ABŪ RAYHĀN MUḤAMMAD B. AḤMAD AL-BĪRŪNĪ
(d. 440 A.H. = 1048 A.D.)

AL-QĀNŪNU’L-MASʿŪDĪ
(Canon Masudicus)

Vol. I

(AN ENCYCLOPAEDIA
OF
ASTRONOMICAL SCIENCES)

Edited by the Bureau
from the oldest extant Mss.
Under the auspices of the Ministry of Education,
Government of India

Published
by
The Dāiratu’l-Maʿārif-il-Oṣmānia
(Osmania Oriental Publications Bureau)
Hyderabad-Dn.
INDIA

1954 A.D. / 1373 A.H.
THIS WORK IS DEDICATED
TO
THE HON'BLE MAULANA ABUL-KALAM AZAD,

Minister for Education, Natural Resources and Scientific Research, Government of India, in grateful acknowledgment of the part played by him in the achievement of our Independence, in the advancement of education, in the promotion of scientific research, in the enhancement of the cultural prestige of India abroad, and as a tribute to his profound scholarship and creative genius, placing the Dāiratu'l-Ma'ārif-i'l-'Oṣmanîa in a unique position to publish one of the masterpieces of Eastern science, the Qānūn-i-Mas'ūdī (The Canon Masudicus) of the great philosopher, mathematician, astronomer and scientist, Abū Rayḥān Muhammad b. Ahmad al-Bīrūnī (d. 1048 A.D.), that had remained unpublished for the past ten centuries in spite of the serious efforts of distinguished scholars and learned institutions of the East and West.

* * * * *
Manuscripts of al-Qānūn’u’l-Mas’ūdī of al-Bīrūnī arranged in chronological order and utilised for a standard edition of the text

* * * * * * * * *

The Director of the Dairatul Ma’arif il-Osmania has been fortunate in obtaining information about the earliest known Mss. of this work in the great libraries of the world and also Microfilms of the most important ones which are as follows:

(1) The earliest known Ms. which is first half of the text is in the Bodleian Library, Oxford, (Or.No. 516) dated 475 A.H. / 1082 A.D. (Abbreviation adopted "O").

(2) The second oldest Ms. which has recently been acquired by the authorities of the Bibliotheque Nationale, Paris, France, is (Arabe No. 6840) dated 501 A.H./1108 A.D. (Abbr. "F").

(3) The third Ms. is in the Library of Millat, (Jārullah No. 1498) Istanbul, dated 531 A.H./1136 A.D. (Abbr. "J").

(4) The fourth Ms. is also in Istanbul in the Library of Bāyazīd (Valiuddin No. 2277). This Ms. has been transcribed sometime before 536 A.H./1141 A.D. and has been the base of the late Dr. Max Krause who copied it carefully, verified the diagrams and collated it with three other Ms. for nearly ten years, but could not finish it owing to his untimely death in the bombarding of Hamburg in 1943 in the World War II. We have followed Max Krause’s transcript closely, but compared and corrected it from other better Ms. (Abbr. "V").
(5) The fifth Ms. is the old Berlin one, now bearing the shelf-mark (Orient Quart 1613) dated 562 A.H./1166 A.D. and preserved in the University Library of Tubingen. (Abbr. “B”).

(6) The sixth Ms. is in the British Museum, London (Or. No. 1997) which has been transcribed in 570 A.H./1174 A.D. (Abbr. “L”).

(7) The seventh Ms. is the one that has been transferred from the Tal‘at Pasha collection to the Egyptian National Library, Cairo (Miqat No. 866) dated 673 A.H./1274 A.D. (Abbr. “M”).

Detailed description of all these and other Mss. will appear in the General Introduction of the Chief Editor.

* * * * * * *

M. N.
GENERAL INTRODUCTION
TO
THE NEW SERIES
OF
THE DĀRATU’L-MA’ĀRIF-IL-OSMANIA,
PUBLISHED UNDER THE AUSPICES
OF THE MINISTRY OF EDUCATION,
GOVERNMENT OF INDIA
GENERAL INTRODUCTION

Since the achievements of Eastern authors in the fields of humanities and sciences are of basic importance and since modern historians of literature, religion, philosophy and science are deeply interested in the evolution of thought and are making great researches into the regions of knowledge covered by the geniuses of the past centuries, the Executive and Literary Committees of the Dāiratu’l-Ma‘ārif, realising the great need of our times, have planned a New Programme of Publications and included in it several literary, scientific and historical works which had remained unpublished and beyond the reach of students, scholars and even experts for centuries.

During the past seven decades, the Dāiratu’l-Ma‘ārif, keeping in view its aims and objects and its resources, has contributed its share to the advancement of Eastern knowledge in various branches of studies and has published nearly 150 independent works in 350 volumes of which a cursory mention has been made in the Glimpses of the Dāiratu’l-Ma‘ārif (1888 - 1956), published recently.

The year 1951 marks a great extension in the activities of the Dāiratu’l-Ma‘ārif and it may well be claimed as one of the lasting fruits of Independence and a symbol of our national re-emergence.
The New Programme of these Publications was first announced in 1951 at the XXII Session of the International Congress of Orientalists at Istanbul and was finalised at the Colloquium on Islamic Culture at Princeton in 1953. It was highly welcomed by the great Orientalists that had assembled there from the four quarters of the globe.

The visit of the Hon'ble Maulana Abu'l-Kalām Azād, Minister of Education, Government of India, to the city of Hyderabad, the Osmania University and the Dāiratu'l-Ma'ārif on 24th September 1952 and his survey of the activities of the Dāira and its future plans put a new life into the work of the Dāira and enabled it to render greater service by reviving the glorious past of the East and presenting to the world a few masterpieces of the Medieval times which have been the coveted goal of the Western nations during this and the past centuries. This was but a consummation of the patronage that had been extended to Oriental Studies by India in the past ages.

The New Series of which a list is given below, (this work forms one of its components) would not have seen the light of day, had it not been for the continued financial subsidy from the Government of Hyderabad and the Osmania University, as well as for the specific grant of the Ministry of Education, Government of India. Thus the Dāira has been fortunate in opening fresh fountains of knowledge for new workers in free India and has been able to depute a few silent ambassadors of our own country to foreign lands where Arabic is studied seriously and where Eastern thought and learning are
valued highly for the sake of liberal knowledge and for preserving the cultural unity of the South-East Asian nations.

In spite of the magnitude of the task and the variety of subjects and technical difficulties of editing such highly specialised works, the Dāira has, to an appreciable extent, attempted to bring out these works in the original Arabic text with as much accuracy as possible and with as few drawbacks as are inherent in all human undertakings and with as little equipment and resources as are necessary for publishing such highly learned texts.

Details of all these efforts, the position of the author in a particular branch of knowledge, the place of a particular work in the literature of that subject, the introduction, essays, notes and indices as are necessary for modern research publications, have all been appended to each and every work. The interested reader will thus know the part played by a particular author in advancing human knowledge in his own days and the importance of that particular book in the present times.

The Dāira owes a deep debt of gratitude to all those who have helped it to produce the works in the present form. Due acknowledgment has been made of all such benefactors in the right place. It further wishes to seek the indulgence of all scholars for any shortcomings they may come across and requests them to help it by their advice in future also.
The New Series

SCIENTIFIC WORKS

(I) The *SUWARU’L-KAWĀKIB* of Abu’l-Ḥusayn ‘Abdu’r-Rahmān aṣ-Ṣūfī (d. 986 A.D.). (Description of the 48 Constellations and revision of Ptolemy’s *Almagest* or Syntax.


(III) The *KITĀBU’L-ANWA‘* of Ibn Qutayba (d. 879 A.D.) Meteorology of the Arabs, and exposition of technical terms lexicographically.


TRADITON & TRADITIONISTS

(V) AL-JARḤ WA’T-TA’DĪL of Ibn Abī Ḥātim ar-Rāzī (d. 938 A.D.). *(Criticism of the Sciences of Tradition and Traditionists).* Vol. IV, pts. i-ii. *(Whole work completed in 9 vols.)*


HISTORICAL & BIOGRAPHICAL WORKS


(X) NUZHATU’L-KHWĀṬIR of ʿAbdu’l Ḥayy of Nadwatu’l-ʿUlamā, Lucknow. Biographies of Eminent Indians from the I-XIV century Hijra) (Vols. IV&V) (to be continued).
Besides these the Dāira has planned its fresh Programme of Publications for the next triennium after due consultation and collaboration with famous scholars of various countries. It is earnestly hoped that the Dāira will be enabled to complete the monumental works it has already started to edit and publish, and to provide richer and more original material in future through its later publications also.

In conclusion, the Chief Editor solicits that his appeal will meet with greater response in the coming years and that with the help of distinguished collaborators and with the financial subsidy of generous patrons, particularly the Ministry of Education, Government of India, it will be possible for the Dāira to implement these great literary projects in the near future, to maintain its past reputation, to justify its position among the premier institutions of Eastern research in India, to render greater service to the cause of humanities and to promote cultural unity amongst kindred nations.

D/31st March 1956, M. Nizāmu’d-Dīn
Dāiratul-Mā’arif-il-Osmania, (Editor-in-Chief)
Hyderabad-Dn. 7
STANDARDISATION OF THE TEXT AND A BRIEF SURVEY OF THE EXTANT MANUSCRIPTS OF THE Qānūn-i-Masʿūdī OF AL-BĪRŪNĪ

The Qānūn-i-Masʿūdī, the magnum opus of al-Bīrūnī, which was compiled in 421/1030 is one of those monumental works that had remained unpublished for the past nine hundred years inspite of the efforts of old and new schools of Arabists and Mathematicians.

It was Nicholas de Khanekoff, Russian Orientalist, who first drew the attention of European scholars in 1866 to the scientific achievements of al-Bīrūnī and the necessity of a complete translation of his works. Edward Sachau laid the scholars under a deep debt of gratitude by editing and translating two of the important works of al-Bīrūnī, the Athārul-Bāqiya and the Kitābul-Hind in 1878 and 1887 respectively, but the Qānūn had remained a sealed book.

A proposal dated 30th April 1913 which emanated from the portals of the Muslim University, Aligarh, by Dr. Ziauddin Ahmed and Dr. Horovitz is found in the files of the Dāiratul-Maʿārif and it runs as follows:

"Abu Raihan Muhammed Ibn Ahmed El-Biruni lived in the time of Mahmud of Ghazni, with whom he came to India on several occasions. He studied Sanskrit and he acquired the reputation of a chronologist and an astronomer. Two of his important
books, History of India and Chronology of Ancient Nations, have been edited and published by Sachau, the Director of Oriental Seminar, Berlin. Nallino, who has made special study of Arabic, says of him: he is the most original, the deepest thinker that Islam has produced in the field of physical and mathematical research. The most important work of his life, on which his reputation chiefly rests, i.e., *Qānūn-i-Māsʿūdī* has not yet been published. It is the most complete and the most authentic work of the Arab Astronomers, and it contains certain theories which are commonly supposed to have been discovered in Europe in XVII century.

Both the Oriental scholars and the Astronomers have been demanding its complete publication since 1868, when Sir Henry Elliot published the tenth chapter of the fifth book of *Qānūn-i-Māsʿūdī*.

The Royal Asiatic Society of England and the Academies of Science of Paris and Berlin have passed resolutions expressing very great desirability of the publication of *Qānūn-i-Masʿūdī*.

In the following years, Dr. Ziauddin Ahmed, during his own researches on higher Mathematics, contributed two articles in the journal of *Islamic Culture* of Hyderabad in 1931 and 1934, emphasising the necessity of the publication and translation of the *Qānūn-i-Masʿūdī*. Later another Indian mathematician and physicist, the late Sir Shah Sulaiman, once the Vice-Chancellor of the Muslim University, Aligarh, had collected lot of material and got it translated into Urdu with the idea of publishing it, but the
scheme did not materialise and scholars all over the world were anxious to see its text published.

In 1951 when, the Dāiratu'l-Maʿārif was making a fresh inquiry into its assets, and re-orientating its policy of publications, it included the Qānūn-i-Masʿūdī in its new programme of publications, little knowing the difficulties that it will have to surmount in the implementation of this project.

The present writer on whom the burden of the management of the Daira had fallen recently announced in 1951 at the XXII Session of the International Congress of Orientalists at Istanbul the intention of the Dāiratu'l-Maʿārif to publish the Qānūn-i-Māsʿūdī in its New Series. This idea was welcomed by several Orientalists, particularly by Prof. Dr. Zeki Velidi Togan, Head of the Dept. of Islamic Studies in the University of Istanbul, Turkey. He had made definite contributions to Birunica by the publication of "Bīrūnī's Picture of the World" in the Memoirs of the Archaeological Survey of India. No 53.

Another great scholar, the Doyen of German Orientalists, Prof. Dr. Helmut Ritter, Director of the Orientalisches Seminar of the University of Frankfurt who had made his researches in Istanbul Libraries for more than 20 years revealed that Dr. Max Krause, one of the leading German Orientalists and Mathematicians, had prepared an edition of this work from the earliest known manuscript which had remained incomplete owing to his calamitous death in the bombardment of Hamburg in 1943 and was in possession of the mother of the late Dr. Max Krause.
That very day, a letter was addressed to her to release the transcript as a posthumous bequest of her late son to the Dāiratu'l-Ma'ārif and Professor Otto Spies of Bonn and Dr. Roemer, Director of the German Oriental Society at Mainz, were approached to use their good offices. In the meanwhile, the present writer was deeply engaged with the work of collecting fresh information and microfilms of the existing manuscripts of the Qānūn-i-Mās'ūdī in the known libraries of the world and had collected the requisite data for a standard edition of the text, when in November 1952 through the kindness of Prof. Otto Spies of the Orientalisches Seminar, Bonn, the much longed for transcript of Dr. Max Kaurse arrived in Hyderabad. It was a great gift and legacy of a very serious nature. It would be in the fitness of things if the real debt of the late Dr. Max Krause is acknowledged at this point. It is his labours in the solution of the technical side of the work, and in his contribution to medieval astronomy that the Daira is reaping great benefit. His transcript of 1229 pages of foolscap size in his neat, clear, beautiful hand is a marvel of European scholarship on scientific subjects.

