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ISBN 978-981-15-6902-9 ISBN 978-981-15-6903-6 (eBook)
https://doi.org/10.1007/978-981-15-6903-6

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The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

To

Arunabha

Siddhartha

Debolina

&

Mili

So that they do not forget their roots

Preface

Though the term ‘archaeoastronomy’ is of relatively recent origin, the technique has been employed in estimating the antiquity of an ancient astronomical reference since quite some time. The author of this volume has taken the liberty of dividing the subject archaeoastronomy into two classes—physical archaeoastronomy and descriptive archaeoastronomy. In physical archaeoastronomy, ancient structures are studied for possible stellar alignments. However, the scope of this technique is somewhat limited as very few ancient structures of adequate antiquity are available for application. The only exceptions are the major pyramids of Egypt and some ancient megalithic structures. In all these cases, however, only the astronomical alignments are related to the rise and setting of the sun on the solstitial and equinoctial days. In some cases, the rising and setting of moon are also studied. The types of studies are conducted mainly to understand the cultural aspects of the ancient civilizations. Since the sunrise positions on the solstitial and equinoctial days do not change due to the precessional motion of the earth, no information regarding the antiquity can be extracted from these studies.

India’s case is very unique as it possesses a vast corpus of very ancient literature rich with a large number of astronomical references. In many cases, the stellar alignments can help in determining the antiquity of a particular description. Of course, often only an approximate idea about the antiquity can be gained because of the inherent inaccuracies involved in the ancient naked-eye astronomical observations. Only in some cases, somewhat accurate dating is feasible using the analysis of some spectacular astronomical events like total solar eclipse described in the ancient texts. It is hoped that the database of ancient astronomical references can be expanded in the future. With this expanded database, appropriate computer programmes can be developed that can help more precise dating employing a 'temporal triangulation' technique type approach.

This book is written for general readers only and, so, a chapter on positional astronomy presents the basic ideas and terminologies of positional astronomy. The phenomenon of the precessional motion of the spinning earth has been explained in detail. The effects of this precessional motion on the stellar alignments and other

astronomical matters have been explained. The applications of these effects for dating old astronomical observations have also been elaborated.

Since one has to refer to the ancient observational references, it is essential for one to be familiar with the system of positional astronomy followed by the ancient observers. In this respect, India offers a very rich heritage as astronomy was developed in ancient India to a reasonable degree of sophistication. Thousands of years of observation led the ancient astronomers of India to develop a luni-solar calendar based upon the twenty-seven nakshatras as the markers in the sky. The twelve zodiacal sign-based astronomy was started towards the beginning of the common era.

Apart from the precession of the equinox, the exaltation of a planet against a particular nakshatra can also help in dating ancient observation. An application of this technique has also been presented. Various astronomical references in the scriptures have been studied and an approximate chronology has been developed. However, to create enough confidence in the approximate chronology of the protohistoric period of India, the astronomical dating has been corroborated by other approaches. As has been declared by many scholars, the sheet anchor of ancient Indian history is the Mahābhārata war. Because of this, a very large number of scholars have attempted to arrive at the date of this epochal event. The results have been presented.

Once the Mahābhārata date is decided, the recorded genealogical trees of the ancient kings help one to guess the antiquity of the various periods ruled by these kings. This way a tentative chronological order can be established. Major geological happenings also provide some clue to the ancient India's history, and a very large number of scholars from eminent research organizations are working along this direction.

Although a very direct archaeological corroboration of the events described in the ancient texts is still not possible, many eminent archaeologists appear to have found indirect evidences. A major problem in Indian archaeology is the extensive settlements above the ancient sites. But with the advent of more advanced technologies in this area, it is hoped that in the near future more conclusive evidence of many major events of Indian civilization will be found out.

