e. more ancient than 3000 B.S.; but the phenomenon of Mṛgāśiśra star being on equator was an impossibility then; the reason for the year commencing on Mārgaśiśra could not have been anything else than the occurrence of vernal equinox in Mṛgāśiśra star.

Mr. Bal Gangadhar Tilak wrote a book ‘Orion’ in English in 1893 A.D. in which he has proved, from quotations in the Rigveda Saṃhitā, particularly the verse 1.163.3 and the stanza 10.86, that the vernal equinox used to take place in Mṛgāśiśra in Vedic times; and many legends current in India, Persia and Greece are fully explained by assuming the truth of this phenomenon; and the Mṛgādi-system suggests that the time of compilation of some verses in the Rigveda Saṃhitā must have been about 4000 B.S. which has been shown to be true from ‘Āgrahāyaṇi’ being the name of Mṛgāśiśra.

Mr. Tilak has also shown that some Vedic references suggest that the equinox used to occur in Punarvasu. Although the references are not so clear or so many as in the case of Mṛgāśiśra, yet the phenomenon is not impossible to have occurred. The equinox used to be in Punarvasu before 6000 B.S. and some of the Vedic Sūtras could have been possibly compiled then.

Mr. Tilak argues from the stanza describing the annual sacrifice (samvatsara satra) that the phenomenon of W. S. happening on Citrā full moon and the Phalguna full moon days leads one to infer that vernal equinoxes used to occur on Mṛgā and Punarvasu respectively. But the fact that vernal equinox used to occur in Mṛgā nakṣatra can be proved independently and does not require the support of the quotation viz. ‘W.S. used to take place in Phālguna’. There are certain difficulties in not accepting these stanzas for consideration. The first one is that this fact is not stated therein explicitly. The second one is that the ‘Phālguna-Pūrṇimā’ has been said to be the commencing day of the year; similar ideas are found expressed in Taittirīya Śruti as gīven below:

“वसंते ब्राह्मणोपनिषत्मात्रे || वर्षो व ब्राह्मणस्मृति || सुखं वा एनुसुन्तानं || यद्वसंतम् \| ||
यो वसंतेनिन्द्राय || सुख्यं एव चक्रविद्याय || न पुंसिकः-पुंसिकः एव || एषः वें जयमा
रात्रि संवससरसम् || यतं पूर्वं फलगुनी || उत्तरयोगराविती || एषः वें प्रथमम् रात्रि
संवससरसम् || यद्यरस्ते फलगुनी || सुख्यं एव संवससरसानिमित्तम् || वसीयो भविष्यति \|... ||

त. ब्रा. १. १. २.”

“A Brahmin should ‘establish fire’ (i.e. commence the annual sacrifice) in Spring season, which is the (proper) season for a Brāhmaṇa, because it is the ‘mouth’ i.e. the first season of the year. Now, about Spring season. He who commences a sacrifice in Spring becomes a leader.............never
commence it on Pūrva Phalgunī, because it is the hindernost (i.e., last) night of the year. . . . . . . . . . . .do commence it on the Uttara Phalgunī naksatra, as it is the first night of the year; one who 'establishes fire' in the beginning of a year, becomes wealthy.'

According to this, the word 'Phalgunī' we have to understand the full moon night, the moon being conjoined with Phalgunī naksatra. At present the Phālguna-month of the 'Pūrṇimānta' system ends on the Phālguna full moon day and Caiatra begins on the next day. Similarly we find in the above lines, the Pūrva Phalgunī full moon day being mentioned as the last day of the year, and the next night as the 'mouth' (commencing night) of the new year, and the 'ādhāna' ceremony has been recommended for that day; and in the foregoing lines we find that 'ādhāna' ceremony has been ordained to take place on the same day, it being the beginning day of the Spring season. All these lines are given in the same stanza and must be correlated. This proves that the Phālguna-full-moon day must have definite relation with Spring. The Āśvalāyana Śrauta Sūtra gives, in relation to annual sacrifice, the line (1.2.14.3).

अतः अध्यवसायनं सांवतसिकाणि तेषा फाल्गुन्यं-पूर्णीभवं एवं या प्रयोग:

"Those who desire to commence yearly or half-yearly sacrifices should make use of the full moon day of Phālguna or Caiatra."