He had taken meticulous care in transcribing the Arabic text from the Veluuddin (No. 2277) Bayazit Library Istanbul Manuscript written certainly before 536 A.H. /1141 A.D. and in giving variants and difficult readings and emendations from the other four oldest manuscripts known to him at that time:

(2) The second best of the oldest Mss. Jarullah No 1498, in the Millat Library, Istanbul, dated 531 A.H./1136 A.D.

(3) The third one, the so called Berlin Ms. No 213 acquired in 1927, once belonged to the Imperial Library of Calcutta, is now preserved in the University Library, Tubingen (Orient Quart 16/13) dated 562 A.H./1166 A.D.


The technical subject-matter, enormous astronomical tables, diagrams, figures, mathematical calculations, geometrical and trigonometrical problems and their solutions were a Herculean task which would have bewildered any other scholar except Max Krause. Only those who have worked on such undertakings can realise the amount of scholarship and the labour of love bestowed on such highly technical works. In fact our printed text may be considered as a posthumous edition of Dr. Max Krause.

But when the transcript arrived in Hyderabad, the key to the manuscripts was missing and the results of the researches of Dr. Max Krause had not been completed. Therefore this edition had to be revised and collated in the light of the new material acquired by the present writer. There was no one scholar who combined in himself the knowledge of medieval mathematics and Arabic language. The Daira with the help of one of its workers, Maulavi Sayyid Zainu’l-‘Abidin and another scholar of mathematics, Prof. Khwâjâ Mohi’ud-Dîn of the Dept. of Mathematics, Osmania University has attempted to complete this task under trying circumstances.
A CONSPECTUS OF THE EXTANT MSS. OF THE QAN\'UN-\'I-MAS'\'UDI

I [Or. 516] Bodleian Library, Oxford dated 475/1082, the oldest known Ms. and transcribed only 35 years after the death of al-Bīrūnī and collated with an original evidently a contemporary copy, contains only first-half and ends with the VI Maqala. It retains all archaic features and is written in a close cursive Naskh in maghribi script in a scholarly hand. This Ms. has also been utilised for recording of variants and correction of the printed text, and gives very intelligent readings, and approximates the printed text; hence much nearer the authors own version. For want of the second-half, it could not be made as a base of the text. It appears that the author originally intended to divide the Book into two volumes and this being the first volume, ends on the VI Maqala.

Its fuller description is found in the Latin Catalogue of the Bodleian by Nicolli on p. 360, Codex CCCLXX. Folios 160; size $8\ 1/2'' \times 7\ 1/2''$; 24 lines per page, 5'' length; without diacritical marks but with dots on د as usual in the 5th Century A.H. Defective in the beginning: Folio 1 a, begins with عنها في الجنوبية و تسمى ثلثان القطمان and corresponds with the printed text p. 62. l. 6 which is the end of the 3rd Bab of 1st Maqala and ends on the VI Maqala with a colophon and a note of collation on folio 160 b, but the name of the scribe is not mentioned.

The text of this Ms. corresponds materially with the Veliuddin Ms. used as a base for this edition and enhances incidentally the value and authenticity of both the Ms.
as the variants are negligible. It is denoted by the letter "O" for Oxford or "|" and the variants are given accordingly in the footnotes to the printed edition.

II. [Arabe 6840] Bibliothèque Nationale Paris, France, dated 501 A.H. /1108, A.D., is the second oldest known Ms. recently acquired by authorities. This Ms. was kindly shown to me by Prof. Georges Vajda, Cataloguer of the recent acquisitions as one of the priceless possessions of the Bibliothèque Nationale, and is a complete copy of the text, perhaps the oldest complete dated text known so far. It bears the title in ornamental Kufic letters on f 3 a on the frontispiece and several important endorsements on the fly-leaf showing the authenticity and preciousness of this copy.

The scribe is Abu Ghālib b. abi‘alī who transcribed it in Iṣfahān at the end of Ramazan 501 a.H. Apart from endorsements of other owners, this Ms. has been in possession of the Astronomer-Royal of Bābu‘l-‘alī, Muḥammad known as Munajjimak the little-astronomer.

This is a historical Ms. bears several seals and endorsements of Royal Libraries, one in Yamanite handwriting, recording that this Ms. belonged to ‘Abdu‘llah b. Amīru‘l Muminīn al-Manṣūr-bill‘ah-i-Rabbi-‘Alamin‘Alī b. Amīri‘l Mu‘minīn al-Mahdī al-‘Abbās, dated 4th Muharram 1226 A.H. It contains 204 Folios; its size is 38 x 27 cm; 36 lines per page; cursive Naskh, but very clearly and carefully written; rubrications; tables and diagrams neatly drawn. All headings in Kufic ornaments. The chief feature of this Ms. is that it closely resembles with the oldest copies and probably belongs to the same family, and corresponds
materially with the printed text. This again enhances the value of the printed edition and leads to the standardisation of the text and adds to its authenicity. It has cursorily been mentioned by Prof. Vajda in his List, but has not been catalogued and is not known to scholars at all. It is denoted by the letter "F" for France or ف.

III. [Jarullah 1498] Millat Library, Istanbul dated 531 A.H./1136 A.D. is the Third complete important, correct vocalised and dated Ms. of the Qānūn. It was especially prepared for the library of a noble or ruler entitled Maknu'd-Dawlatān Abī 'Alī Ahmad b. Ismāʿīl whose native place or kingdom is not recorded. It is no doubt transcribed by an anonymous scholar in round bold cursive but legible clear Naskh with archaic script. It contains 401 folios; 20 lines per page, rubrications, tables and diagrams very carefully drawn and the text is highly vocalised and offers finest readings.

It has been extensively utilised by Dr. Max Krause for collation and variants. In fact this may be considered as a second base for our printed text, and has been the prized possession of several astronomers and bibliophiles in the past ages, one of them being Abu'l-Ḥasan 'Alī b. Muḥammad ash-shahrābādī in 639 A.H. It is a unique phenomena in the history of editing of such a highly technical text, that the Daira has been fortunate in utilising the oldest and the most correct Mss. of the work known to the world as yet. This positively adds to the authenticity of the printed text of this work. This Ms. is denoted by the letter "J" for Jarullah, or چ in the foot-notes to the text. It has not been catalogued as yet, hence its descrip-
tion is given here for the first time.

IV. [Veliuddin 2277] Bayazid Library, Istanbul, the base of our text. The scribe of this Ms. has left out the year of transcript in the Colophon on f. 313 b; but after mentioning his own name as Abū Ya'ālā Muḥammad b. al-Ḥusayn bin Fāṭik? or Qāṭik? (without dots) al-Qāshānī or Kāshānī has recorded: “Wednesday 14th Ramazān” as the date of transcript without giving the year. This according to calculation coincides with one of these years, 487, 495, 503, 511, 519, 527 and 535 A.H. There is an endorsement of an owner on the fly-leaf dated 536 A.H., so then, this Ms. according to the indications of the character of the hand-writing and antiquity appears to have been written much earlier than that 536, probably in the beginning of the 6th century, about 503 A.H. or so. This is practically the fourth dated Ms. of the Ḍānūn that has been utilised for our edition of the text.

This Ms. has been selected rightly as the base of the transcript by Dr. Max Krause and variants have been recorded from the other three Mss. utilised by him as mentioned above on pp. 10-11. As regards the accuracy of the text and the variants it gives with the other six Mss., it may be said that it offers a very reliable text and the tables and diagrams are also neatly and carefully drawn, although figures in the tables of almost of all Mss. differ slightly. Again this Ms. probably belong to a cognate family. Every attempt at standardisation of the text has been made and intelligent readings from all the above Mss. have been given in the foot-notes to our printed edition. These show the extent to which attempt
has been made to standardize the text, particularly the variation of figures in the tables has been a very difficult feature. While retaining or admitting Veliuddin Ms. as a basic-text, minor variants have been noted in the foot-notes.

This Ms. contains 313 folios of 23 lines per page. It is in broken Nashk and is vocalised in parts and written on Kān-Bālīgh paper with bronze coloured ink. Frontispiece and Unvans of chapters are in ornamental Kufic characters with endorsements of various important owners:

(1) An owner whose name is obliterated and who perhaps purchased the Ms. in Baghdad in 536 A.H.

(2) Muḥammad b. Muḥammad at-Turbati? temporary resident of the Great Mosque at Damascus, dated 774 A.H.

(3) Another endorsement of Muhammad b. Ahmad al-Khaṭīb, an inheritor of the book, dated 823 A.H.

Then it was acquired by Shaikhu’l-Islām Veliu’d-Din for his own Library, as it bears his seal and autograph signature. It is now preserved in the Bayazid Library, Istanbul and is one of the most valuable Mss. of the Qanūn existing in the world. It is denoted by the letter “V” for Veliuddin or in the foot-notes.

V. [Orient Quart 1213,] now in the University Library Tubingen, Ex. Preussische Staatsbibliothek, Berlin, bearing old acc. No. 213, acquired by that Library in 1927, is the fifth almost complete Ms. dated 562 A.H. /1166 A.D. which once belonged to the Imperial Library, Calcutta, now the Indian National Library, Belvedere, Calcutta,
The identity of this Ms. can be easily ascertained from the internal evidence found in the Ms. and from the external features described by persons who have used it in Aligarh. The date of colophon i.e. Rabi 'II, 562 A.H. = February 1167 A.D. is a conclusive proof, as there is no other Ms. of this work known to scholars so far bearing this date. The description given by Mr. S. H. Barani in his article on "Muslim Researches in Geodesy" in the Al-Biruni Commemoration Volume on page 19 also confirms this fact.

This Ms. is transcribed carefully by Abu'l-Fath Nasr b. Muhammed b. Hibatu'llah b. Mansur, an Iranian scribe who mentions the date of transcript in two places: on folio 120 b at the end of the first-half of the text and also on f. 239 b in the colophon, where he gives the corresponding Iranian date, month and era: Isfandar Mudh 565 A.H. Shamsi.

This is a historical Ms. as it contains several endorsements of great owners, the earlier ones being erased purposely. On the fly-leaf, underneath the title, in Kufic gold letters in a quadrangular space of 4" x 3" with gold borders and rubrication, the history of the entry of this Ms. into the library of a high Iranian revenue official is recorded. The owner mentions his name as Awhad b. As'ad b. Bahrám al-Mustawfi al-Baihaqi who takes great pride in possessing this unique manuscript and calls it a "precious diadem with which he has been crowned in the month of Shabdan 818 A.H."/October 1415 A.D.

It appears that this Ms. had been transferred in the earlier days from Iran and other countries to India and entered into the Library of the Mughal Emperors, as is
borne by the circular seal of "Fāzil Khān, the servant of the Emperor Shāhjahān dated 1059 A.H."/1649 A.D. Since then, it had remained in India as a prized possession of the Mughal Emperors in their special archives and later belonged to the Imperial Library, Calcutta. Thence lent to the Lytton Library, Muslim University, Aligarh from where it was stolen and taken to State Library, Berlin, about 1927. After the Second World War, this Ms. along with others has been deposited in the custody of Tubingen University Library. In 1951 the Chief-editor had the good fortune of examining it thoroughly for the first time, and to acquire its photostats and check it again with the transcript of Dr. Max Krause, before finally editing the text and printing it at the Dāira.

The frontispiece and title of the work are in Kūfic ornamental letters, in gold and rubrications. It contains 239 folios of large folio size, 33 lines per page, written on brownish Khan-Baligh paper, in beautiful Naskh, vocalised in parts, in tan-coloured ink still bright and legible. The tables and diagrams have also been carefully drawn and the whole text is excellently preserved, except for a few folios 121-130 which have been replaced in a later hand to complete the missing folios of the original transcript. The Ms. appears to have been collated with another original copy by the scribe himself. Hence the authenticity of the text is all the more confirmed. It has not been catalogued any where as yet.

After the author's "Introduction" to the book comes the list of contents of the 11 Maqālas, then the actual text. At the end of each Maqāla, a short colophon is given by the scribe, showing the progress of his transcription till he reaches the end of 11th Maqāla or the end of the book.
This Ms. stands fifth in the chronological order of our survey, and has proved very valuable during our collation of the text and for verification of Max Krause’s transcript. For the sake of reference, we have denoted it with the letter B Berlin and ٧ in our edition and footnotes.

VI. Or. 1997, British Museum, bearing Sir Henry Miers Elliot’s Library seal and number 440, is also a de-luxe Codex which once belonged to the Mughal Emperors, ‘Ālamgīr and Farrukh-Siyar. It contains the seals of several officials of the Mughal Emperors, inspection notes and Imperial endorsements, one of them bears the date: 25 Urdu-bihist 1064 Faṣlī. So then this Ms. may have entered into the Royal Library in the days of the Emperor Shāh-jahān (ruled 1621-58 A.D).

This Ms. has been described in full detail by Rieu in his Supplement to the Catalogue of the Arabic Mss. in the British Museum, No. 756. on p. 513. It is a complete text, transcribed at Baghdad in 570 A.H./1174 A.D. i.e., eight years after the copying of the previous Ms. (No.V) described above. It has been collated carefully in 571 A.H./1175 A.D. Hence it is the Sixth dated Manuscript of this work that is known to exist in the world. It contains 262 folios. Its size is 13½” × 9” red morocco leather-binding with gold medallions in the centre and sides; 31 lines per page of 7” long, on brownish Khan-Baligh paper, in bold Naskh semi-cursive, but very legible style dark tan ink, partly or sparing vocalised, sometimes without dots, but in a masterly hand with scholarly mannerism of writing e.g the projection of the letter Alif to the bottom to give it a tail shape. This Ms. has been designated by us as “L” for London, and ٧ in our foot-notes.
VII. Miqāt 866, Dāru’l-Kutubu’l-Miṣriyyah, Cairo, is the Seventh dated de-luxe copy of the work written evidently for a great Eastern potentate whose name has purposely been obliterated, but from the date and other indications, it is obvious that it has been prepared for the treasury of one of the rulers of Ḩisn Kīfa and ‘Āmid during the rule of the Ayyūbids in Sinjar and Naṣībīn. It once belonged to the Ṭalʿat Pasha Library and has since been transferred in 1918 to the National Library of Egypt, where the Chief-editor had the good fortune of examining it in detail and adding it to the list of manuscripts utilised by him during the preparation of the monumental edition of the Qānūn-i-Masʿūdī.