As mentioned, this book is meant for general readers only so as to make them interested in the subject. It is hoped that this volume will also make many to be aware of the current level of the understanding of ancient India's civilization. Professor Asok Mallik has critically examined the manuscript and his suggestions have made remarkable improvement. He deserves most sincere thanks from the author. The author is grateful to his wife Meena for her constant supportive actions. Sincere thanks are also due to his son and daughter-in-law, Arunabha and Debolina. Sourav Kundu has done an excellent job of typing the manuscript. Author's former student Deepayan has helped him by developing the computer programme for solving some nonlinear equations related to the change in relative positions of the stars with the passage of time. The author would also like to record his thanks to Mr. Ashok Bhatnagar, former Director, Positional Astronomy Centre, for providing the websites for studying eclipses. This book would have not been possible without

the interest taken by Ms Swati Meherishi of Springer. The author is grateful to her. Many friends and colleagues of the author provided him constant encouragement to work in this field and all of them are being thankfully acknowledged. Finally, the author takes this opportunity to thank the Indian National Science Academy, New Delhi, for providing the financial help to meet the cost of preparation of the manuscript.

A book of this nature is bound to have mistakes and omissions of various types. The author will remain grateful if these are pointed out by the readers. There will be sincere efforts to make the corrections and to take care of the suggestions received to prepare an improved version in its next edition.

Shibpur, Howrah, India Amitabha Ghosh
Deepavali 2018

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About the Author

Amitabha Ghosh received his Bachelor's, Master's and Doctoral degrees in Mechanical Engineering from Calcutta University in 1962, 1964 and 1969, respectively. After serving as a Lecturer in Mechanical Engineering at his alma mater, Bengal Engineering College, Shibpur (now an Institute of National Importance—Indian Institute of Engineering Science and Technology, Shibpur) from 1965 to 1970, Prof. Ghosh joined Indian Institute of Technology Kanpur as an Assistant Professor in January 1971. He served at the Institute as a Professor of Mechanical Engineering from 1975 until his retirement in 2006.

From 1977 to 1978, Professor Ghosh visited the RWTH Aachen as a Senior Fellow of the Alexander von Humboldt Foundation, and subsequently visited the RWTH Aachen in the same capacity several times between then and 2012. He served as Director of the Indian Institute of Technology Kharagpur from 1997 to 2002. His primary areas of research are manufacturing science, robotics, kinematics and mechanism theory and dynamics of mechanical systems. Prof. Ghosh has received many academic awards including a number of Calcutta University Gold Medals, the D.Sc. (h.c.), Distinguished Teacher award from IIT Kanpur and the Award for Excellence in Research by the National Academy of Engineering.

Chapter 1
Introduction

1.1 Preamble

The dawn of civilization in ancient India is still shrouded in mystery and controversy. Whether civilization flourished in the soil of Indian subcontinent or was brought from outside by the invaders is still not conclusively established and the subject is still hotly debated. It was not customary in ancient India to record history in the conventional way. Since it is generally accepted by scholars and historians that literature reflects the characteristics of contemporary society and depends in many situations on the actual events, quite often historians use such literature in establishing history. Unfortunately, when it comes to the history of ancient India the western scholars refuse to accept the vast literature available from ancient India to have any relation with the real happenings of ancient India and consider such literature not to reflect real events and treat all such literature to be purely figments of imagination. However, many ancient texts refere to historical events. In fact quite a few Purānas viz Vāyu Purāna and Brahmānda Purāna state very clearly that they record history. In the concluding chapter of Vāyu Purāna it states.

इमं यो ब्राह्मणो विद्वानितिहासं पुरातनम् । शृणुयाच्छ्रावयेद्वाऽपि तथाऽऽध्यापयतेऽपि च ॥४८
स्थानेषु स महेन्द्रस्य मोदते शाश्वतीः समाः । ब्रह्मसायौ (युं) ज्यगो भूत्वा ब्रह्मणा सह मोक्ष्यते ॥४९

When translated it means "The learned Brāhmana who hears or tells or teaches the old history will enjoy happiness for eternity in the abodes of Mahendra."