And in Āśvalāyana Sūtra the months of Phālguna and Caiatra are related to Śiśira and Vasanta respectively; and the Hemanta season is bound to commence with W.S.; but nowhere do we find any relation of Phālguna with Hemanta. In some provinces the spring season is taken to begin even two months before the sun comes to the equinox and on this basis, the commencement of spring season with Caiatra Pūrṇimā must be taken to happen about 4000 B.C., and the spring season can be seen to take place in the same particular month for 2000 years and hence the commencement of spring with Phālguna Pūrṇimā must be taking place about 2000 B.C. and the idea of introducing the system of commencing the year at this very moment could have struck people's mind and no discrepancy is so far noticed in our reasoning. The Viṣuvān day used to occupy the central place in the Samvatśara-Satra (annual sacrifice); but the word 'Viṣuvān' does not appear necessarily to mean that day on which the day and night are of equal length. The year has been described as commencing on a full moon day; and once it is assumed that the central day should be one equinoctial day, it follows that the commencing day also must be another equinoctial day (within a limit of two days); and in order to satisfy this condition, it will be seen that the year cannot be made to begin on a full moon day. For, supposing a certain full moon day (being the commencing day of a year) was an equinoctial day; then the next equinoctial day would be the 11th day after the full moon day and the 3rd one, the 22nd day and so on. This shows that the word 'Viṣuvān' used to mean in the beginning the 'central day of an annual sacrifice or of any other sacrifice' and this was particularly true about the Taittiriya Samhitā; and as time went on, the term perhaps used to be applied to the equinoctial day and the year began on such day, and that is why the formula for finding out the Viṣuvān day has been given by Vedaṅga Jyotiṣa. Even according to Mr. Tīlak's belief, the Viṣuvān day of 12 hours' (30 ghatiś) length, does not occur in the middle of an annual sacrifice, but at the end of the 3rd and
9th months. It has been shown above, that there is no ground for any one to suspect that in the times when the stanza describing the annual sacrifice in the Taittiriya Samhitā was compiled, the Viṣuvān (of the meaning of an equinox) used to occur in Phālguna.

The Limits of Vedic Age

The lower limit of the Vedic age can be roughly estimated on the basis of the fore-going discussion. But who would be able to fix up the upper limit? It can only be said that it can not be later than the year 6000 B.S. No one can say as to when the Vāedic mantras evolved in the human mind and in one sense the Vedas can be said to be ‘Anādi’ i.e. without a beginning. The lower limit of the Vedic age is about the year 1500 B.S. This is followed by Vedāṅga Jyotiṣa. The Samhitās (i.e. collections of mantras) of all the Vedas, Brāhmaṇas and some of the Upaniṣads have been compiled during this period. Some Upaniṣads might have been compiled even during Vedaṅga Jyotiṣa period; but the lower limit of the Vedic age has already been given above. A part of the Rigveda Samhitā belongs to 4000 B.S. The Taittiriya Samhitā belongs to 3000 B.S. The Brāhmaṇas were compiled between 3000 to 1500 B.S. Those of them which contain terms like ‘Caitra and others’ were compiled later than 2000 B.S., while others were compiled earlier. Nothing definite can be said about the Upaniṣads; but many of them were compiled between 2000 to 1500 B.S. It is not that the mantras of the Samhitā and Brāhmaṇa were compiled in the same time in the form in which they appear to us to-day, still it can be said that they emerged in their complete form before 1500 B.S.

Prof. Max Muller has thus attempted to fix up the period of the Vedic age:—“Lord Buddha attained ‘Nirvāṇa’ in the year 477 B.C. The Baudhā religion had its beginning about 100 years before this. The Vedic works were completely compiled till 600 B.C.” They appear to belong to 3 periods —Sūtra, Brāhmaṇa and Mantra, the Sūtra period ranging from 600 to 800 B.C., the Brāhmaṇa period 800 to 1000 B.C.; and the Mantras of all Maṇḍalas (sections) of the Rigveda were compiled in an earlier period.” It is his opinion that no human being will be able to say whether the Rigveda Śūtras were compiled in 1000, 1500, 2000 or 3000 years B.C. and Europeans accept this view. These inferences are based only on history and philology. Taking into consideration this fact and also the assumption of a period of only 200 years for each Vedic subperiod, the author feels that the limits fixed above, on the basis of astronomical evidences should be accepted as correct.

The Limits of Vedāṅga Period

1500 B. S. is the upper limit of the Vedaṅgas. The lower limit can be fixed up after examining the problem as to when the 7 week days and Meṣādi signs came into vogue. The names of seven week days are not found in the Vedic literature. Of the remaining ancient works, references of week days are found in none except in Atharva Jyotiṣa and Yājñavalkya Smṛti; and references to Meṣa and others are found in none other than Baudhāyana Śūtra.

It is needless to say that both are mentioned in Śūrya Siddhānta and another such works. Even if it be supposed that both of them are products of Indian mind, they, at least, did not belong to the Vedic period.