It is transcribed by one astronomer-calligrapher Muḥammad bin Masʿūd as-Sinjārī al-Munajjim in Jumada II 673 A.H./ December 1274 A.D., sixteen years after the fall the ‘Abbasid Caliphate. It contains 268 folios, its size is 11" x 14 1/2", 19 lines per page, written in beautiful bold Naskh with rubrications golden frontispiece and highly decorated semi-kufic headings and titles, and profusely vocalised. The tables and diagrams have also been carefully and neatly drawn and preserved. The Chief-editor has availed this Ms. through the kindness of the authorities of the Egyptian National Library, Cairo in 1951 during his second visit to Egypt.

This is the Seventh dated Ms. of this work existing in the world. It is designated as M Misr and ♦ in our edition and foot-notes.

Thus seven de-luxe royal copies transcribed by famous scribes have been utilised in the standardisation of this text.

* * * * *
THE PLACE OF THE QĀNŪN-I-MASʿŪDI IN THE HISTORY OF SCIENCE

The second half of the eleventh century A.D. is highly significant in the history of mankind as period of great intellectual activity in Persia. Amidst this flowering of the Persian genius the achievements of Abū Raiḥān Muḥammad ibn Aḥmad al-Bīrūnī (973–1048 A.D.) bear witness to a profound erudition and a generous humanity. The spirit of this age may be said to dwell in the critical al-Bīrūnī, the philosophical Ibn Sīnā, and the poet Firdausī; whilst of the first-named Professor Sarton has written:

"Traveller, philosopher, mathematician, astronomer, geographer, encyclopaedist. One of the very greatest scientists of Islam, and all considered, one of the greatest of all times. His critical spirit, toleration, love of truth, and intellectual courage were almost without parallel in medieval times".

Born in Khwārazm in 362 A.H. our celebrated author passed his adult life first at the courts of Qābūs b. Wasmagir, Prince of Jurjān, and of Abuʾl-ʿAbbās Maʾmūn b. Maʾmūn; but soon after the assassination of the latter in 407 A.H. 1016 A.D. he went to Ghaznah, where he came under the patronage of the Ghaznavi Sultans Maḥmud

and Mas'ūd. It was during their invasions of India that al-Bīrūnī was able by accompanying them to gain at first hand his deep understanding of Hindu thought. He died at Ghaznah on 2nd Rajab, 440 A.H. (1048 A.D.).

Amongst the many important writings of al-Bīrūnī are al-Qānūn u'l-Mas'ūdī, the subject of the present notice, and three others which inevitably enter into our discussion of it, namely, al-Kitāb al-Athār al-Bāqiyya (Vestiges of the Past, or Chronology of Ancient Nations), Tā'rikh al-Hind (History of India,) C. 1030 A.D. and al-Tafhīm li-Awā'il Sīnā' ati'l-Tanjīm.

Al-Qānūn u'l-Mas'ūdī is a lengthy and important encyclopaedia of astronomy dedicated to the Sultan Mas'ūd. The preface relates how Mas'ūd overcame his opponents in the struggle for succession, and the work itself consists of eleven books, subdivided into chapters which are still further sectionized. It was written in Ghaznah between 421 A.H., when Mas'ūd came to power, and 427 A.H., when it appears in the list of completed works set down by the author himself. After the stormy reign of Maḥmūd, al-Bīrūnī was sincerely thankful to be able to settle quietly to the writing of what is probably his greatest work, for Mas'ūd, despite his other failings, gave the astronomer-astrologer the much-needed respite from material cares. There is no doubt that al-Bīrūnī had an uneasy time during the reign of Mahmūd and had little to admire this sovereign, for he says of this period, ".... it is quite impossible that a new science or any new kind of research should arise in our days. What we have of sciences is nothing but the scanty remains of
bygone better times;" (1) but in the preface to al-Qānūn u'l-Mas'ūdī where high-sounding phrases extol the virtues of the new ruler, a feeling of gratitude permeates his words—" Is it not he who has enabled me for the rest of my life to devote myself entirely to the service of science, . . . . . . ."

The eleven books of this encyclopaedia deal respectively with fundamental definitions, calendars of different races, properties of the circle, the mathematical astronomy of the sun and constellations and its use in the study of night and day and of the latitudes of cities, the further mathematical treatment of latitude and longitude, motion of the sun in the zodiac, motion of the moon, eclipses of the sun and moon, the fixed stars, the motions of the five planets in their spheres, and finally, motion of a planet in the zodiac and its astrological significance. Embracing as it does the whole field of observational astronomy and the measurement of time, together with the mathematics of the Ptolemaic system, a work of these dimensions cannot be discussed fully within a short space for it raises many interesting questions, but it is hoped in this notice to indicate its main features and to emphasize its significant place in the history of science.

To realise the personal background of the author in this connection is important. He had studied and mastered both Greek and Hindu astronomy, though after he had returned and settled in Ghaznah he does not seem to have made any progress beyond what his Indian

travels had taught him; indeed, as with most Islamic astronomers, he shows overwhelming support for Greek methods, preferring the lucid deductive argument and the geometrical representation. Of critical independent outlook, he did not merely follow tradition in this, being in fact anti-Arab in disposition and for his times, extremely tolerant of the intellectual outlook of other nations. It was simply that he preferred the directness of Greek methods to the subtler analytical ideas of the Hindus, which usually had philosophical and religious implications. Thus we find his work lucid and orderly, with each section usually divided into three parts—a short general introduction, a statement of the problem under discussion, and an elaboration of his own. In this last he attempts to get a better understanding and to arrive at a conclusion, often by comparison with Greek and Hindu evidence on the subject. He uses the manuscripts of earlier writers with the utmost discretion, exposing errors of both authors and scribes. We find a special regard for the astronomical investigations of Ptolemy. As for al-Bīrūnī’s knowledge of the geometry of the sphere, whilst it reveals a thorough acquaintance with the Greek contribution, it is in no way a complete anticipation of the great treatise on spherical trigonometry which was to appear some two hundred years later from the hand of Naṣir al-Dīn at-Ṭūsī. Finally, one should not ignore the medieval mind in al-Bīrūnī when praising the objectivity of his outlook in regard to scientific problems. He undertook a lengthy study of Hindu and Greek astrology, being especially influenced by the latter, and undoubtedly
made the customary assumption of the influence of the planets and the zodiacal signs upon the destinies of men. An Arabic translation with commentary of Plato's *Timaeos* found an honoured place in his library.

In the introductory Book al-Bīrūnī deals with the nature of the universe and with the system of planetary spheres, the division of night and day and of the year into months and days by different races, and the solar and Lunar years. These general conceptions are essentially those of Ptolemy. However, on the possibility of a motion of translation of the earth, al-Bīrūnī's objective outlook, with its realization of the relativity of astronomical motions, seems to have led him to a position of reserve, for in the *Ta'rikh al-Hind* there are to be found these words:-

"Besides, the rotation of the earth does in no way impair the value of astronomy, as all appearances of an astronomical character can quite as well be explained according to this theory as to the other [with the earth immovable]. There are, however, other reasons which make it impossible. This question is most difficult to solve. The most prominent of both modern and ancient astronomers have deeply studied the question of the moving of the earth, and tried to refute it. We, too, have composed a book on the subject called *Miftāh 'Ilm-al-Hai'a* (Key to the Science of Astronomy), in which we think we have surpassed our predecessors, if not in the words, at all events in the matter."

Calendaric problems occupy the whole of the second book. Following upon his earlier reference to the practices

(1) *Ibid* 1, 267-277. This requires further research.
of the Arabs, Jews, Hindus, Romans, Nestorians, Copts Persians, and Sogdians in respect of the division of the year, al-Birūnī now deals in detail with the three systems of chronology adopted by Muslims, Greeks, and Persians, their similarities and the conversion of dates between them, obscurities and errors, and the comparison of these three with Hindu chronology. Next the periods of fasting and the great days of the feasts are considered in respect of Judaism, Christianity, Islam, and the ancient Persian religion. Finally, a chronological survey is made through Chaldaean, Assyrian, Babylonian, Medean, Persian, Alexandrian, Ptolemaic, Roman and Byzantine times to Muhammad, *al-hi jra*, and the Caliphs. This work is similar to that in *al-Kitāb al-Athār*, and on the question of Hindu eras it reveals no progress beyond what is also mentioned in *Ta'rikh al-Hind*. In fact, al-Birūnī mixes up the era of the astronomers, as in the *Khandakhādyka* of Brahma-gupta, with the Guptakāla.

Book three is of an entirely different character. It provides the fundamental plane geometry and trigonometry required for subsequent chapters and deals principally with the reckoning of angles. Its importance rests in (1) the use of the sine and (2) the trigonometrical treatment of the shadow of the gnomon. There is also an interesting reference to terminology in which al-Birūnī says that the word *zījāt* (tables) derives from *al-ziq* (the measure of a chord), which may be traced to a Persian word which he writes *saj*, again, *jīvabā* (half-chord) is called in India *jībārd*, but since the half-chord is widely used there instead of the chord, it has taken the name of
the whole chord \((jiba)\). The main treatment is that of the sides of circumscribed polygons, al-Bīrūnī establishing these sides as the fundamental units from which other chords might be evaluated; thus, he derived the chord of a particular arc in the case where the chord of the supplementary arc is known; the chord of the double arc given the chord of the single arc and vice versa; so, by a process of halving, the chord of the quarter arc, etc.; also, the chord corresponding to the sum and difference of two known arcs. This investigation was extended to include the determination of the chord of \(1^0\), the properties of the nonagon, and the relation between the circumference and diameter of the circle by successive approximation. al-Bīrūnī’s value of \(\pi\) was slightly greater than the accepted 3.1466 from Greek and Hindu sources. Superseding now the Greek method of reckoning by chords, al-Bīrūnī calculated the sine \((al-jaib)\) of an angle from the corresponding arc, and vice versa, and treated similarly the sinus versus \((jaib mankūs)\); his sine table was based on intervals of \(15^1\) whereas that of the Surya Siddhānta had been in intervals of \(3^045^1\). An important application of plane trigonometry to the gnomon (miqyās) enabled al-Bīrūnī to measure the shadow in terms of the length of the gnomon, to define the tangent and co-tangent and angular elevation, and to investigate elevation by movement of shadow. Tables of shadows \((Zill-i-ma‘kūs)\), corresponding to tangent tables, could then be constructed. Such tables are to be found later in the Zīj-i-Ilkhānī of Nāṣir al-Dīn al-Ṭūsī and the Samarqand Tables, Zīj-i-Ulugh Beg. The basic relationships for the horizontal
and vertical shadows, \( m \) and \( n \), cast by a gnomon of length \( q \) are given as

\[
\begin{align*}
m &= q \cot h, \\
n &= q \tan h,
\end{align*}
\]

where \( h \) is the angle of elevation, or (when the shadow is along the mid-day line) the meridian height, of the sun.

This next book IV is a long treatise of 26 sections in which (1) this basic theory of the gnomon is fully elaborated and applied by al-Bīrūnī and in which (2) trigonometrical relationships are developed for the sphere. Thus problems of geographical latitude are particularly prominent since they involve both (1) and (2). By considering a meridian section of the celestial sphere in which the horizon, zenith, celestial equator, and N pole of the heavens are shewn, al-Bīrūnī was able, through the maximum and minimum heights, \( h_1 \) and \( h_2 \), of the path of a circumpolar star around the celestial axis (or through the “Zenith heights” of the Sun when in positions known with respect to certain constellations), to determine the latitude of the place of observation in the form

\[
\phi = \frac{h_1 + h_2}{2}
\]

This expression, written as \( \phi = h^1 \text{ Plus } 1/2 (h_2 - h_1) \), actually occurs as early as al-Battānī (c. 929 A.D.); and again, \( h_1 - 1/2 (h_1 - h_2) \) is to be found in the work entitled *On the Use of the Astrolabe* by ‘Alī ibn ‘Isa (Māhān), who flourished still earlier, c. 850 A.D. What is especially significant about al-Bīrūnī’s treatise in his interpretation of the implications of this equation and his good result \( (33^\circ 35' \) for the latitude of Ghaznah. A table of meridian heights
of the sun as observed from Ghaznah was also compiled; a similar one had been recorded for Baghdad by Ḥabash al-Ḥāsib (c. 870). If the sun's latitude reckoned from Aries is \( \text{Lambda} \), and in relation to Cancer is \( \text{Lambda} - 90^\circ \), the corresponding sun's declination is \( \text{Delta} \), and the obliquity of the ecliptic is \( \text{Epsilon} \), then

\[
\sin \text{ Delta} = - \sin \text{ Epsilon} \cdot \sin \text{ Lambda}
\]

Also since \( \text{Delta} \) and \( h \) are related by the equation

\[
h = 90^\circ - \phi + \text{Delta}
\]

the approximate meridian height \( h \) for any day may be calculated and compared with the direct measurement made by quadrant or octant. In addition, al-Bīrūnī discussed in this fourth book the nature of the obliquity of the ecliptic, and the method suggested by Muḥammad ibn Ṣabbāh for its determination in which the assumption of the sun's passage through equal distances in equal times al-Bīrūnī shows to be false. He also describes the principal types of alidade, and here he reveals his dependence upon Ptolemy.

In book V al-Bīrūnī extends his mathematical discussion to the problems of longitude. He writes especially of the longitudes of cities in terms of the distances between them and in relation to the occurrence of solar eclipses, and effects trigonometrical calculations such as the determination of the distance between two cities of known longitude and latitude. There is also an important chapter on the direction of the qibla. In concluding this book, the author deals with tables of latitude and longitude for the location of cities on the earth, and describes the regions of the spherical universe as a whole in terms of these two
conceptions.

The earlier part of Book VI deals with the latitude of Ghaznah, and of Alexandria according to Hipparchus; whilst there is a discourse on intersecting orbits with reference to the zodiac. Later, this discourse leads on to a study of the orbit of the sun. Ptolemy in Almagest Book III, had explained the excentric and epicyclic theories, the epoch and mean path of the sun the anomaly of the sun (with a table), solar days and the solar year. This investigation had been well conducted by Ptolemy, and we find that al-Bīrūnī has closely followed him.