तथैव त्रिषु वर्णेषु ये मनुष्याः प्रधानतः । इतिहासमिमं श्रुत्वा धर्माय विदधे (दधते) मतिम् ॥५६

Purāna word itself implies history (Daftari 1942). Most Indian scholars and historians also do not dare to oppose the stand taken by conventional scholars and ignore the huge amount of ancient literature while establishing the ancient history of India.

A. Ghosh, *Descriptive Archaeoastronomy and Ancient Indian Chronology*,
https://doi.org/10.1007/978-981-15-6903-6_1

Of course, the primary reason behind such an attitude is because of extensive use of allegory in the descriptions of ancient events in such literatures. Even though, the events described in these scriptures and epics may not be taken to reflect real events, there is no reason why the description of contemporaneous stellar alignments in the sky should be considered totally imaginary and devoid of any relation with the reality. As will be shown later in this volume, the characteristics of the celestial sphere change with the seasons. Besides, this season-sky correlation also slowly varies with time very slowly due to the precession of the equinox. It takes about 26,000 years to complete a cycle and, therefore, this phenomenon can function as a time keeper covering the whole of late Pleistocene and the Holocene periods. Thus, almost the whole history of the modern man after civilization began is taken care of by this phenomenon. Of course, there are two other techniques which are used for dating of ancient events besides using the precession of the equinox. One of these is to study the descriptions of ancient total or annular solar eclipses. A total or annular solar eclipse at a particular location at a particular day of the year and at a particular time of the day is an extremely rare phenomenon. Apart from that these types of events are very spectacular in nature and cannot go unnoticed. Study and analysis of such descriptions can help in establishing the antiquity of the event. A third technique that is used occasionally for establishing antiquity is the exaltation of the planet Mars. Since this phenomenon plays a very important role in astrology, there are enough references of exaltation of Mars in the past. But this phenomenon plays a relatively less significant role in establishing ancient chronology.

It has been noticed that the major structures in the ancient times used to be constructed keeping a strict alignment with the cardinal directions. Apart from that many features of such important major structures used to have unique relationship with contemporary stellar alignments. Such alignments are lost due to the precession of the equinox. Studying the accumulated error in the alignments it is possible to estimate the time elapsed after the original construction. Such techniques of physical archaeoastronomy have been applied to the study of major pyramids of Egypt and some other major structures in other ancient civilizations. The results have been found to be quite useful and indicative.

Unfortunately, in ancient India there was no tradition of constructing major structures in memory of kings, queens and other important personalities. Megasthenis wrote in his memoir on ancient India of the third century BCE that in ancient India it was believed that a person was remembered after his/her death because of the good work done. Only after Buddha's time (seventh century BCE) major structures were started; but these were also not enough in number. Besides, the post Buddha period comes within the purview of recorded history of India. Thus, India lacks huge structures created in ancient times; and, consequently, the technique of physical archaeoastronomy is not of much assistance in establishing the ancient chronology. But India possesses a unique wealth—a huge body of ancient scriptures and literatures rich in astronomical description. Over and above that, positional astronomy in ancient India was very well developed and matured. Therefore, the descriptions of ancient star alignments and their arrangements in the celestial sphere are quite significant. Above all, astronomical observation and its recording played a very significant

role in the daily house hold activities. Many texts, viz. Mahābhārata, contain a large amount of descriptions of various astronomical phenomena many of which can be very useful for application of descriptive archaeoastronomy. Of course, in most situations exact dates cannot be established but reasonably good idea about the epoch for a particular astronomical reference can be formed.

Application of archaeoastronomical technique requires a number of precautions. The descriptions of a phenomenon that is being analyzed should be as unambiguous as possible for a correct interpretation and casting it in modern scientific language. The descriptions should be also reasonably accurate and well specified. Good results can be obtained if the described phenomenon is reasonably rare. Establishing antiquity through analyses of reasonably frequent phenomenon is difficult and not very reliable. The names of various stars given in ancient descriptions need to be matched carefully with those used in the present times. Since positional astronomy reached a high level of maturity, many times the descriptions are highly scientific. The last text of ancient Indian astronomy that has been preserved is *Vedānga Jyotisha* which gives various algorithms for different astronomical calculations. This has been dated around 1400 BCE. This dating has been done by analyzing the astronomical characteristics contained in the text itself.