*Physical Religion, pp. 91-96 (1891 A.D.).
The order of names for the 7 week-days is as follows:

If the planets are regarded as revolving round the earth, they can be written in their order as Saturn, Jupiter, Mars, Sun, Venus, Mercury and Moon. It is assumed that the day is divided into 24 hours (Horā) and these horās are controlled by these seven planets in this very order. These planets get the lordship of the horās thrice in a day and 3 more horās remain. Hence, the lordship of the 1st horā at sunrise passes on to the 4th planet. If, for example, the lord of the first hour on the first day be Saturn (then last 3 hours will be controlled by Saturn, Jupiter & Mars) and Sun will be the lord of the first hour on the next day; and following the convention that Lord of the first hour to be reckoned as the lord of the whole day, if Saturn be the Lord of the first day, the Sun becomes Lord of the second and hence, Saturday is followed by Sunday. Thus we get the usual order of names of week days. It should be noted that the next day bears the name of every 4th planet from the previous one. The Sūrya Siddhānta observes as follows about it:

रात्रिधाते, कमलेष्वर स्नद्यताला दिवसाचित्रः ||८२१||

योऽसरेष्ट: कुर्मयतन्त्रवथ: कमशास्त्रः ||७४१||

मूललक्षणः

“The Lords of days are to be reckoned in order fourth from Saturn downwards. The lords of hours also are to be reckoned commencing from Saturn downwards.”

Even Āryabhāta says that the lords of days are to be taken as “4th from the previous one” “Sīghra Kramāt catvārthāh dīnapāḥ” (Kal Kri. 16).

The system of dividing a day into 24 parts called ‘horā’ is true only in consideration with the theory of week days and astrology. The astronomical works, Siddhāntas, do enumerate time-units but they do not mention ‘horā’ as one of them, and no work belonging to Vedic and Vedaṅga period ever mentions it. This word is not Sanskrit in origin. Varāhamihira has attempted to justify its Sanskrit origin by explaining that the word is ‘coined’ by taking the middle portion of the word Aḥorātra, leaving out ‘A’ and ‘Tra’, but this explanation is not satisfactory. The Chaldeans had this unit in use since a long time and they did have a week of seven days as at present. Considering this the author feels that ‘Week-days’ do not belong to us but have been borrowed from Chaldeans.

It has been shown under the topics of Vedaṅga Jyotiṣa and the Mahābhārata that the terms Meṣā and others are Sanskrit and it can not be said for certain that the system of dividing the ecliptic into 12 parts did not originally belong to us. Even from Vedic works we find that people did conceive the idea of giving to asterisms names similar to some well known shapes. We can not, therefore, say for certain that the Meṣādi signs are not ours. These terms, however, do not belong to Vedic or Vedaṅga Jyotiṣa period, which means that these were not in use before 1500 B.C. Now looking to the history of other nations, some say that these were known to Egyptians before 2160 B.C. and according to others even before 3285 B.C. Some are of opinion that Chaldeans knew both Vāra and Rāsi before 3800 B.C. In any case, it can be said for certain that both these nations knew the terms before 1000 B.C. and Mr. Laing writes emphatically that the ‘ Vāras’ were known to Chaldeans long before 3800 B.C.*

* See Proctor Leckie’s English book “Nineteenth Century” and his article in the July T892 issue, page 34; also see S. Laing’s Human Origins, Chap. V, pp. 144-158.
It can be seen from Vedāṅga Jyotiṣa that both of these were unknown in our country before 1500 B.C.

It is a matter of controversy if the terms Meṣa and others originated with shapes of clusters of stars. There does not appear to be any relation between their shape and name, irrespective of the consideration whether these belonged to Indians or have been borrowed. We do not get the form of a ram (Meṣa) from the clusters of stars of Aśvinī, Bharaṇi and some stars from Kṛttikā. Meṣa happens to be first in order of signs and begins from Aśvinī. Just as we have a definite reference of a Kṛttikādi system having been in vogue before the Aśvinīyādi system, we do not find any reference by which it can be said that the order of Rāṣis began from a sign other than Meṣa or the Meṣa sign began from a nakṣatra other than Aśvinī; and there is no doubt that these terms were not current in the Vedāṅga period. Hence, it can be easily inferred that these terms came into vogue at a time when the vernal equinox occurred in Aśvinī nakṣatra and Meṣa sign simultaneously. The tropical longitude of the star Beta Arietis was 31° 53′ and that of Alpha Arietis 35° 34′ in 1850 A.D. Hence, the years when the longitudes of these stars were zero come to be 31° 53′ × 72 (= 2296) − 1850 = 446 B.C. and 35° 34′ × 72 (= 2561) − 1850 = 711 B.C. It is, therefore, impossible that the terms Meṣa etc. were known in our country before these dates, the mean of these dates being 579 B.C. Another important fact is that the time when Śravaṇādi system described by the Mahābhārata came in vogue, has been proved to be about 450 B.C. (See page 110), and the Mahābhārata does not contain any reference about Meṣādi terms; hence, it can be safely inferred that these terms were unknown in our country before 500 B.S. It will be shown in Part Two that some of the Siddhāntic works like the old Sūrya-Siddhānta do not belong to a date later than 200 B.C. They do contain the terms Meṣa and others; similarly it can be proved beyond doubt that some of the astronomical (Siddhānta) works were compiled earlier than this date. All these considerations lead one to infer that the Meṣādi terms were introduced in our country about 500 B.S. and the week-day names came into use 500 years before this date. It has already been pointed out that suggesting a system of Rāṣis (Meṣa and others) and of week days is not a matter of much importance; what is very important is the calculation of actual positions and motions of planets (See page 108).