Motion of the moon is the subject which occupies almost the whole of the next Book. Here the author deals with the path of the moon in the zodiac, its phases, the discrepancies between its observed and calculated positions, and the first and second anomalies. Again, the elaborate treatment of Ptolemy in Books IV and V of Almagest, in which he not only applies corrections to the moon's motion for longitude and anomaly, latitude and epoch, but compiles a table for the complete double anomaly, and adds further chapters on parallax and on the moon in syzygy:—this is indeed so full that al-Bīrūnī could hardly hope, whilst retaining a geocentric system of the universe, to give a better account.

Following once more the general plan of Ptolemy's Book VI, al-Bīrūnī proceeds in his own Book VIII to deal fully with the characteristics of lunar and solar eclipses both from the standpoint of orbital motion and the optical questions of light intensity and shadow. He discusses the limiting conditions beyond which eclipses
cannot occur, deduces the diameters of luminous and illuminated bodies and of the shadows of the latter, and has several chapters devoted to such subject as the times of rising and setting, twilight, the "mansions" of the moon, and the lunar calendar.

The last three Books of al-Qānūn u'l-Masʿūdī are concerned almost entirely with the motions of the spheres of the five known planets, their rising and setting, periods and conjunctions, and their positions with respect to the "mansions" of the moon according to the Arabs and Hindus; and especially with the way in which Ptolemy accounted for their motions in the final five Books (IX-XIII) of Almagest. al-Bīrūnī, with his leanings towards astrology, was clearly interested in knowing the time of arrival of a particular planet at a given position in the zodiac; so we find him, in sections 7 and 8 of his last Book, writing about the fortunes of children in terms of the years and months and days of their birth. Owing to the tremendous influence and the extensive mathematical investigation of Ptolemy's planetary theory it is worth re-stating some of those major features which could scarcely fail to determine al-Bīrūnī's approach. In Almagest Book IX, the Greek astronomer, after setting up tables for the mean path of the five planets in longitude and anomaly, discussed the orbit of Mercury, proved that whilst in its circular path the planet could twice attain its greatest elongation, and calculated the numerical values for the epicycle of the planet. A similar treatment followed in Book X for the apogee, epicycle, period, and excentricity of the planets Venus and Mars:— a compli-
cated mathematical section using Euclid, VI, and ending with tables of anomalies for the five planets and the calculation of their longitudes. Jupiter and Saturn were investigated, with tables of anomalies, in Book XI. General planetary theory, an attempt to account for the apparent irregularities of motion, based largely upon the pure geometry of circles and chords (Euclid III, VI), occupies the whole of the last two Books. Ptolemy investigates the extent of recession, or slowing down in a part of the orbit, for each planet in turn also the greatest elongation of Mercury and Venus, obliquity conditions and the path in latitude, and helical rising and setting. Difficulties which could only be met by more corrections and an increase in the number of circles, as in Ptolemy's general theory, are the result of the adherence to a geocentric theory and reveal at once both the ingenuity and the limitation of the Greek mathematical mind.

In conclusion, we summarise briefly the real significance of *al-Qānūn u'l-Masʿūdī*. Encyclopaedic in character, it is representative of those great medieval treatises, written by such scholars as al-Bīrūnī and Ibn Sīnā, which by the power of synthesis and zeal for completeness in their authors, remain for historians of science a mirror of all the knowledge of their day. In the nature of their vastness, compilation overshadows originality, and one has to search, as in *al-Qānūn u'l-Masʿūdī*, amongst the accumu-lated achievements of past generations and earlier races to find whether the author has himself contributed any new knowledge. With al-Bīrūnī the debt to Ptolemy, and in turn Hipparchus, within the field of general planetary
theory is almost complete. But in other directions, as for instance, in the manner of recording astronomical data, in certain problems of spherical trigonometry, and in the knowledge of the calendars of the ancient peoples of the East, he advances the cause of science. It is true that sines occur as early as c. 1007 in the Hakemite Tables of Ibn Yūnus, but al-Bīrūnī, with his unique knowledge of Hindu sources, both explained their value and extended their use. Though the scope of his work relating to the sphere is not comparable with that in the treatise *Shakl u'l-qatta* of Nāṣir al-Dīn at-Ṭūsī, it is by no means insignificant, for he exhibits versatility in his application of the sine relationship for spherical triangles. Moreover, he was able to use the method of orthographic projection. As for chronology, al-Bīrūnī's *al-Āthāru'l-Bāqiya* (c.1000 A.D., 390/1 A.H.), with all its technical and historical detail of the various methods for computation of time, is a primary source; and since *al-Qānūn u'l-Mas'ūdī* draws upon it in certain respect we must attach considerable importance also to the latter. Al-Bīrūnī is always liable to introduce some new fact. Thus his list of names of the months of the Sogdians is the scanty remnant of a lost Iranian dialect and therefore of considerable interest to philologists. Upon the author’s accuracy we can generally rely. In spite of occasional lapses, e.g. in the interpretation of experimental results or in poorness of expression, he had great faith in his own instruments and methods. and originality was seldom lacking.

---

We end with a quotation from E. Sachau’s preface to the English edition of *Ta’rikh u’l-Hind* published in 1910:

“As far as the present state of research allows one to judge, the work of Albiruni has not been continued. In astronomy he seems by his *Canon Masudicus* to represent the height, and at the same time the end, of the independent development of this science among the Arabs. But numerous scholars toiled on in his wake, whilst in the study of India, and for the translation of the standard works of Sanskrit literature, he never had a successor before the days of the Emperor Akbar.”

Whilst joining Sachau in his general commendation of the eminent medieval scholar, we have to modify somewhat his opinion regarding al-Bīrūnī’s achievements in astronomy, without however detracting appreciably from the high excellence of al-Bīrūnī’s learning as a whole.

Dated 9th January 1956,

University of Exeter. 

England

H.J.J. WINTER

AL-BİRŪNĪ AND HIS MAGNUM OPUS
Al-QANŪN UʼL-MAS′UDĪ

وَلِلهِ اسْتَلِيَ ان يَوْفِقَ لِلصَّوابِ وَيَعِينَ عَلَى دِرَكِ الْحَقِّ،
وَيَسَهَّلُ سَبِيلِهِ وَيَنِيرُ طَرِيقِهِ، وَيُرَفِّعُ الْمِوَانِعَ عَن نَّيلِ الْمَطَالِبِ المُحْمُودَةِ.
بِمَثْنِهِ وَسَعَةِ جَوْدَهُ، اٰنَّهُ عَلَى مَا يَشَاءُ قَدِيرٌ.
(كتاب التحديد ص ۴۵)

“And I pray for God’s favour and spacious bounty
to make me fit for adopting the right course and help
me in perceiving and realizing the truth, and facilitate its
pursuit and enlighten its courses, and remove all impedi-
ments in achieving noble objects. He is all powerful to do
as He pleases.”

(From the autograph Ms. dated A.H. 416,
of al-Birūnī’s Kitābu’t-Taḥdid p. 45)

فَاتَى لَا أَيْنَ قَبْلِ الحَقِّ مِنِّي عَبَدٌ وَجَدَتِهِ
(كتاب التحديد ص ۱۴)

“I do not scorn to accept truth from whatever
source I can find it.” (Idem p. 104)
THE MILIEU

A very early tradition tells us that when al-Bīrūnī dedicated his magnum opus to Sulṭān Masʿūd of Ghaznavah, after whom the work is named, the Sulṭān in his turn rewarded him with a camel’s load of silver, but the savant thankfully returned it, saying that he did not need the money, nor loved money for its own sake. Truly no amount of riches could match the wealth of knowledge that this really great work contains. With the publication of al-Qānūnu’l-Masʿūdī, the historians of astronomy would, as never before, be in a position to appreciate the actual achievements of the Muslim astronomers, as well as al-Bīrūnī’s theoretical and practical contributions to his favourite subject.

His times, talents and experience were all perfectly suited for the work in which he undertook to render a complete and up-to-date account of astronomy, when it had reached its climax amongst the Muslims.

He had, at his disposal, about half a century’s incessant personal labours as well as more than two centuries of continuous labours of other Muslim astronomers. In the Preface to this book, he says that from the very outset he had devoted himself exclusively to this department of knowledge, and did not count his achievement in so many other fields of learning, almost encyclopaedic in its range. For no other scholar ever before or after him has combined the study of all that was available in his times from the Indian, Greek and Muslim sources and at the same time left behind him so many original contributions of his own in numerous spheres of learning.
This is hardly the place to give a fuller account of all his achievements. Something to that effect has already been attempted by the present writer in his Life of al-Bīrūnī and some other writings including a lecture on “al-Bīrūnī’s Scientific Achievements” delivered in 1952 in the Iran Society of Calcutta. Here I would like to confine myself to a brief account of al-Bīrūnī’s life and contributions in relation to the work in hand.

Like all great men al-Bīrūnī was a product of his age and his greatness lies in his being much ahead of his own times. His age was particularly marked for its keen interest in astronomy. Its history, of which, at present, we have some glimpses only, has got to be written completely.

That history goes back to the beginning of the ‘Abbāsid Caliphate in the first half of the second century of the Hijrah and received its greatest impetus at the hands of the most enlightened Muslim sovereign, al-Ma’mūn. The Muslims started with some translations of the Indian and Persian works on astronomy and then with the translations of the Greek astronomers, including Ptolemy, whose magnum opus Syntaxis, better known as Al-Magest, occupied a special position in their minds. Most of those translations and original works of al-Ma’mūn’s times are lost. We know what happened to the scores of books in Baghdad at the hands of the Mongol hordes of Hūlākū, and much of what was left, was eventually destroyed later by the ravages of time and subsequent wars in the Muslim countries. Some glimpses of these we have in the works of authors like al-Bīrūnī. A searching study
would reveal a very fascinating story of the achievements of al-Ma’mūn’s scientists, particularly the astronomers of the age. We know that he had set up at least two well-equipped centres for astronomical observations and researches in Baghdad and Damascus under a band of distinguished astronomers. He had almost a passion for this science and sought verifications and necessary corrections on every particular point. Let us take one instance. He wanted to ascertain the actual dimensions of the earth and got a single degree measured more than once at several places. But his insatiable zeal for research is vividly illustrated by a curious anecdote mentioned in an unpublished work of al-Bīrūnī, where he relates that towards the end of his life in the course of his invasion of the Byzantine territory, while al-Ma’mūn happened to pass by a mountain adjacent to the sea, he ordered one of his astronomers, Sind b. ‘Alī, to ascertain the earth’s dimensions by a trignometrical method, which was later successfully repeated by al-Bīrūnī at Nandna in India. A glance at the chapter of this book dealing with the Obliquity of the Ecliptic (الميل الأعظم) will be sufficient to show that a large number of independent observations, as against a couple only of the times of Greek astronomers, were carried out in the lands of the Eastern Caliphate to verify the actual degree. al-Bīrūnī himself carried out at least three of his own, two in his homeland and the last at Ghaznah.

The Muslim astronomers tried to reinvestigate almost the entire field of astronomy and, it appears, specially directed their attention to those parts where differences
of observations or opinions existed. As we proceed further al-Bīrūnī’s efforts in this direction by carrying out his own independent researches on such points will be noticed markedly.

The fourth and fifth centuries of the Hijrah (X & XI centuries of the Christian era) were marked by conflicting political divisions in the Muslim world. The cultural contacts, however, did not altogether cease amongst the various parts and what was written in one part was often after a short while available in the other parts, except perhaps the extreme East or the West. From al-Bīrūnī’s books it appears that he was not cognizant of the researches in the Fatimid land of Egypt, and the Umayyad land of Spain. No references to his contemporaries, Ibn Yūnus and Ibnu’l-Haitham in Egypt, or Maslamah and Ibnu’l-Samḥ in Spain are found. By this time these countries had also improved in their scientific studies, but the Eastern lands had a much earlier start in this respect.

By reading al-Qānūnu’l-Mas‘ūdī one can have a glimpse of that spirit of scientific adventure that had been infused in these countries and the rivalry that existed amongst the several states. One finds, references to some of these distinguished astronomers and their chain of observations from the metropolis of the Eastern Caliphate, Baghdad, and the headquarters of the Buwaihids to semi-independent states at Isfahan, Hamdan and Raiy to Khwarazm and Ghaznah and other important places. al-Bīrūnī had a knowledge of the results achieved in all these centres in the East and kept himself in touch with the chief organisers of those establishments.
HIS LIFE