The ancient chronology that has emerged through the application of descriptive archaeoastronomical technique matches well with that obtained through other procedures. This provides the technique and data enough credibility and the results can be accepted as reasonably correct.

It is important to have some minimum idea of positional astronomy for understanding the techniques used in descriptive archaeoastronomy. Therefore, a simple introduction to the subject has been given in this volume so that the reader can follow the procedure without requiring to refer to other books. Apart from this it is necessary to have some basic idea about the astronomy followed in ancient times for applying the techniques of archaeoastronomy to ancient descriptions. It is important to know the terminologies used in the past and the system developed for the description of the stellar arrangements. The section on ancient Indian astronomy is very useful to the readers who are not already familiar with the subject and this volume becomes self explanatory.

Establishing ancient Indian chronology by employing the technique of descriptive archaeoastronomy is not a new subject. Even in the nineteenth century various scholars and astronomers have worked in this field. Very notable work on this subject was done by Prof. Prabodh Chandra Sengupta in the 3rd and 4th decades of the twentieth century as an eminent Professor of Astronomy in Calcutta University. His book 'Ancient Indian Chronology' was published by Calcutta University Press in 1947. This is a valuable asset to the researchers in this field. However, this book is not very easy to follow by common readers as it was written for the professionals in the area. Calcutta University had excellent programmes on ancient astronomy. Its deterioration is a matter of great concern as such subjects have been abandoned since long.

With the advent of computer science many planetarium softwares have been developed. Using these it has become much easier to analyze astronomical data. Earlier analysis of ancient astronomical data was a laborious task and only highly competent astronomers could handle the task. Since now it has become much easier, many enthusiastic scholars can make significant contributions in the field and enrich the understanding of ancient India. One of the primary objectives of this book is to encourage common readers with familiarity with ancient scriptures and some interest in basic astronomy to contribute and enrich this field. If this book helps to create enough awareness and interest among common readers the author will find his endeavour a success.

1.2 Importance of Chronology in History

History of a country unravels the story of her progress with time. It encompasses all areas of activities involving politics and governance, development of infrastructure, growth of economic status and, of course, progress in education leading to expansion of the knowledge domain. Since all these are intimately related with the passage of time the temporal interrelation of various aspects are inseparable components of a nation's history. It is well known that in most situations culture and customs followed by a society are dynamic entities and change with time. Indian civilization is considered to be the oldest living and continuing civilization in the world. The Indian society has undergone many transformations although certain basic features of the Indian civilization have remained unaltered.

Knowing the history of one's own country is essential for preserving one's dignity and self confidence. It is observed that all societies show a keen interest in establishing the antiquity of their beginnings and the progress along the path of civilization. Generally one feels happy to be a part of a society whose civilization is old and possesses a rich ancient history. Even if one does not agree to the suggestion that history teaches a society to avoid earlier mistakes in the future activities, it is generally accepted that being aware of a rich historical past can be useful in providing impetus to future growth of civilization.

In the case of India the importance of establishing the correct history of her past is more important as it is still shrouded in mystery and is full of controversies. It is very important to figure out how this great and ancient civilization started in Indian subcontinent. The richness of Sanskrit language has tempted the scholars of the whole world to investigate the past history of this language.

Chronology forms a very important component of history and without a correct chronological component history is never complete. It is for this reason a major task of the archaeologists is to establish the date of their new findings. A very large number of scientific methods have been developed for this purpose and with the progress of science and technology newer methods are being invented. Recording of history needs the dates and the historians attempt to estimate the dates by establishing these events, relationships with certain cardinal events for which the dates are already

established. Such events are usually termed as 'sheet anchors'; for example the western scholars consider the visit of Alexander as a sheet anchor in Indian history. Using this the period of Gautam Buddha has been estimated and, according to most western historians, the history of India begins with the birth of Buddha! Nothing can be more ridiculous! It is very well known that civilization in India must have a hoary past as indicated in many contemporary literatures.