In short, the lower limit of the Vedāṅga period comes to be 500 B.S.

All those original works which contain the Caitrādi terms but neither the Vāra or Rāṣi names, must be taken to belong to the Vedāṅga period, since these two must have got entry into them, had these been current in Vedāṅga Jyotiṣa period. The works on astronomy and religion belong to this category, and naturally the ‘Kalpa Sūtras’ and ‘Smṛti’s come to belong to this category. All works described in Part One, excepting Baudhāyana Sūtra, belong to the Vedāṅga period; and there is no harm if we say that, of these works, those which do not contain any reference of week days, were compiled earlier than 1000 B.S. The date of compilation of each particular work must be decided after considering the work independently. Fresh additions have been made in the text of the Mahābhārata from time to time till 500 B.S.; the matter of Śravaṇādi system lends a support to this view. Some more interpolations might have been made even after this date; but some portions of the work are very ancient. The astronomical description of the planetary positions definitely points to the age in which Pāṇḍavya ved. This is the author’s view.
The lower limit of the Vedânga period is the upper limit of the Jyotiṣa Siddhânta period.

It is needless to say that the limits of the Vedic and the Vedânga age as fixed by the author are not very accurate. The ancient history and ancient literature are still matters of research and the above limits are likely to change when the research is made. The author is, however, certain that the lower limit for the Vedic period can not be later than 1500 B.S. and that of Vedânga period not later than 200 B.S.

IN VEDIC AGE THE YEAR WAS SEASONAL I.E. SOLAR.

The so far made discussion must have made it clear that excepting the last few centuries, the year was strictly seasonal or solar throughout the Vedic age. The months were lunar and adjustment to solar year used to be made by interpolating an intercalary month at a suitable place. We find in the Rk-Saṃhitā the names of seasons like Śarad, Hemanta etc. used in the sense of a year. This shows that one complete cycle of seasons formed the measure of a year and such a system of maintaining the measure of a year was followed in the Rigveda Saṃhitā age. The lines like:


“A year can stand only with the help of seasons” indicates the same idea. The derived meaning of the word “Saṃvatsara” is “Saṃvasanti ṛṭavaḥ yatra” i.e. year is that period in which the seasons stand completely. These quotations clearly support the view that in Vedic times, by the term year was understood a period of one complete revolution of seasons.

Madhu and Mādhava were the months of a year (Saṃvatsara). These indicate seasons. The importance of these months in the Yajurveda Saṃhitā and in all Brāhmaṇa works will be clear from the divine status which these months received. It will also be seen from the terms Arūṇa and others that they are associated with seasons and not with nakṣatras. The names of months current in the major portion of the Vedic age were Madhu and others; the Caitrādi names got introduction in the last period of the age. These names got their association with the nakṣatras and hence, the year calculated on this basis must have been sidereal. It appears from this, that the sidereal year came into use about 2000 B.S., when the Caitrādi names associated with nakṣatras came into vogue; and before this time, people could carry on their affairs with Madhu-Mādhava months and hence it is proved that the year was seasonal (i.e. tropical). Some people might argue that the Caitrādi names must have come into vogue not much later than the Madhvādi name system. But it has been shown (pp.30-31) that there were difficulties for the introduction of Caitrādi names after the nakṣatras got their names and that much time must have elapsed in between. Even without any other support it can be shown that the very fact that Madhvādi names have a divine status in the Vedas and not the Caitrādi, is sufficient for one to infer that a number of centuries must have elapsed before Caitrādi names became current. The nakṣatra occupied by the sun is never visible; hence it is but natural that the seasonal year came into vogue earlier than the sidereal year which is the interval between the sun’s two consecutive coincidences with the same star. Now when the author says that the solar year came into use first and not the sidereal one, it should not be taken to mean that a correct tropical year came into are after the actual difference between the lengths of the two years occurred.
known after studying the precessional motion of equinoxes. They in the Vedic age had the system of interpolating an intercalary month at the proper place so as to maintain the correct relation of lunar months with the seasons, so that the months of Madhu and Mādhava would on average be found to occur in the spring season. Even when a “fixed year” came into vogue in the latter part of the Vedic age, the year was to commence with W. S. as ordained by Vedāga Jyotiṣa, and other works recommended the commencement of a year with spring. From this, it is clear that their object was throughout that of following a seasonal year and they never dreamt that they are not following a tropical year system just as we in the present time do not suspect the change. Even if Mr. Tilak’s argument be accepted that in Vedic times year commenced from W. S., the commencement of a year with a solstice is nothing else than following a seasonal year, and the year proves to be tropical and not a sidereal (or fixed) one. In short, we find that the seasonal year was in long use before the fixed year and from historical point of view the tropical year was acceptable to ‘Śrutis’ and it was a natural one. Spring has been described as the ‘mouth’ of a year, Madhu and Mādhava as months of the spring season and the Madhvādi names were current. All these things can not remain true without following a tropical year. The seasons will not be found to occur in the same months by following the nakṣatra-month-system, and an idea of their departure from the usual position is already given on page 132. From this it is proved that it was the tropical year which was acceptable to Śrutis.