He was born in the forenoon of Thursday, the 3rd of Zilhijj, 362 A.H. (4th September, 973 A.D.) of an unknown family, in the outskirts of Kath, the old capital of Khwarazm, and most probably was left an orphan at a very early age. He was brought up and educated by Abū Naṣr Maṣṣūr b. ‘Alī b. ‘Irāq, a distinguished member of the ruling family of Khwarazm and a leading mathematician and astronomer of his time, who by oral and written instruction instilled in al-Bīrūnī an insatiable love for scientific studies. It was Abū Naṣr who put al-Bīrūnī in contact with the former’s own veteran teacher, the famous astronomer, Abu’l-Wafā al-Būzjānī, then living in Baghdad, for simultaneous observations of solar eclipses, for determining the longitudes in Khwarazm. In his unpublished “al-Tahdīd”, al-Bīrūnī says that he almost lost his eyesight by repeated solar observations in the observatory he had set up for himself in a small village near Kath. He began his literary career very early. His activity was unfortunately disturbed towards the end of 385 A.H. (995 A.D.) by the war between the two rival chiefs of his country, M’amūn of Jurjānia and Abū’ Abdillah Khwārazmshāh of Kath, resulting in the latter’s murder and the fall of his ancient dynasty. al-Bīrūnī did not stay there for long after the event and shortly after 387 A.H. (997 A.D.) left home in search of some suitable patron and for a time found one in Shamsu’l-Ma’ālī Qābūs b. Washmgīr, the Ziyārid ruler of the neighbouring country of Jurjān, and himself a distinguished poet, literateur and lover of learning, to whom al-Bīrūnī dedicated his first
major work *al-Āthāru'l-Bāqiyya*, which deals with the calendars and chronology of all the peoples known to him. Qābūs held al-Bīrūnī in very high esteem and desired him to share the ruling power. But al-Bīrūnī left Qābūs as he did not like his patron’s tyrannical nature. Previous to his visit to this court al-Bīrūnī had stayed for a short time in Raiy and met al-Khujandī, an eminent astronomer of those parts and the inventor of the sextant known as *sudsul-Fākhir*, for which al-Bīrūnī has expressed much admiration. Some time in 394 A.H. (1003-4 A.D.) he returned home at the invitation of ‘Alī b. Ma‘mūn who had succeeded his father in 388 A.H. (998 A.D.). Time had healed the old wounds and al Bīrūnī found in ‘Alī and his Vazir Abu’l-Ḥusain Muḥammad b. Aḥmad al-Suhaillī more humane and enlightened patrons at home, where later on, the third of the line, M‘amūn, proved to be a great lover of learning and in later days appears to have appointed al-Bīrūnī his Minister, till after that king’s murder by the rebels in the army and the fall of his short lived dynasty in 407 A.H. (1016 A.D.). Maḥmūd invaded and annexed Khwarazm in 408 A.H. (1017 A.D.). al-Bīrūnī set up an observatory in the royal palace and was particularly busy in those days in his studies in astronomical geography. This was probably the most unhappy moment in his life. Not only was his scientific work once again disturbed and his most loving patron dead, but he was also himself carried away by the conqueror to Ghaznawah and for a short period even kept as a political detainee in the fort of Nandna, where, however he was able to carry out his measurements of the Earth’s
dimensions. Next year we find him wandering in the vicinities of Kābul and Qandhār carrying out his researches for latitudes in those parts. He met Maḥmūd somewhere on the way, while the latter was returning after his famous expedition to Mathura and Qannauj and showed to al-Bīrūnī the unique precious stone weighing some 450 Mithqals taken from a temple in Mathura. al-Bīrūnī, who has described it in his al-Jamāhir was not much impressed by its quality and Maḥmūd discerning the fact immediately withdrew it from al-Bīrūnī’s view just to keep up the much exaggerated notions of its value in the people’s minds. This curious incident very well illustrates the relations that subsisted between these two great men. al-Bīrūnī was forgiven and allowed to continue his work and establish an observatory in Ghaznah. He was even consulted now and then on scientific matters, and probably highly valued as an astrologer, but he was never totally reconciled to his fate at that court.

In his "al-Tahdīd", an autograph Ms, or at least contemporaneous copy of which exists in Istanbul (dated 416 A.H. 1025 A.D.) , we find him most disconsolate, but not altogether despairing of resuming his scientific work which he had left incomplete at home and regaining all the materials including a hemisphere on which he had been marking all the longitudes and latitudes of the various places ascertained by his own exertions. Of the several works he wrote at Ghaznah, we have fortunately recovered two mathematical treatises Istikhrājul-Auliār and Ifrādu'īl-Miqāl written in 413 A.H. (1022 A.D.) , both published by the Dāiratu'īl-Maʿārif, like several other tracts connected with al-Bīrūnī.
But by far the most notable event of his life in those days was his study of Sanskrit and extensive researches on India, its people, literatures, and sciences, specially mathematicas and astronomy. Out of a number of his profound studies in this particular line, including a very exhaustive work dealing with Indian Astronomy, which are all lost, we are still left the most valuable Kitābu'l-Hind, the unique testimony of his arduous labours on India so well known throughout the world.

By his vast Indian studies the later generations were so much impressed that they believed that he had travelled in India for forty years. But after a long study of the subject, I am fully convinced that most of his studies were carried out in Ghaznah with the help of the Indian scholars living there. There is no doubt that he travelled in some parts of the Western Punjab up to Multan. But beyond that he never went and knew of Sindh, like other parts of India, only from the account of other people who had travelled in or, belonged to those regions.

How many years did he actually devote to these Indian studies? It may surprise many, but it is another proof of his great genius, that before writing his Indica he does not appear to have given more than four or five years of his time to these exacting Indian studies. But he never ceased to continue his work in this special field along with his other studies, for some five years after we still find him keen on finishing his books and translations on Indian subjects. What other books he was actually able to write on India even after this we do not know, for no records are available and such books, like so many.
others of his, are lost. We have his own list up to 427 A.H. (1035-36 A.D.), when he was already 65 but still full of zest for life and work in the future. He tells us that at the age of 60 he had fallen ill severely and recovered after much difficulty. No doubt all these Indian studies must have taxed him a great deal.

Something of his method in pursuing the Indian studies is mentioned in the *Indica*, but not very explicitly. Some references in other works throw further light on the subject. At first he relied entirely on the interpreters, whom he tried to check by sheer tact. Later on he made appreciable progress in testing them by the texts themselves. By this time he must have gained sufficient knowledge of Sanskrit for his purpose. Further on, he advanced far enough to translate by himself from Sanskrit into Arabic and vice-versa. But of this later stage we have not much left to form our final judgement. He had collected a whole library of Indian books from far and wide. It is a matter of great regret for us also that on account of political strife and warfare between his own people and the Indians, he was precluded from visiting the real centres of Indian learning like Benares and Kashmir.

What interest Mahmūd himself had in these studies is not quite clear? Evidently through al-Bīrūnī’s influence Mahmūd got some of his coins struck in Sanskrit legends. But al-Bīrūnī was never in sympathy with Mahmūd’s ways in India, and we do not know as yet of a single work which he dedicated to the conqueror. On the other hand a well known passage in the *Indica* actually speaks dis-
paragingly of his Indian exploits.

All this attitude of al-Bīrūnī changed with the great conqueror's death. The first thing he did was to take stock of all that he had learnt of India, while writing *Indica*.

With Mas'ūd's accession to the throne the atmosphere became distinctly favourable for al-Bīrūnī. We know there was not much love lost between the father and the son. In the last days Mas'ūd had been actually labouring under Maḥmūd's displeasure. Mas'ūd was temperamentally a very different man from his father. Never so much successful in the affairs of state, he was quite a learned person and an enlightened patron of the sciences.

In this very book we have al-Bīrūnī's own testimony that the Sultan was very good to him and it was only as a mark of sincere gratitude that he dedicated *al-Qānūn* to that ruler. From the internal evidences in the book, it appears that it was begun some time before 421 A.H. / 1030 A.D. and completed sometime after 427 A.H. / 1035 A.D.

**HIS SUBSEQUENT LIFE**

He wrote some other minor works for the Sultan, but during Mas'ūd's reign his main occupation must have been the completion of the *Qānūn*. It appears that as soon as he had finished it, he took up other works. For his successor Mawdūd, he wrote his famous "*al-Jamāhir*" on Gems and Precious Stones, which has also been published by the Dāira. This is reputed to be the best book written on the subject during the whole Muslim period. He wrote another book on Ethics for the same ruler. His best known work compiled after he was eighty, is a Medical
Treatise *Kitābu’s-Ṣaīdana* dealing with simple drugs, some extracts from which have been published by Prof. Zekî Valîdî Togân of Istanbul in the Memoirs of the Archaeological Survey of India. No. 53 pp. 108–142. An imperfect translation of this work was made in India in the times of Iltutmish, the slave-king of Delhi, and the late Dr. Meyerhof left an incomplete edition of it which is now lying in the Institute Francaise, Cairo.

We do not know the exact date of his death, but the traditional date, Friday, the 2nd. of Rajab, 440 A.H. (11th. Sept. 1048 A.D.), after he was seventy-seven, is altogether fictitious. Unfortunately we have no precise knowledge in regard to the last 15 or 16 years of his life. From a contemporary jurist we have a report showing al-Bīrūnī’s anxiety to learn something new even in the very throes of death.

In “*al-Tahdīd*”, al-Bīrūnī has remarked that a scholar should try to learn at least the basic principles of every science, even though it might not be impossible to master all the details of a science. He wanted everybody to be a philosopher *i.e.* a true lover of wisdom in the real sense of the word.

His method of study was to concentrate on one particular branch of science at one time and after exhausting all its contents to take up fresh studies, never losing sight of his main concern as a specialist while trying to make his own, what ever else he chose to deal with. Thus every book that he has written bears the distinct impress of his genius and in every science that he has undertaken to deal, he has left original contributions of his own. What a vast range of studies he commanded and
what a balanced and mature mental critique he had developed, is not easy to imagine. He is a most independent scholar and no respec tor of personalities where truth is concerned. He was always very critical of Aristotle's scientific theories, and no less of Ptolemy's and pointed out boldly wherever he found that they had swerved from the right path. Thus al-Qānūn bears ample testimony to his independence of judgement.

As soon as we open the book, we find him disputing and censuring some of Ptolemy's arguments in support of the very first propositions of this science. And if he accepts the rotundity of the Earth or the Heavens it is not for the reasons given by Ptolemy, which he rejects one after another, as being mere assumptions of an unscientific nature. Ptolemy thought that the sun and the moon and other heavenly bodies were of divine nature uncreated, everlasting, incorruptible and spherical in form and moving in circles, as the sphere and the circle were the most perfect form and more becoming for those bodies and their movements. For such fantastic views al-Bīrūnī had no patience, he ruled them out as altogether beyond science's sphere. He even contends the idea that the circle is better suited than the other forms like the elliptic. If al-Bīrūnī thinks that the Earth is not in motion and stands at the centre, he accepts and expounds the view for strictly natural and scientific reasons of his own. He is almost free from the theological or even metaphysical bias and works with an entirely independent mind rejecting all the supernatural or superstitious notions about Astronomy.

xii
AL-QANUNU’L-MAS’UDI

In the face of great achievements we are apt to forget the spade work and other preparatory labours leading to such astonishing results. In the case of al-Biruni they had involved a tremendous effort. There is hardly any portion in this book which had not already received from him ampler treatment elsewhere. It appears that with that rare insight, which is part of his genius, he had directed his studies in a most ordered manner. He had, for example, started with the subject of Calendars and Chronology on which he had written elaborately some 35 years before. Then he took up Trigonometry and Shadows and on these two subjects we have two of his earlier works published by the Daira. On the Longitudes and Latitudes he wrote several books including al-Tahdid, which deals much more in detail with topics like the Obliquity of the Ecliptic. On the measurements of the Earth, he has treated more fully in the same book and in a special treatise of 120 pages no longer available to us.

From his early age he had begun to collect an extensive library of his own on his favourite subjects, and apparently possessed all the well known books on Astronomy written within the area extending from the Mediterranean Sea to the Bay of Bengal. These included all the extant Greek, Indian, and Muslim authors, except probably those belonging to the Western Muslim lands of Spain and Egypt.

He is not one of those who are reluctant to acknowledge the debt of his predecessors. In the preface he
expresses his full sense of gratitude to all of them and
takes equal care to indicate his own share and views
where occasion arises. He intended al-Qānūn to be an
up-to-date Encyclopaedia of Astronomy supplanting
all previous works ranging from Ptolemy’s al Mageṣt to
al-Mageṣtin’ṣh-Shāhī of his own teacher, Abū Naṣr. Almost
a tradition had grown up of writing comprehensively, and
there was another such work written by Abu’l-Wafā also.

For those who have not studied his life and works
it is not easy to realize the pains he had taken to master
the entire subject before putting his pen to this book.

He had already commented on all the outstanding
works of his predecessors like Ḥabash, al-Khwārazmī,
al-Farghānī, al-Battānī, Abū Ma‘šār and the Siddhan-
tas of the Indian Astronomers. He had himself com-
piled formerly some more restricted and moderate sized
texts on Astronomy, and even Astrology, in which he
was thoroughly versed but does not appear to have
implicit faith, though in the people’s mind and in the
court he was treated as the greatest astrologer of the
world. Some five years earlier he had compiled for an
educated lady of his native land named Raiḥānā his
Kitāb Ṭafšīm both in Arabic and Persian versions,
treating of the elementary Mathematics, Astronomy and
Astrology. There he remarks that most people consider
the last subject as the real fruit of the entire science,
although on his part he prefers to range himself on the
side of the minority. i.e. those who think otherwise.

In al-Qānūn al-Bīrūnī’s method is to collect the best
available information on every point and sometimes in
xxxv
important matters to render a historical and comparative treatment and to disclose whatever he had personally observed or investigated as well as the complete processes by which the various results had been achieved.

He had a special skill for devising instruments and equipped under his own supervision two observatories in his native land and one at Ghaznah. He has left quite the best book on Astrolabes named al-Istāb still extant in manuscripts. He invented for the cathedral mosque of Ghaznah a time-machine based on the Roman calendar, but was much annoyed by its rejection by the Imam on account of its being based on a non-Muslim calendar system. He remarks that the measurement of time was a purely secular matter and convenience and utility were the only considerations which should prevail.

It would, however, be unjust to compare al-Qānūn with an Encyclopaedia of modern astronomy, as the former has a very limited range. It is only when we compare al-Bīrūnī’s work with his predecessors and contemporaries, that we notice his advance on all sides.

AL-BĪRŪNĪ’S THEORY OF THE UNIVERSE

al-Bīrūnī had some ideas very strikingly similar to those of Einstein and other modern scientists regarding the Universe as a whole. Like them he considered it to be situated on the outermost surface of a limited sphere.

Like Einstein he also rejected the idea of the universal gravitation as an actual force on the ground of its being altogether opposed to experience:

 xv
Further al-Bīrūnī considered that when a part of a mass at rest moves from one part to the other, it moves in a straight line, but on the other hand its movement round another body at rest is of a circular nature and represents a movement round a fixed point like the Earth's centre.

و إذا نقل جزء من نوع ساكن إلى مكان نوع آخر منه تحرك على استقامة نحو حيزة حركة عرضية، وما حول هذه الساكنات في اطرافه فهو متحرك بحركات مستديرة مكانية حول الوسط الذي هو حقيقه السفل ومركز الأرض (ص 31).

Here too he is very much in agreement with Einstein, who held that curvature of the space-time in the neighbourhood of the Sun causes the planets to describe ellipses, whereas if all the masses were infinitely removed they would describe straight lines.