Max Mueller attempted to date the most ancient text of the world 'Rigveda'. He gave some adhoc decisions based on a number of unsound assumptions and at a later time he himself withdrew his suggestion that Rigveda is 3200 years old. This again he related to a proposed hypothesis suggesting that there was an invasion by a western race termed as 'Aryan' and it was taken for granted that India's civilization was brought by these invading 'Aryans'. However, the scenario got completely transformed after the discovery of the Indus Valley cities which were estimated to be more than 4000 years old. Subsequently a huge amount of investigation has shown that many settlements in the north and north-west part of this subcontinent are more than 9000 years old.

An erroneous dating of Rigveda by Max Mueller has introduced enormous aberration in the history of India resulting in a large number of controversies and mystery. It very clearly indicates how important it is to establish a correct chronological order. Without correct estimates of the antiquity of various phases of the past history of India it will not be possible to form a correct picture of the progress of civilization.

1.3 Problems with Establishing Ancient Indian Chronology

Indian subcontinent lies in the tropical region and, therefore, is a very suitable place for sustaining all forms of life. Because of its temperate climate, abundance of water, plant and animal life it is expected that it is a very suitable location for civilization to flourish. However, at the same time the tropical climate does not permit preservation of ancient objects and all evidences of ancient structures decay with time unless these are made out of stone or similar durable materials.

According to the writings of Megasthenis Indian people did not have the custom of erecting large structures in memory of kings; the philosophy was that a person should be remembered by his/her good work done during his/her life time. Thus, evidences of ancient creations are not in abundance in the country.

Although language and literature in ancient India were extremely well developed there was no tradition of recording history in the conventional format. Whatever information the ancient people wanted to preserve these were in allegorical form couched in complex language. Perhaps, the objective had been to make the knowledge inaccessible to the general public. There is a huge amount of ancient literature. It is quite indicative of the existence of a very well developed civilization from very ancient times but explicit proofs of that is not available. This leads to a situation where conflicting conjectures and interpretations can be arrived at depending on the personal bias of the historian/scholar involved.

India was ruled for many centuries by the people from the Islamic world and they had no interest in the ancient history of the country, nor were they interested in the ancient wisdom of India. Only after the British rule was established in India the western scholars started investigating the ancient past of this country. The richness of Sanskrit language and its similarity with the European and other languages drew their attention to investigate the possible origin of Sanskrit language and its relation to other languages. Since there was no archaeological evidence of any ancient civilization in Indian subcontinent it was surmised that some outside race (termed as Aryan) came from the west along with Sanskrit language and established the ancient Indian civilization. In the nineteenth century this theory became very popular and was known as the Aryan Invasion Theory. It was suggested by the famous Indologist Fredrich Max Mueller that these 'Aryans' came to India around 1500 BCE. They created the vedic literature and the basic foundation of what is known as Hindu religion, was laid. This theory explained a few things no doubt. It became easy to explain why the Indian subcontinent has two totally different language groups—north Indian languages derived from Sanskrit and the four languages of south India which do not appear to have any relation with Sanskrit and represent the language prevalent in India before the 'Aryans' came from the west. The AIT (Aryan Invasion Theory) became extremely popular with the western scholars, particularly the British rulers for a number of reasons, a detailed discussion of what is out of place here. And gradually the theory took the form of an established truth.

On the contrary, no Indian tradition hints at such a situation. It was never imagined in India that Sanskrit is a language from outside and the ancient civilization of India was an import from outside. All ancient literatures give extensive details of happenings and events in ancient times but nowhere in this huge body of literary work there is any indication of Aryan Invasion! The date of Rigveda was fixed by Max Mueller to match his suggested date of Aryan Invasion and he suggested that the antiquity of Rigveda does not go beyond 1200 BCE.