THE YUGA SYSTEM

Almost all aspects of the Yuga-system have been discussed in the preface. According to Āryabhaṭa II, Mercury was behind the sun by about 9° in the beginning of the present Kaliyuga. According to the Sūrya-Siddhānta and Āryabhaṭa I the longitude of the moon’s Apogee was 90° and that of its Node 180°; but Brahmagupta and Āryabhaṭa II quote different values for them.

While examining the works of the Manu Smṛti and the Mahābhārata it has been shown that the measures of time units, yugas etc., as given by astronomical (Siddhānta) works, were already defined and fixed. These works are said to give as a criterion of the commencement of yuga the condition that all planets must come together in the beginning of Kaliyuga and of each other Yuga. (According to some other works all planets come to a close conjunction at the beginning of a Kalpa and come together within a reasonable proximity in that of a Mahāyuga). This criterion or condition is neither found in these works or in any of the works discussed before. On the contrary we find in the Mahābhārata the condition for starting a Kṛtayuga, to be “the coming together of the sun, Jupiter, the moon and the Tiṣya (Pūṣya) star” (Vana Parva, 190.90/91). Similarly according to the astronomical works, the Kaliyuga started in the year 3179 B.S. But we do not find in any later works an explicit or implicit mention of this yuga having been so started. No reference to this age or to a criterion of the commencement is found in any of the Purāṇas and the above mentioned condition also is not well known.

The current year Śaka 1817 is the 4996th year of Kali elapsed. It shows that so many years have elapsed after the commencement of the Kali era. This era, according to the Sūrya Siddhānta, commenced on Thursday at midnight when it was the mean Amāvasyā of Phālguna. According to some other Siddhāntas it commenced after 15 ghātis more, that is on Friday morning. Prof. Whitney has, in his translation of the Sūrya-Siddhānta in English
calculated mean positions of planets by accurate European formulae true for the midnight of Thursday, the 17th February 3102 B. C. (Julian period) which is the moment of commencement of Kali. The author has given in the following table these positions and also those calculated by him with the help of Astronomical Tables by Prof. Keropant Chhatre. These tables have been prepared by him with the help of European books on astronomy, and Prof. Whitney has calculated the figures with the help of these European books. The true places of planets at the beginning of Kali as calculated by the Sūrya Siddhānta formulae are also given in a separate column. The author has also given in another column planets’ true places, the calculations of which have been based on Whitney’s mean places, and taking nodes and perihelions from Keropant’s tables. The European tables are proved to be very accurate in modern times and their calculations are verifiable by actual observations of planets in the sky. If these tables are followed, the positions of planets 5000 years ago must be found to be tolerably accurate, if not quite correct.

PlACES OF PLANETS IN THE BEGINNING OF KALI

<table>
<thead>
<tr>
<th>Sāyana mean longitudes</th>
<th>According to Whitney</th>
<th>According to Chhatre’s tables</th>
<th>European (Sāyana)</th>
<th>According to Sūrya Siddhānta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>301° 45’ 43&quot;</td>
<td>301° 13’ 42&quot;</td>
<td>303° 35’ 42&quot;</td>
<td>2° 07’ 27”</td>
</tr>
<tr>
<td>Moon</td>
<td>308</td>
<td>36</td>
<td>312</td>
<td>15 30</td>
</tr>
<tr>
<td>Moon’s Perigee</td>
<td>44 56 42</td>
<td>67 32 42</td>
<td>90 00</td>
<td></td>
</tr>
<tr>
<td>Moon’s Node</td>
<td>148 02 16</td>
<td>145 00 00</td>
<td>147 53 34</td>
<td>180 00 00</td>
</tr>
<tr>
<td>Mercury</td>
<td>268 34 05</td>
<td>267 36 42</td>
<td>288 03 54</td>
<td>358 07 27</td>
</tr>
<tr>
<td>Venus</td>
<td>234 36 30</td>
<td>333 45 24</td>
<td>316 12 06</td>
<td>0 52 12</td>
</tr>
<tr>
<td>Mars</td>
<td>289 48 05</td>
<td>289 11 18</td>
<td>300 34 18</td>
<td>5 42 30</td>
</tr>
<tr>
<td>Jupiter</td>
<td>318 16 07</td>
<td>318 04 06</td>
<td>317 45 54</td>
<td>0 42 00</td>
</tr>
<tr>
<td>Saturn</td>
<td>281 36 18</td>
<td>280 02 18</td>
<td>278 00 18</td>
<td>353 24 57</td>
</tr>
</tbody>
</table>

The author has not applied the (कालांतर) time correction to the mean positions of planets calculated by him by Keropant’s tables. Keropant has mentioned a “Kālāntar” [time] correction to be given only to the sun, moon, moon’s perigee and moon’s node. If it be applied to them they would agree with the places given by Whitney; and other planets, even when no “Kālāntar” (time) correction be given to them agree with Whitney’s places. This shows that Whitney has not given this correction to the five planets, Mercury and others.