No doubt al-Bīrūnī's conception of the Universe was more static than that of our modern astronomers who hold it as an altogether restless body full of movements and even expanding and contracting. Of course some of these most advanced theories can in our present state of knowledge be considered as more or less of tentative nature only.
Newton's theory of Universal Gravitational pull remained undisputed for two centuries till it had to be modified in the light of better knowledge and substituted by Einstein's more advanced theories of Relativity, which have revolutionized our ideas of Space, Time, Matter & Energy as conceived by former thinkers, so much so that in the present state of our knowledge we find Bertrand Russel remarking:—

"In fact because all motion is relative we cannot distinguish between the hypothesis that the Earth goes round the Sun and the hypothesis that the Sun goes round the Earth. The two are merely different ways of describing some occurrence like saying that A marries B or B marries A. .......... To Kepler and Galileo and their opponents, however, since they did not recognize the relativity of motion the question in debate appeared to be not one of convenience of description but of objective truth. " (Religion & Science, pp. 30–31).

It should go to the everlasting credit of al-Bīrūnī that much in advance of his times he held an identical view and has expressed it in his al-Iṣṭiḥāb:—

وَقَدْ رَايَتْ لَآمِنُ سُعيد الْسُّجَرَى اصْطَلَارَابَا مِنْ نَوعٍ واحِدٍ بِسيطٍ
غير مُركِبٍ مِنْ شَمَالٍ وَجَنُوْبٍ سَمَّاهُ الزُّرْقَيْنِ، فَتَحَسَّنَّنَّهُ يَجِدًا
لَاحْتِرَاعُهُ إِيَّاهُ عَلَى أَصْلٍ قَامٍ بِذَاتِهِ، مَسْتَخْرِجَ مَنْ يَعْتَقَدُ بِهِ اَلْتَّنَّاسِ
مِنَ الْحَمْرَةِ الْكَلْتِيَّةِ الْمُرْئِيَّةِ الْشَّرْقِيَّةِ هِيَ لَلْأَرْضِ دَرْنَ الْفَلَقِ.
وَلَعْمَرِي هِيَ شَبَهَةُ عَسْرَةُ التَّحَلِيلِ صَعْبَةُ الْمَثْقَلِ، لَيْسَ لِلْمُحْلِّلِينِ عَلَى
الَّخَطَوْطِ الْمُسْأَحِيَّةُ مِنْ نَقْصِهَا شَيْءٌ، أَعْنِي بِهِمَّ الْمُهْدِيِّينَ وَعَلَاءِ الْهَيْتَةِ،
عَلَى أَنَّ الْحَمْرَةِ الْكَلْتِيَّةِ سَوَاءُ كَانَتْ لِلْأَرْضِ أَوْ كَانَتْ لِلسَّمَاةِ، فَأَنْشِئَتْ
فِي كَلَّتا الْحَالَيْنِ غَيْرَ قَادِحَةً فِي صِنَاعَهَا، بِلَانْ أَمْكَنْ نَقْصُ هَذَا
الْاَتْخَادُ وَتَحَلِيلِ هَذِهِ الشَّبَهَةِ فَذَلِكَ مَوْكُولٌ إِلَى الْطَّبِيعِيِّينِ مِنْ الفَلَاسِفَةِ.
"I saw a kind of simple Astrolabe, invented by Abū-Sa'īd-al-Sijzī, not composed of the Northern and Southern sections of the Sky, and known as az-Zauraqī. I liked it immensely and praised him a great deal, as it rested on an independent foundation, the basis of its operation and construction lies in some people's belief that the motion lies in the Earth and not in the Sky. I swear that it is an uncertainty extremely difficult to resolve or by my life contradict. The Geometricians and Astronomers who depend merely on the lines resulting from measurements, have no means to contradict this theory. For in view of the fact that it is the same so far as the movement itself is concerned whether one ascribes it to the Earth or the Heavens. In both the cases it does not affect their science, but if it is possible to contradict this belief and resolve the uncertainty, then amongst all the philosophers it should be the concern of the physicists."

It may be pointed out here that the question of the Earth's movement was being very keenly debated amongst the Muslim Astronomers in the 10th and 11th centuries of the Christian era, and the echoes of their discussion are still discernible in al-Qānūn, where (pp. 50 & 51) al-Bīrūnī has tried to meet their objections. It is a pity that the works of az-Sijzī and others who held such views have not survived. It is certain that centuries beforeCopernicus, a few Muslim Astronomers had freely believed and worked on this hypothesis.

Similarly, regarding gravitation some of al-Bīrūnī's contemporaries, and Newton centuries after believed in a universal force residing in matter and attracting the
bodies. Al-Bīrūnī did not believe in such a universal force. Nor did his illustrious contemporaries Ibnu'l-Haitham and Abū-Sahl-al-Qūhī. Like Einstein all these believed that gravitation is only the acceleration of the mass and is neither derived from outside nor parts the mass and would not deviate unless obstructed by some impediment. I take liberty to quote from al-Khāzinī who wrote some 75 years after al-Bīrūnī, borrowing from the two above-mentioned Muslim savants:—

الف) النقل هو القوة التي بها يتحرك الجسم الثقيل إلى مركز العالم
ب) والجسم الثقيل هو الذي يتحرك بقوة ذاتية ابدا إلى مركز العالم فقط اعنى ان النقل هو الذي له قوة تتحرك إلى نقطة المركز وفي الجهة ابدا اينها المركز ولا تحرك تلك القوة في جهة غير تلك الجهة.

و تلك القوة هي لذاته لا مكتسبه من خارج و غير مفارقة لها دام على غير المركز و متحركا بها ابدا ما لم يعده عائقا الى ان يصير إلى مركز العالم (كتاب ميزان الحكمة ص 16)

Some day we may perhaps discover some unpublished work of al-Bīrūnī where in he may have dealt with the subject in detail. but we have sufficient indications in al-Qānūn that like our modern scientist, he did not at all believe in the objectivity of such force in the Universe.

COSMOGONY

In al-Qānūn, al-Bīrūnī has not hazarded any scientific hypothesis about the origins of the Universe, but in at-Taḥdīd we have a long discourse on this subject. Against the prevalent philosophical ideas of the Universe he has
demonstrated that it cannot be treated as eternal. On the other hand from the evidence of the rocks and the study of the natural forces like water and fire on the surface of the Earth, he concludes that in the long periods of its history it has been and is still under-going changes. But it is not easy to compute the precise time the Earth should have taken since its very beginning. He was very much interested in the various Cosmogonies known in his time and had even collected some of them in his book.

نكيل حكایات عبد الملك الطيب البتتي في مبدا العالم و انتهائه,
(في قريب من 100 ورقة)

which formed a supplement to another earlier collection by a physician, 'Abdu'l-Malik of Bust relating to the beginning and the end of the Earth. It would repay to persue this subject in Prof. Validdi's extracts and more completely in the original text of the *Kitābu't-Tahdid*.

**THE GEO-CENTRIC THEORY OF AL-BĪRŪNĪ**

In *al-Qānūn*, al-Bīrūnī has upheld the Geo-centric theory, not because he was unaware of or belittled the Helio-centric theory. In fact time was not yet ripe for deciding this problem with absolute certainty. The Astronomers were still busy in observing and collecting their data for checking as well as correcting the former observations. It goes very much to his credit that al-Bīrūnī, as we know, throughout kept an open mind in such matters. We have to remember the difficulty in supporting the Helio-centric theory. It was the absence of any apparent changes of the distant stars' places in the Heavens or of the objects falling from the height on the
earth's surface. After very complicated modern observations and computations such shift (parallax) has been actually observed in the case of some nearer stars and even the distant Nebulae. But in the absence of the telescope and other modern instruments of precision, the ancients had no means to ascertain such displacements. In fact except a few philosophers like Ibn Sīnā and Fakhru’d-Dīn Rāzī, they thought that all the fixed stars belonged to the one and the same Heaven and calculated its distance from the Earth at a much shorter range than even our nearest star. Each planet, they thought, had a separate Heaven for itself. And then they had another difficulty to face, i.e. the supposed movement in the circle, an idea originally based on Plato and Aristotle’s metaphysical notions of perfection and beauty.

Even in his earlier days, in his controversy with Ibn Sīnā, al-Bīrūnī had questioned the soundness of this notion, asserting on his part the equal validity of the elliptical or oval form. The same is his view in al-Qānūn. It stands to his credit that he came so close to the very revolutionary idea of Kepler, who for the first time enunciated the planetary movements in the elliptical forms.

Even from his own teacher Abū Naṣr’s treatise on the Sphericity of the Earth (كwl solid) published by the Daira, it is evident that to him and his pupil, the circular movements of the Heavens always meant mere geometric representation of man’s observations from the Earth’s platform and nothing more real or sacrosant:—

و لكننا نقول أولا ان القدماء ومن اهل هذه الصناعة لم يكن غرضهم
المقصود معرفة شكل الشه. في كريته أو غير ذلك بل كان الفرض وجود السبيل في كل حين حتى . . . معرفة موضع الكواكب و ابعاد بعضها من بعض (صف 4).

Similarly al-Bīrūnī remarks in al-Qānūn:

و هذا الشكل يمكن ان يكون كريما كما يمكن ان يكون يضيّ أو عدسيّ أو أسطوانيّ أو مخروطيّ أو مضلع، فليس استدلال بطليوس ثباث اقدار الكواكب في جميع نواحي السماء. وجهاتها على حال واحدة بناء للتضعيف عن الشكل، اما هونافية عن نفس الحركة والرسم التي ترسمها الاجرام بها (صف 30).

"It is equally conceivable that the shape of the Universe be spherical, or oval or elliptical or cylindrical or conical or consisting of several sides, Ptolemy’s argument from the stars retaining the same magnitudes in all the parts of the Heavens and keeping the same direction is no sufficient reason by itself, but it precludes the other forms owing to the nature of the motion itself as well as the figures that the heavenly bodies describe in their movements."

It cannot, however, be denied that all these old masters were straining the evidence to bring it in line with the idea of describing the movements of the heavenly bodies in circles. For if it were true that the Earth is in the centre and the Heavens move round it, it should have served as its real centre and the very pivot of their Geocentric Heavens. But all those planets’ centres never actually corresponded with the Earth’s centre and they had to invent the cumbersome system of the Eccentrics.
and Epicycles to describe the zig-zag paths as recorded by the stars in the course of their apparent motions.

With the advance of science we are always wiser than our predecessors, but let us give them the credit that is their due. This theory, how-so-ever faulty, achieved its object to a very great extent, so far as the study of the apparent aspects of the Heavens was concerned. For ordinary purposes it hardly matters whether we consider the day and night due to the movements of the Earth or the Sun.

How some eminent Astronomers like Aristarchus, Aryabhata and al-Sijzī were able to advance the Helio-centric theory could only be described as lucky flashes of inspiration, not much based on the known demonstrable data as on more or less barest assumptions. The same is true of Copernicus, who was yet far from any precise theory of the Universe. He retained the system of circles and Epicycles. It was really an advance on many fronts, the invention of telescope, use of pendulum and the precise observations of Brahe and subsequent theorization of Kepler that eventually led to Newton, and in our times to Einstein. We, however, do not know if we have yet reached the Ultimate, perhaps we shall never reach the end in our scientific adventure.

It was only the labours of the great scientists like al-Birūnī that gradually led to extend our range of knowledge. Some of their observations are still valuable and probably of perennial interest. Others have lost their intrinsic value. As AbūNaṣrMansūr rightly remarked: This only shows that human knowledge, like human nature is
imperfect. The truth is difficult to reach and the ultimate
or absolute truth is beyond the reach of science:—
ضعف جبأة البشر وظاهر العجز ونقص فلقب الاملأ على آثار
الحكمة والانتقان والصنعة وحسن التقدير أو ائتئام التدبير و
(رسالة كرية الصيا ص 10 - 11)

CALENDARS AND CHRONOLOGY

After discussing in an original manner Ptolemy's six
basic propositions regarding the sphericity of the Heavens
and the Earth and the latter's fixed and central, but ex-
tremely insignificant, position in the Universe, and the
nature of the Eastern and Western motions in the Hea-
vens, al-Bīrūnī proceeds to define those imaginary circles
like the Poles, Equator, Longitudes, Latitudes, Obliquity,
and the signs of Zodiac etc. which are used by the As-
tronomers as technical terms for their treatment of the
Heavens and the Earth and which every student should
know before entering the subject.

The next part from the fourth chapter of the first Maq-
ala to the end of the next Maqala (pp. 63-170) relates to
the discussion of Time as treated in Astronomy, and after
defining the day-night and the various kinds of lunar and
solar months and years, proceeds to render a detailed
account of the calendars of the different peoples known
to the author. In al-Qānūn he has supplied additional in-
formation about Indian systems and the mode of convert-
ing the most important Indian era Sakkala into the Hij-
rah, Yezdgerd and Alexanderian eras and vice-versa.

According to al-Bīrūnī's researches Zoroaster, the noble
prophet of Iran, lived 267 years before Alexander, (p. 59)
and 1218 years before the last Persian Emperor Yezdgerd (p. 131). Similarly he points out that the era known after Alexander began from the tenth year of his death, and most important era Sakkala precedes by 587 years the other called Guptakala on which the Indian Astronomical treatise Khandakhandyaka is based.

He points out that the beginning of the Muslim era of *al-Hijra* corresponded with the first of Ramzān according to the pre-Islamic calendar. He calculates that exactly 3472 days had elapsed between *al-Hijrah* and Yezdgerd. He informs us that the ancient Arabs had learnt the system of inter-calation from the Jews of Yathrab some 200 years before the Prophet's migration to Medina, and the pilgrimage to Mecca as well as the marketing days and festivals fell in fixed seasons. In the year of the Prophet's migration, the pilgrimage fell in *Sha'ban*, and so the Prophet did not like to perform it and restored it to its ancient position after the conquest of Mecca. It is also noteworthy that according to al-Bīrūnī, the Prophet died on the 8th of *Rabi'u'l-Awwal*, and not on the 12th as it is generally believed now. He calculated that nine years, eleven months and twenty days had elapsed since the date of his migration.

Very valuable and curious information may he gleaned from this part of the book by those interested in the history of ancient Persians, Jews and Christians living in the Muslim lands in al-Bīrūnī's time. For instance, he points out that the Jews and Christians very much differed amongst themselves in reckoning the date of Adam's birth. He, on his part, thought that it was not possible
to assign any exact dates for such remote events for
which no reliable reports were available (p. 145). On the
other hand like our modern Geologists, he believed that
very long periods of time were needed to account for the
past history of the Earth.