In the third decade of the twentieth century the Indus Valley civilization was discovered and the antiquity of Indian civilization was pushed back immediately by more than two millennia. But the theory of Aryan Invasion continued to rule the scene and, even today, it is a matter of serious debate if Indian civilization is indigenous or a foreign import.

Thus, the true story of ancient India is still a debatable issue. The very large amount of ancient literature can be used to date the events described therein and some idea about the ancient Indian chronology can be formed. On the whole it has remained as a difficult task to establish ancient Indian chronology in the absence of conventional evidence of various major events described in the ancient literature available to us at present. One group of scholars, predominantly from the west, refuses to accept the major epics like Rāmāyana and Mahābhārata to have any relevance to reality and are considered as purely imaginary stories. Since the conventional archaeological techniques cannot help us in dating ancient scriptures, application of the technique of archaeoastronomy can be useful and can yield scientifically established information.

1.4 Application of Astronomical Technique

It is mentioned in the previous section that no ancient structure or artifacts are available in India for applying conventional dating techniques. In case of India, however, something unique is available– the large volume of ancient scriptures and literatures. As astronomical observation has been an integral part of many ancient civilizations, ancient Indian literature is also full of astronomical references. It has been briefly hinted at the possibility of its use in the preamble. The star alignments have very specific relation with the seasons and this relationship changes very slowly with time as mentioned earlier. Since observation of such stellar arrangements for the onset of various seasons was an integral part of the ancient society, records of such observations are available in ancient texts. Examining the difference with the currently observed stellar patterns at different seasons, an idea about the antiquity of the recorded observations can be formed. It is not only the seasonal relationship which can be helpful for the dating technique there were other types of very interesting features of the ancient stellar alignments which are now different. This variation can be used to determine the epoch when the recorded observations were possible.

Total and annular solar eclipses are also spectacular astronomical phenomena and such events rarely go unnoticed. Apart from being very interesting and rare, many rituals got associated with eclipse phenomena in Indian custom. A total or annular solar eclipse at a particular location is not a frequent phenomenon. So, studying the location, the date in a solar year and a particular time in a day, an eclipse can be dated. Since matching all conditions becomes a rare possibility, very ancient dating is possible. A number of planetarium softwares are available with which the dates of such ancient observations of total or annular solar eclipse can be derived. Since the phenomenon depends on the umbra of moon's shadow falling at a particular spot on the earth's surface the history of earth's rotation must be accurately known for such dating. Sometimes error may occur due to certain uncertainties in the information about exact rotational history of the earth. Thus using the description of ancient eclipses may not always help in establishing the chronology.

Astronomy in India was reasonably well developed even in the proto historic period. In the presiddhantic[1] astronomy a very well developed 'Nakshatra' system used to be followed in which the groups of stars at locations occupied by the moon during a lunar month were identified and used as the markers in the sky. Thus, these 27 nakshatras along the ecliptic became a very well defined frame of reference for the planets, the sun and the moon. The positions of the sun along the ecliptic at different seasons were also recorded in ancient texts and such information can be used for astronomical dating as will be elaborated in the later chapters.

[1] Siddhantas were authored from the onset of the common era and became matured from the time of Aryabhata I (fifth century CE). The astronomical system before that is termed as 'Presiddhantic'.

Deriving the epochs from astronomical references may not provide very accurate results always but a reasonably good idea about the antiquity of ancient events, as described in ancient texts, can be achieved. In some cases very interesting star alignments are found in the ancient texts. As in many cases these are couched in allegory correct interpretation of such events is essential. Some very interesting cases exist in ancient Indian astronomical observations and scholars have used such descriptions to form some idea about the antiquity of the observations.

Another phenomenon that is rare is the exaltation of the planet mars. Though this phenomenon has special significance in astrology, it represents very special astronomical configurations involving Mars, the sun and the earth. Such events occur at long periods of interval and description of the exaltation of planet mars against the backdrop of a particular nakshatra can help in establishing the date of occurrence of the event. In some isolated cases this phenomenon has been used for the dating of ancient observations.