The mean longitudes of all planets except Rāhu (moon’s ascending node) are zero, according to the Sūrya Siddhānta. The European positions of planets are Sāyana and those of the S. S. are Nirayaṇa. The measure of the error of our astronomical works is equal to the excess or deficit of the difference between sāyana sun and any sāyana planet and that between the longitudes of the sun and the corresponding planet according to the S. S.
We find that the sun's place according to Whitney is in advance of Mercury by about 33° and Venus is in advance of the sun by about 32°. If, therefore, the European tables are correct the error in the mean places of planets calculated according to our works should be taken to be equal to the planetary differences.

The planets in the sky are observed to occupy the calculated true places and not their mean places. A glance at the places calculated by European tables shows that the maximum distance between the sun and other planet is that of Saturn (25°) behind and of Jupiter (14°) in advance. According to the Sūrya Siddhānta all planets are within 9 degrees of the sun and are therefore 'invisible' and there appears to have occurred a solar eclipse on Thursday, it being an Amāvāsyā day. According to European calculation only Mars seems to be invisible in the sun's rays. If Rāhu's figure, according to Whitney, were taken 15° less, then there is a solar eclipse. Taking the longitude of Mercury 10° more, of Venus 9° less, of Jupiter 4° less and that of Saturn by 11° more, we get the following figures for true places of planets, showing that all planets are heliacally set:

<table>
<thead>
<tr>
<th>Planet</th>
<th>°</th>
<th>′</th>
<th>″</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>303</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>Mercury</td>
<td>290</td>
<td>40</td>
<td>06</td>
</tr>
<tr>
<td>Saturn</td>
<td>288</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Venus</td>
<td>312</td>
<td>28</td>
<td>48</td>
</tr>
</tbody>
</table>

In brief, according to our astronomical works, all planets were together in the beginning of Kaliyuga, but the fact is otherwise. It may be that all planets were heliacally set, but we do not get even such a description in the Mahābhārata and other works. At least 2600 years elapsed after Kaliyuga till the Sūrya Siddhānta and other works were compiled, and the Yuga system described by the Manu Smṛti was in vogue before these works; but it does not seem to have been proved that Kaliyuga actually started at such particular time. The quotation from the Rig-Yajurveda viz. "the herbs which grew in three yugas before" has already been given on page 12. The fact that Kaliyuga commenced in the year 3179 B. S. was established beyond doubt in the Vedic and Vedāṅga Jyotiṣā age, is not proved from this quotation. Hence, there are grounds for suspicion that the astronomers fixed up that moment as the beginning of Kaliyuga at which all planets were found to be together, starting backward calculation from the year of compilation of the astronomical work.

ROHINI ŚAKAṬA BHEDA

The Rohini constellation consists of 5 stars; these together form the shape of a cart and hence, the group of stars is known as 'Rohini Śakaṭa'. Of these 5 stars the latitude of the northernmost star (Epsilon Tauri) is 2° 34' 43" S and that of the junction star is 5° 28' S; and when a planet while passing through this constellation possesses a latitude lying between the two figures, it is said to be piercing the 'cart'. The value of a planet's latitude depends upon its node. The moon's mode makes a complete revolution of the heavens in about 18 years during which the moon is able to pass through the constellation for 5 or 6 years only. It was pointed out on page 31 that the moon generally used to pass through Rohini constellation from September 1884 to March 1888. The conjunction of the moon with Rohini star has remained an object of interest since very ancient time. The story of the Moon's love with Rohini is very famous in the Purāṇas. The whole paragraph No. 5 (in Chapter

* There is a detailed description of this conjunction (and translation of the paragraph also) given in chapter 'Rajani Vallabha' in the book "Jyotirvilasa" (See page 52, second edition.)
3, 2nd-Aṣṭaka of Taṅṭirîya Samhitā) contains stories about the moon’s special attachment with Rohini, who was one of the 33 Prajāpatī’s daughters given in marriage to him. These 33 daughters are the 27 stars from 27 Nakṣatrās and six stars from Kṛṣṭikā group. It is evident that the story originated from the often observed conjunction of the moon with this star. This conjunction and its effects are described in detail in Garga and others’ Samhitās; and we find that whole chapter No. 24 in Brhat Samhitā is devoted to the topic of “Moon’s conjunction with Rohini”.