TRIGONOMETRY

The third Maqala dealing with Trigonometry has
already been translated in German by Carl Schoy and
subjected to critical study by Mr. M. A. Kazim of the
Muslim University, Aligarh, in his article “Al-Biruni and
Trigonometry” in the “Al-Biruni Commemoration Volume”
which he concludes by paying a tribute to the mathema-
tical genius of al-Biruni:

“How astonishing it looks to modern mathematicians
that a person existing thousand years back happens to
produce so much original work inspite of very little
resources of those times, at the same time plays a consi-
derable part in diverse fields with astonishing accuracy
and mathematical care.

The world still knows very little of al-Biruni as a
great mathematician and many of his original contribu-
tions to mathematics still lie hidden in the pages of his
master-work the Qanun-i-Mas‘udi and many of his other
books which perhaps may never come to light.”

OBLIQUITY OF THE ECLIPTIC

The fourth Maqala opens with the detailed discussion
of the Obliquity of the Ecliptic, a subject of much histor-
cal and scientific importance.

We know that in its path round the Sun the Earth’s
axis is keeping an inclined angle of about 23 1/2 degrees.

xxvi
al-Bīrūnī calls it the angle formed by the inter-section of the Celestial Equator and the Ecliptic.

(زاوية تقاطع معدل النهار مع البروج، وهو الميل الأعظم)

The Indian, Chinese and earlier Greek Astronomers agreed that it amounted to 24 degrees. But the later Greek Astronomers like Eratosthenes, Hipparchos and Ptolemy found that the angle had declined to $23^\circ 51'$ and some seconds ranging from $19'$ to $23'$ only. When the Muslim Astronomer renewed their observations in al-Ma'mūn's time they discovered that it had still further decreased in the meanwhile. They thought that it was due to the defect in the instruments, and the matter was pursued continously by their successors to establish the real value.

After many observations from time to time the results were found to vary from 35 to 32 minutes. al-Bīrūnī himself repeated the observations several times in Khwārazm and Ghaznah and found that his results, amounting to $23^\circ 35'$ tallied with those obtained by his illustrious predecessors like Muḥammad and ʿAbd al-Muṭṭaqqin and Ibn al-ʿAbd al-Wafā. According to Nallino, al-Bīrūnī's value exceeds to a nominal extent of 0.57 only.

It did not, however, strike al-Bīrūnī that in reality the angle of the Obliquity itself had been declining progressively. It was reserved to some other subsequent Muslim Astronomers like al-Zarqālī and Naṣir al-Dīn al-Ṭūsī to come to this conclusion, which corresponds with the view of our modern scientists, who compute that the change amounts to about a minute in 125 years.

xxvii
ASTRONOMICAL GEOGRAPHY

In this and the next Maqala al-Biruni deals with the theories of Latitudes and Longitudes and their applications in determining times in day and night and fixing the positions on the Earth’s globe. This was a very favourite subject of al-Biruni and his \textit{al-Tahdīd} mainly concerns with it. There he mentions that he had an idea of compiling a Geography, combining the features of the Sāmānid Minister al-Jaīhāni’s work (now lost), describing the various countries and illustrating them by maps, and other kind of books (like that of Ibn Khurdādbih) on the Routes and Distances of important places meant for the benefit of the state and the travellers. He tells us that he spared neither his influence nor money for collecting information and constructed a hemisphere of about 15 feet in diameter on which he marked the Longitudes and Latitudes ascertained by his own investigations or from other reliable sources. As we know the work was interrupted by Mahmud’s invasion of Khwārazm in A.H.408.

His researches in Geography constitute a very significant part of his original contribution to our knowledge. Dr. Zeki Vali Togon has already published some extracts from the \textit{al-Qānūn, as-Saidana} and \textit{al-Jamāhir} in the above mentioned Memoir entitled Biruni’s \textit{Picture of the World}, particularly from the \textit{al-Tahdīd}, which served as a middle stage between his researches in Khwarazm and the much more advanced knowledge amassed before undertaking \textit{al-Qānūn}.

It is a pity that most of the other books he wrote on this subject are lost beyond much hope of recovery. We
know at least the following titles, from his own list compiled in 427. A.H.

(1) كتاب تثبيت نهاية الأماكن لتصحيح مسافات المسكن في
(2) وكتاب تهذيب الهقاوق في تصحيح المروض والاطوال في
(3) وكتاب تصحيف المنقول من المروض والاطوال في
(4) ومقالة في تصحيف الطول والعرض لمساكن المعمار من الأراض
(5) وأخرى في تعين البلد من المروض والطول كاثما في
(6) ومقالة في استخراج قدر الأرض برص اطخاط على قلل
(7) الجبال في
(8) وفرصور الشمس عند منارة أسكندرية في
(9) وفي الاختلاف الواقع في تقسيم الأقاليم في

رسالة للبيروني، (ص 33) الفهريست، طبع باريس سنة 1363 م

and half a dozen treatises on the correct determination of the Muslim Qibla, a subject also briefly dealt with in al-Qānūn, and at-Tahdīd where he rightly emphasises its importance for the correct performance of Muslim prayers. Besides the theoretical discussion, we know he actually took the trouble to fix such direction from Ghaznah and another place in Afghanistan called Bust.

HIS PREDICTION ON THE EXISTENCE OF THE AMERICAN CONTINENTS BEYOND THE WESTERN SEAS

In chapter nine of the fourth Maqalah, where al-Bīrūnī presents a short account of the inhabited world, he remarks that the Greeks had terminated the inhabited
world on their side by the coast line of the Atlantic Ocean, as they had no reports except about those islands (Canaries and Madeira), not very far from there. Nor did the reports from the Far East exceed beyond the limit of a half circle, thus confining the known inhabitation mainly to the two northern quarters of the globe, not because, says our author, it is necessary by nature or climatic conditions but simply because of the lack of reliable reports about the remaining quarters. It is indeed most remarkable that he goes still further in his at-Tahdîd by asserting that land must exist beyond the seas between the Western and Eastern coast lines of the known world, thus anticipating the discovery of the American Continents in the Western hemisphere:

"There is nothing to prohibit the existence of inhabited lands in the Eastern and Western parts. Neither extreme heat nor cold stand in the way ................. and therefore it is necessary that some supposed regions do exist beyond (the known) remaining regions of the world surrounded by waters on all the sides."

HIS GENERAL PICTURE OF THE WORLD

Even the general picture of the world as presented by al-Bîrûnî is remarkably accurate. He tells us that the length of the inhabited world is greater than its breadth. It is surrounded by the seas on all its sides, and the
various oceans in the North, East, West and South all combine at different points. In the North, his limits are set by the habitations of the Suwars, Bulgars Russians, Sclavs and Azovs, in the West by the northern regions of Africa, Spain, France and some other parts and unknown lands, and then the coldest regions unsuited for habitation. In the South, except the groups of East-Indies Islands (الزاج و الزاجات و قير والوقواق و الزيج و مثله) and Ceylon and a few others, he admits nothing much is known of the lands or people from the sailors in those parts. In the East, China forms his terminus, although as mentioned above, he very much believed in the existence of the regions (e.g. Japan) lying in the Far Eastern ocean as in the West.

Except for the upper portions, he knows nothing much of Africa beyond the sources of the Moon across the Equator after which he thought the oceans coming from the West and the East combined. His detailed knowledge of the seas, gulfs and inland lakes like the Caspian is very precise.

MEASUREMENT OF THE EARTH BY AL-BİRŪNĪ

In chapter seven of the fifth Maqala, al-Bīrūnī deals with the dimensions of the Earth's globe. As I have already treated this subject in full detail in my special study "Muslim Researches in Geodesy" in the Commemorative Volume published by the Iran Society in 1951 on the occasion of al-Bīrūnī's Millenary Celebrations, I propose to touch upon it here rather very briefly.

The ancient Greek and Indian Astronomers had
attempted the measurement of the Earth, but the standards of their measurements were not precisely known to the Astronomers of al-Ma’mūn who was keen to know the actual dimensions. He, therefore, ordered two parties to measure separately two degrees of Longitude by operating from the same point in opposite directions in the plains of Sinjar near Mosul. After comparing their results they computed that a single degree consisted of 56 2/3 Arabian miles and the Earth’s circumference 20,400 miles, which according to my calculations come to 364, 106 1/4 feet, and 24,825 3/4 English miles respectively and when compared with the modern calculations the former exceeds by 5/11 mile and the latter by 171 miles only.

In order to satisfy himself, al-Bīrūnī tried without success to measure a degree by the same method in the plains of Dīhistān (Jurjān). But later on, while in detention in the Fort of Nandna (in West Punjab), he resorted to a trigonometrical method as suggested by al-Ma’mūn’s Astronomer Sind b.ʿAli. The whole operation is described in at-Tahdīd without mentioning his actual values, al-Bīrūnī obtained his own by calculating the height of the peak of a mountain in the neighbourhood plain and ascertaining in the sight the declination of the horizon from the same point. He found the length of a degree to consist of a little more than 56 Arabian miles, which, according to my calculations, falls short by about 12 miles in the radius and 70 1/2 miles in the circumference as compared with our modern scientists.

A slightly different account of this event is also given in at-Tahdīd, from which I conclude that it must have
happened sometime towards the end of A.H. 408 or towards the very beginning of 409, when soon after we find al-Bīrūnī in a very sore state of mind wandering in the neighbourhood of Kābul.

I may further mention, by the way, that subsequently al-Bīrūnī also measured the area of the Earth’s surface, and its volume and weight in gold.

We should, however, remember that although his results came very close to those of al-Ma’mūn’s Astronomers, al-Bīrūnī has preferred to use their measurements, as he says their instruments were more precise and their labours of extremely exacting and fastidious nature.

TABLES OF LONGITUDES AND LATITUDES

In at-Tahdīd al-Bīrūnī tells us that as he had made Ghaznah his second home, he was anxious to carry out all his favourite scientific researches there, and determine for the first time the correct Longitude of Ghaznah by reference to Baghdad. He had fixed the former’s Latitude as soon as he was there, but the establishment of the Longitude was a much more complicated affair. By the time he wrote the present work he had accomplished it successfully.

It is necessary to remember that in the matter of Longitude much confusion prevailed in those days. Some had taken the Canaries Islands as the starting point, according to which they calculated Baghdad lying 80 degrees to the East, while others treated the farthest point on the Atlantic coast as the primary Longitude, according to which Baghdad was supposed to lie at a distance of
70 degrees only. al-Bīrūnī determined that the difference between the Longitudes of Baghdad and Ghaznah amounted to 24°-20', wonderfully close to the actual difference of 23°-34', considering the fact that it was by indirect method of calculating from distances and directions that this result was obtained. He, however, admitted that inspite of his best efforts there might still be existing slight differences in his computation.

In order to ascertain the vast amount of altogether new information collected by him, one has to compare his list of more than 600 names with al-Battānī's 100 only and the contents of some contemporary geographical works like Hududul-Ālam, compiled only half a century earlier. One will notice that extensive regions like India, little or altogether unknown to the outsiders, have come into full light. Of course, his knowledge of India is incomparably the finest for his times, and even later when we come to Abul-Fazl's Ain of Akbar's time. It is, however, necessary that excepting a few, the Longitudes and Latitudes in al-Qānūn have been computed by the author by means of comparing their positions to one another and the distances ascertained from travellers or inhabitants of those countries or on the basis of other written and oral reports.

After a close scrutiny, I find that generally speaking the Latitudes are more approximately correct than the Longitudes, in respect of which he has erred to a much larger extent. But allowing for such inevitable deficiencies, some of the results are strikingly successful. For the benefit of the readers who want to make a detailed com-
parison it may be pointed out that al-Bīrūnī has chosen the most distant place of the West African coast on the Atlantic Ocean near Susu’l-Aqsa as his prime meridian, according to which he calculates the Longitude of Cordova in Spain as 9, 40 E, and its Latitude as 35, 2 N. Now according to the Greenwich Meridian its position is 4,48 W and 37, 52 N. al-Bīrūnī’s coastline should, therefore, be some 14, 28 W of Greenwich line.

But as we proceed Eastward and reach Cairo the difference exceeds the right value by a considerable extent. Cairo’s position is 31, 13 E, and 30, 1 N. In al-Qānūn it is 54, 40 E and 30, 20 N. Thus his Latitude corresponds quite closely. But according to his prime meridian it should be 45, 51 E i.e., 8, 49 degrees less than the calculated position in al-Qānūn.

By the time we reach Baghdad the discrepancy has still further widened. According to Greenwich line Baghdad is 44, 30 E and 33, 18 N. In al-Qānūn it is 70 E and 33, 25 N. Here again the Latitude corresponds, but the Longitude exceeds the correct position by about 11 degrees.

Let us stop here and consider the point. al-Bīrūnī had admittedly no personal knowledge or direct means to check the correctness of the true Longitudes and Latitudes in those distant regions. He had generally to depend on his predecessors and take their estimate more or less on credit. We know, e.g., that Ptolemy’s Africa was too wide and vastly exaggerated particularly in the South and the East, virtually connecting itself with Asia and making the Indian Ocean a lake surrounded on all
its sides by land. This unreal extension of land in the Far East was responsible in fostering a belief in the mind of Columbus that it was possible to reach Asia by direct navigation across the Atlantic. Leaving the dark Continent of Africa and most of the Western and Central Europe aside, al-Bīrūnī's knowledge of Asia and the Indian Ocean was vastly superior to that of any earlier Geographers. Africa too he does not extend much beyond the source of Nile in the Mountains of the Moon, i.e., not very far from the Equator, and thereby joins the Atlantic Ocean with the Indian Ocean. He has a very accurate idea of the position and form of the Indian Peninsula. As to China, which to him meant the rest of the Far East land beyond India, including the Indo-Chinese and Malay Peninsulas lying between the fifth and the fortieth Latitudes and hundred sixteen and hundred sixty two of his Longitudes, i.e. some 46 degrees, his knowledge, thanks to the Muslim sailors and traders, had grown to some extent, but as compared with India it was still rather vague, and we find that in locating some of the identifiable places like Khanfu (Canton) the Latitude are much lower down than their exact positions. On the other hand of the Turkish lands, which also included the homelands of the Tartars and the Mongols, he has a better knowledge. During his stay at Mahmūd's court two embassies from the Far-Eastern part had visited Ghaznah and al-Bīrūnī may have collected information about those lands which he has utilised in al-Qānūn.