In Indian custom offering prayers facing the east at very early hours of dawn used to be a common practice, particularly among the sages and priests. This resulted in observing the stars which were visible just before the sunrise (called heliacal rising). Heliacal rising of some stars became identified with the seasons. This correlation of heliacal rising of some identified stars (or constellations) with the tropical seasons also undergoes change with the passage of time. This provides another technique for ancient dating. In case of ancient India this extensively practised observation form a rich source of material for application to establish ancient chronology.

Since in ancient times the observation used to be done through naked eye astronomy the accuracy of positions etc. were limited. Therefore, a few other types of effects due to the variation of astronomical parameters cannot be of much help. The most dependable methods are based on the precession of the equinox (to be explained in the next chapter).

1.5 Influence of Astronomy on Society

Since the dawn of civilization mankind has remained fascinated by the star filled sky and the apparent movement of the celestial objects. As the time progressed and the quality of observation improved many interesting correlations of the stellar alignments with the phenomena on the earth were established. The changing shape of the moon during a lunar cycle (called a lunar month) and the daily rising of the sun became two most important factors for calendrical purposes. Changing phase of the moon became one of the obvious markers for keeping track of the day; this has been followed by many tribal societies and is followed even at the present times. Man also observed some connection of the terrestrial phenomena with the sky. For example the strength of the ocean tide depends on the lunar phase, position of the sun among the constellations dictates the seasonal changes and the menstrual period of the women is linked with the lunar cycle. Thus, relating the rituals with astronomy was a very natural thing to happen. This led astronomy to be an influential subject and

the tradition of linking the heaven with the daily life on the earth slowly developed. In many ancient civilizations where erecting huge monuments and structures used to be practised, using astronomical alignments for planning such structures was quite frequent. Major examples are the pyramids in Egypt and Central America. Even the prehistoric megalithic structures and arrangement were created with special astronomical alignments to identify the solstice and equinoctial days during a year. So, it is very natural that during the proto historic period astronomy played a major role in the daily affairs of the society. As a result in ancient India, where astronomy reached a well developed state, the literature is full of astronomical references.

1.6 Structure of Ancient Indian Chronology and Its Self Consistency

Being the cradle of the most ancient continuous civilization of the world India's correct chronology is essential for understanding the development of world civilization. At the same time scholars over the last two centuries have found the task extremely elusive and complex. As mentioned earlier the study of ancient India's chronology has been further complicated by a number of false steps at the early stage of the subject. Correcting those mistakes and erasing the wrong impressions and removing the fixed motions in the people's minds created by the long standing dogmas render the subject very challenging. Above all the subject of ancient India's chronology is increasingly becoming more multidisciplinary in nature.

In the 19th and early twentieth century the scholars had to depend primarily on the conventional procedures for studying history. Soon the subject of linguistics emerged and the technique of linguistics used to be employed for establishing the antiquity of a text and the descriptions therein. With this procedure there are significant chances of personal bias to influence the interpretations and opinions. An approach dependent on scientific principles can be more immune to such problems and may lead to dependable results. Since the beginning of the third decade of the twentieth century archaeological discoveries opened up new vistas for ancient India's civilization, and, with the progress of time many new scientific methods are being developed for determination of antiquity of objects. Besides, new subjects like archaeoastronomy, paleoclimatology are emerging to enrich the facilities for the determination of age. Studies of the signature left by the past geological processes are also being employed for establishing ancient chronology. Modern techniques with the applications of satellite imagery are also helping the scholars in this endeavour.

As indicated earlier the dependability of the derived chronology becomes significant if its consistency with other aspects of ancient India can be demonstrated. Thus, the ancient India's chronology has to accommodate the Puranic genealogical order; archaeological data unearthed so far, the results of genetic study and the geological and climatological evidences. That is how the subject has become intensely multidisciplinary. As a result it is now beyond the capability of a historian to establish