It is well known from the astronomical works that the piercing of the constellation of Rohini by Saturn and Mars indicates disaster in the world. Varāhamihira says,

रोहिणीशक्तमकांतों यदी भिनति शंकरोपया शाश्वो ||
किं वारमि यदी नाशसागरे जगद्योग्मयायिं संस्कर्यं। ३५ ॥
ब. सं. ३४.

“If the Rohini constellation is crossed through by Saturn, Mars or the Moon, I will not be surprised if the whole world completely plunges into the ocean of disaster and gets ruined.”

Gaṇeśa Daivajña, the author of Graha Lāghava, says,

भोजायिः शक्तमिव युगातिरेव स्यात॥
प्र. ल. ११६. १२.

“The piercing of Rohini-cart by Saturn or Mars is a phenomenon rarely to occur after interval of yugas”.

In the present times when Saturn approaches Rohini, its maximum latitude becomes 1° 50’ South and that of Mars, about 12° North; hence, neither of them pierces the cart. Then how could descriptions of disasters due to their passing through the constellation get into astronomical works? It is not that such a phenomenon is an impossibility. We know that Jupiter’s south latitude never attains a value of 2° 35’, and we do not read of the piercing of Rohini by Jupiter in the astronomical works; but this is not the case with Saturn and Mars. The maximum value of Saturn’s south latitude is 2° 45’, and that of Mars is 2° 53’. These planets, therefore, do come within the range of ‘Rohini’ cart’, some time during the revolution of their nodes in the sky. These revolutions take about 40 to 50 thousand years and some time during this period, these planets must have passed through the constellation of Rohini. While attempting to calculate possible years for Saturn the author finds that the crossings by these planets have never occurred after the commencement of Śaka era; not only this, it never occurred during 5000 years before Śaka era. He found that in the year 5294 B.S. the tropical longitude of the northernmost star of Rohini was 10° 28’ 2’ and when Saturn came to that position, its south latitude was 2° 34’. From this, it appears that near about this year and during a number of years before this, Saturn used to pierce the cart in each round. The time of piercing the cart by Mars appears to be much earlier. The Samhitā works describe the effects of Śakaṭabhedā by Saturn and Mars and since this crossing did not occur later than 5000 years B.S., it is proved that people in India had acquired knowledge of planets and their motions 5000 years before Śaka era.

* Calculations have been made from Prof. Chhatre’s ‘Table of planetary calculation’. The details of calculation are not given here for want of space.
It is evident that people had acquired knowledge of stars even before this, and this lends a support to our views expressed about the times of the Vedic period and that of compilation of the Rāk-Saṁhitā.

**Kṛtikādī System**

श्रीमान्: प्रवर्ध || विजयवर्ध उत्तरम् || तात्त्विक यान्त्रवाणि ||
अन्तराख: प्रवर्ध || अपभ्रंशीस्तम् || तात्त्विक यान्त्रवाणि ||
ग्यानिनित्राणिः || तात्त्विक यान्त्रवाणि ||
ग्यानिनित्राणिः || १७ || तात्त्विक यान्त्रवाणि ||

तै. वा. १. ५. २.

"Kṛtikās are the first and Viśākhā the last; these constitute Divine nakṣatras: Anurādhā is the first and Apabharaṇi the last; these constitute Yama nakṣatras: The divine stars turn from South (to North) and the Yama nakṣatras from North (to South)". The bracketted words are not given in the original text; but Mādhava-cārya, the commentator of the Vedas has rendered the word 'dakṣiṇena' as 'from south to north' in the following lines in the Taittiriya Saṁhitā (See Chapter on 'ayana' by Kāla Mādhava).

तत्त्वाविविषय: यमासो दक्षिणिति वहतः ||
तै. वा. ६. ५. ३.

"The sun goes by the south for six months and for six months by the north."

The word 'dakṣiṇena' can mean "to the south of a certain object"; but no mention of a second object has been made in the sentence. If the divine stars be taken to be situated to the south of the ecliptic and the others to its north, it is an impossibility; because, Kṛtikās lie to the north of the ecliptic, the next 3 constellations are situated to its south, and the next 2 are again found to lie to the north; the stars are thus irregularly situated and the latitudes of the stars will never change (they might vary only by a minute or two of an arc in thousands of years). Hence, the description can not be said to be with reference to the ecliptic. Similarly it can not happen that all 'Kṛtikādī' groups be found to be situated to the south of the equator and others to the north. The declination of stars always changes due to the precession of equinoxes, i.e. their position, north or south of the equator changes. But because the latitudes of some stars like Arcturus (Svāti), Altair (Sravaṇa), Delphini (Dhanisthā), Alpha-Andromeda (Uttarabhādrapadā) are greater than 24°, these stars will never be found to lie to the south of the equator*. Hence, none of 13 consecutive constellations will be found to lie to any one side of the equator. If an observer stands at any place on the earth, he will not find half the number of constellations moving from the northern side and half from the southern. Hence, the line 'dakṣiṇena pari-yanti' can not be rendered as 'to the south of any particular object'. If we translate the above lines as "the Kṛtikādī stars move from South to North", the sum total of the argument becomes that these are found to be situated in the sun's path when it moves from south to north. This leads one to

* I have attempted to find the positions of stars in 2350 B.C., 1462 B.C., and 570 A.D., but I never found that 13 consecutive constellations were on the same side of the equator. The calculations can not be given for want of space.—Author.
accept that the winter solstice used to occur on Kṛttikā, and the time for the occurrence of the W. S. there comes to be 8750 B.C. But there are certain difficulties in translating the lines in this way. The Satapatha Brāhmaṇa definitely quotes the position of Kṛttikā as “rising to the East”. If the above meaning be taken to be correct, the difference in the times of Satapatha and Taittirīya Brāhmaṇas comes to be about 6000 years, which is not possible and since we get a definite reference of the W. S. occurring on Dhanisthās we should naturally expect to get references of the W. S. occurring on the intermediate 6 nakṣatras; but we do not get this in any of the ancient works. It is also true that the star-lore was known to our people in such an ancient period is not an impossibility, as can be seen from the discussion of the topic of “piercing of Rohiṇi-cart”. It is not still clear what these lines really mean.

THE BRIEF SUMMARY

So far has been described in detail the astronomical knowledge which people obtained during the Vedic and Vedāṅga Jyotiṣa periods. The association of Greek astronomy with that of Indian, if it was formed at all, belongs to the later period. The whole knowledge described in this part has been independently obtained by the people of our country. The author describes in brief some special information chiefly related to their knowledge of motions and positions of planets. Other important things can be referred to the places where they have already been discussed in detail.

People possessed knowledge about stars before 5000 B.S. The system of adding an intercalary month must have been introduced in those days. The months were lunar. They had obtained some knowledge about planets. This should not be taken to mean that they were able to predict planetary positions for the future. They found that planets have motion and they had begun to observe their positions with respect to stars. The months were then probably called by Madhu, Madhava etc. Caitra and other names of months came into vogue at about 2000 B.S. and till that time the year used to be tropical. Later on, it became sidereal in form because of introduction of ‘Caitrādi’ names for months, but in principle the year was no doubt tropical.

The time of Satapatha Brāhmaṇa, from the references about Kṛttikās in it, comes to be 3000 B.S. and the Vedic Saṃhitā undoubtedly belongs to an earlier period.

The time of Vedāṅga Jyotiṣa has been proved to be about 1500 B.S. In those days, the measure of the day was 60 ghāṭikās. The mean motions of the sun and the moon were tolerably accurate. The measure of the solar year was erroneous; still, that kind of solar year was in vogue. Not only the system of adding an intercalary month to bring agreement of the lunar year to the solar one was in use, but the year was divided into 12 solar months. The concept of the system of the Ecliptic being divided into 12 parts, each part being divided into 30 divisions, and each such division subdivided into 60 parts, had taken root during this period; and an important thing viz., introducing similar units for time divisions and area divisions came into practice. There are sufficient grounds to believe that the division of a circle into Ṛāṣis, degrees, minutes and seconds is the result of Hindu-imagination. It seems that people had acquired knowledge of mean motions and positions of planets by the end of the Vedāṅga period.
The next important step is the knowledge of true positions and motions of planets. It has been shown under discussion on the topic of '13-day half-month' that people had acquired working knowledge of calculating true positions of the sun and the moon. It is more difficult to understand and calculate the true positions of planets than those of the sun and the moon. No definite proofs are known for the confirmation of this. But the fact that the retrograde and direct motions of planets used to be a topic of their discussion, leads one to believe that people had come to know that the true positions are not regular like the mean positions, and hence it can be conjectured that they had probably begun to deliberate upon the aspect of true motions of planets. We find a mention of solar months in the Vedāṅga Jyotiṣa period. We come across names of Saṅkṛāntis as Ayana, Viṣuva, Saḍaśī, etc. From this it can be said that the system of dividing the ecliptic into 12 parts had come into vogue in the Vedāṅga Jyotiṣa period or very soon afterwards but the positions of planets are found to have been mentioned with respect to nakṣatras. This shows that the system of indicating planetary places in terms of 12 Rāṣis had not come into vogue then.

The names of Rāṣis (Meṣa and others) came into vogue at about 500 B.S. The names of week days came into use before then, and have been borrowed from foreign countries.

The system of reckoning a Mahāyuga as equivalent to 4320000 years must have come into vogue in a period earlier than Yāska.

The Atharva Jyotiṣa shows that astrology came into existence into our country quite independently.

In short, the origin of the knowledge of calculation of the true places of planets and that of predicting their effects (i.e. astrology) had taken root at the end of the Vedāṅga Jyotiṣa period. The process by which that knowledge gradually developed into the form of treatises will be discussed in detail in the second part.