Of the Muslim countries in Asia his knowledge is full and most reliable. In his Kitābu'l-Tahdīd he remarks that xxxvi
in his times owing to the extension of Islam on the three continents all the barriers and impediments which existed in Ptolemy's times and forced him mainly to depend on hearsay in determining his geographical positions had been removed and facilities for travelling, trade and exploration greatly increased, resulting in a much better knowledge of the countries and the nations of the world.

MENTION OF INDIAN PLACES IN AL-QĀNŪN

A map of India based on the tables in al-Qānūn would not on the whole present a very distorted picture. Unfortunately al-Bīrūnī had no opportunity to travel widely in this country. As explicitly mentioned by him in his Indica he visited only a few places in the Western Punjab and determined their Latitudes. "I have myself found the Latitude of the fortress of Lauhur as 34°. 10, 56 miles from the capital of Kashmir, half the way being rugged country and the other half plain. I enumerate in the below what other Latitudes I have been able to observe myself:

<table>
<thead>
<tr>
<th>Ghaznah</th>
<th>33° 35'</th>
<th>Lamghan</th>
<th>34° 43'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kabul</td>
<td>33° 47'</td>
<td>Purshavar</td>
<td>34° 44'</td>
</tr>
<tr>
<td>Kandi, the guard-station of the prince</td>
<td>33° 55'</td>
<td>Waihand</td>
<td>34° 30'</td>
</tr>
<tr>
<td>Dunpur</td>
<td>34° 20'</td>
<td>Jailam</td>
<td>33° 20'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The fortress Nandna</td>
<td>32° 0'</td>
</tr>
</tbody>
</table>

The distance between the last place and Multan is nearly 200 miles.

Sialkot       | 32° 58' |
|---------------|--------|
Mandakkakor    | 31° 50' |
| Multan        | 20° 40' |

We have not travelled beyond the places mentioned
above nor learnt any Longitudes and Latitudes from the Indian books. God alone will help in achieving our objects’’. 

By the time he wrote al-Qānūn he had collected sufficient data to determine the positions of the Indian places. (Kitābu’l-Hind, p. 163 and English Translation Vol. I. pp. 317-318).

Extent of India from Peshawar (his Long. 970, 10 E) to the mouth of the Ganges (Long. 110, 40 E) would amount to 13 1/2 degrees, while according to the modern calculations it should be 17 degrees, thus making al-Bīrūnī’s estimation short by 3 1/2 degrees only. His Southern-most Latitude for the Adam’s Bridge (9 N) is most exact differing by 15’ only while its Longitude 119 E exceeds by 3 degrees as compared with our 79, 30 E. Similarly the position assigned to Ceylon is nearly correct so far as the Latitude goes but exceeds by about 4 degrees towards the East. In the case of other inland places in the South like Tanjore and Rameshwaram the Longitudes are wrong by as many as 8 to 9 degrees and even the Latitudes by 4 to 4 1/2 degrees.

Judging from the positions of the forts in the mountains of Kashmir’s Southern boundary at 33 N, we find that estimation of India’s length is amazingly close to the real dimension.

So was his idea of its Peninsular form. In an outline map of the inhabited world in the manuscripts of his al-Tafshīm reproduced in the Encyclopaedia of Islam under its article on Geography and also in the Persian edition of the book itself, he gives an almost correct representation of India’s shape and place in the Eastern

xxxviii
hemisphere. The superiority of his notions can very easily be judged by comparing his world map with that of Ibn-Hauqal (c. A.D. 975) reproduced from a manuscript of the 11th century facing page 86 in the 'Legacy of Islam'.

Proceeding Eastward and taking Ghaznah as our starting point, we discover that there is hardly a difference of a degree or so upto the place occupying the site of modern Lahore. By the time we reach Mathura the Latitude errs slightly by more than one and a half degree but the Longitude by one sixth only. Meerut's Longitude is wrong by 2 1/4 degrees and Gwalior's by less than a degree and their Latitudes are short by a single and a quarter degree respectively. Pryag (modern Allahabad) suffers by half a degree in its Latitude and one and a half degree in the Longitude; Benaras by less than a degree (Latitude) and two and a half degrees (Longitude), Ajodhya by one and a half (Latitude) and two and a half (Longitude) Qannauj both by about one and a half degree, Patliputra by two and a half both ways and Mongair by four degrees (Longitude) and less than three (Latitude).

On India's West coast Somnath's Longitude is wrong by 3/4 degree and Latitude by 4 1/4 degrees, Cambay by two degrees both ways and Bharooch by 1/2 degree (Latitude) and 1 1/4 (Longitude). Maharashtra is placed considerably North and its Longitude is wrong by two degrees. Thanah's (Bombay) Latitude (19.20) corresponds with its correct position (19.12), but its Latitude (104) exceeds by more than four degrees and a half. In Sind Daibal on the mouth of the Indus river (called Mehran) nearly corresponds with the modern Karachi. Multan's
Latitude errrs by half a degree and Longitude by one. In the innermost places Dhar’s Longitude is slightly wrong by more than a degree and Latitude by one and a half and Mhow’s Latitude by one and a half and Longitude by three degrees.

In the Western Punjab Sialkot’s Longitude is in excess by one and a half degrees and Latitude by $\frac{1}{2}$ of a degree, Jhelum’s Longitude by less than $\frac{1}{2}$ and Latitude by less than $\frac{3}{4}$ of a degree, and Peshawar’s Longitude short by less than a half and Latitude more than a degree only.

It may, however, be pointed out that al-Bīrūnī’s tables do not mention either Delhi or Lahore, nor does his Indica. The inference is clear. Both did not exist or were unknown by these names in his times. As to Delhi my own researches have led me to conclude that it was founded some time after. Lahore, which is called Lohawar, is mentioned as a regional name and its capital as Mand-kakaur (مند ککور) in the best readings of the manuscripts of the Indica and al-Qānūn. This name should not, however, be confused with the name of a fort called Lauhaur in the mountains of Kashmir as the latter’s Latitude is at least two degrees removed from modern Lahore. But some places near about Delhi like Sunnam, Meerut, Sursawa (now Sarawa) and Thaneswar, the holy city of the Indians are mentioned. But my own place, Baran, (now Bulandshahr) which was supposed by modern historians to be one of the places conquered by Mahmūd in the course of his famous campaign against Mathūra and Qannauj in A.H. 409, is equally missing. I am, therefore, convinced that the place mentioned in the contemporary
history written by 'Utbī tallies with Meerut and by the mistake in the manuscripts has been corrupted to Barana, as in the Arabic script the two names are easily liable to be confused. al-Bīrūnī, however, has mentioned another place in the neighbourhood of Bulandshahr named as Ahar, which occupies a very ancient site. The inference is equally clear, i.e., like Delhi the fort of Baran did not exist or was unknown by this name in those times.

As to Ujjain, the prime meridian of the Indian Astronomers, al-Bīrūnī’s reckoning of the Latitude and the Longitude is most correct.

<table>
<thead>
<tr>
<th>Longitude</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>al-Bīrūnī</td>
<td>Modern</td>
</tr>
<tr>
<td>105 50</td>
<td>79 58</td>
</tr>
</tbody>
</table>

Let us show how we have worked it out. According to al-Bīrūnī Ghaznah has a Longitude of 94.20. The difference between the two places is 11.35°. The modern Longitude of Ghaznah being 68.25 the difference is 11.35. Thus both the results are identical.

But al-Bīrūnī vehemently rejects the Indian Astronomers’ theory of its being situated on the middle-line of the inhabited world, called the Cupola of the Earth, قبة الأرض, running from Lunka on the Equator to the Meru mountain on the top of the Northern Pole, and passing through Ujjain, Rohtak fort, Thaneshwar plains, the Jamuna region and the Himalayas. (p. 504). The Persian Astronomers had also borrowed this idea from India and the tradition passed on to the earlier Muslim Astronomers, who corrupted the word Ujjain to Uzain and eventually to Arin, which persisted for long times to denote...
the prime meridian by which the Longitude according to
the Indian system were calculated in their books.

PROJECTION AND CARTOGRAPHY

al-Bīrūnī was intensely interested in both and, as he
mentioned in al-Athār, devised ways for Cylindrical and
Conical Projections for the Geographical purposes. In his
list of books he mentions

(1) تكيل صناعة التسطيح
(2) تحديد معموره و تصحيحها في الصورة

i.e. a full description of the inhabited world with illustrative maps. If he was ever able to complete these books,
they should have served as valuable guides and models
to the subsequent writers like Idrīsī of Sicily, who com-
piled his well-known Geography and Atlas for the Nor-
man ruler Roger II. Unfortunately none of such maps could
be included in al-Qānūn which was treated by al-Bīrūnī
as a mere summary of his vast knowledge of Astronomical
subjects, each of which received his separate exposition
in more elaborate treatises.

AL-BĪRŪNĪ'S DETERMINATION OF THE
MOTION OF THE SUN'S APOGEE

From the Earth al-Bīrūnī passes to the Heavens and
begins with the Sun. Ptolemy had held that the Sun's
Apogee (the highest point from the Earth) was fixed,
pointing to the same spot in the Heavens as was long
before determined by Hypparchus. When the Muslim
Astronomers commenced their observations they found
that the Apogee had moved further east from the point
mentioned by the two Greek Astronomers. al-Berūnī
mentions one by one the observations by Al-Mamun’s
xl ii
Astronomers, Khalidul-Marwazi, Ali b. Isa-ul-Harrani and Sind b. Ali, and later on the sons of Mūsa and Abūl-Wāfa in Baghdad, al-Battani at Al-Raqqa and Sulaiman b. Ashbah at Balkh and Abul Hamid al-Kho-jändī at Raiy (pp.655-664). Subsequently he carried out his own observations in Jurjania and Ghaznah and was thoroughly convinced of the Muslim Astronomer's observations as against Ptolemy's observation. He rightly remarked that the new results obtained during the preceding two centuries and supported by his own could not be brushed aside.

Rejecting in Chapter seventh of the sixth Maqalah Ptolemy's view about the fixity of the Sun's Apogee he proceeded in the next chapter to determine the correct value of this movement. All his predecessors had determined it as amounting to one degree in 66 years, and, as it appears from his Kitabut-Tashīm he also depended on al-Battani's researches and accepted this value. But six years after further advance and careful studies of his own, all embodied in so much detail, in al-Qānūn, he at last discovered that the movement took more than 70 1/3 years to cover a single degree of Heavens' circle, and 0° 0' 7'' 44⅔ 54⅔ in a single day (p. 677).

This result obtained by al-Bīrūnī is very much in accord with our modern researches, which make the movement as 52.2 every year and one degree during 72 years.

THE LENGTH OF THE SOLAR YEAR

Hipparchus and Ptolemy had found the length of the Tropical year to be 365 days 5 hours and about 56 minutes.
Continuous observations by the Muslim Astronomers from the days of Al-Mamūn had shown that the length of the year was really much less.

Observations at Damascus found it as 365 days 5 hours and 46 minutes, and the same were confirmed by Yahya b. Abī Mānsūr in his observations at Baghdad, but his earlier observations had shown it as 365 days 5 hours and 54 minutes.

Al-Bīrūnī tells us that Al-Māmūn was very keen to measure the correct length of the Tropical year, and for that purpose set up an iron pillar at Dair Marwan in Damascus, but after comparing its measurements was surprised to find out that the pillar had decreased to the extent of a barley's length during the intervening night.

Consequently he almost despaired of ascertaining the true length of the year with the help of the available instruments. Commenting on this episode al-Bīrūnī remarks that a single individual's life—nay, even the lives of several generations put together are not sufficiently long as compared with the requirements of such matters. This, on the other hand, should be a sufficient warning to an individual against constituting himself the sole authority on the basis of his own observations only. It is, therefore, necessary that the process of observation should continue over many generations, one passing the work to the other (p. 637).

al-Battani's researches had resulted in establishing the solar year as consisting of 365 days 5 hours, 46 minutes and 24 seconds. But the subject engaged the attention of other Muslim Astronomers also and eventually
al-Bīrūnī undertook to solve it for his own satisfaction. After complicated researches based on his own repeated observations as well as those of his predecessors, of which he has rendered a detailed account from the days of Hipparchus and Ptolemy, he found the length of the year as 365 days 5 hours, 46 minutes and between 46 and 47 seconds (or 47 seconds as he puts it in *At-Tafhīm*).

In an article on the Jalali Calendar, based on the results of the Muslim Astronomers including Omar Khaiyyam, (published in Islamic Culture, Hyderabad Deccan, 1943, pp. 166-175) we have dealt with the researches of the Muslim Astronomer for determining the correct value, which soon after al-Bīrūnī eventually led to the best reformed solar calendar of Jalaluddin Malikshah Seljuqi. It appears that his Astronomers found the length of the year as 365 days 5 hours and 49 minutes, which most nearly approximates to the true length of the mean Tropical year according to the most modern researches, i.e. 365 days 5 hours, 48 minutes and about 47\(\frac{1}{2}\) seconds.

It is, however, still a moot question whether the length of the year has always been constant or has been gradually increasing progressively. But for the specialists al-Bīrūnī’s careful researches and observations may yet serve as a useful record.

**AL-BĪRUNĪ’S OPINION ABOUT THE PHYSICAL NATURE OF THE SUN**

In *al-Qānūn* al-Bīrūnī did not as a principle enter into matters which he thought should belong to the domain of Physics rather than Astronomy, which had not yet emerged from its geometrical stage. It was reserved for
our modern times to develop the dynamical and physical aspects and make them necessary parts of Astronomy. Anyhow, it goes to al-Bīrūnī’s credit that wherever he has rarely touched on such questions he has generally maintained sane views. For instance in the case of the Sun, against the prevalent metaphysical or rather mythological notions, inherited from the Greeks, making it a spiritual body destitute of any mundane elements, al-Bīrūnī uniformly held that it was a fiery body and the, solar prominences noticeable during the total eclipses were just like the flames arising in the atmosphere round some burning body (p. 646).

وأما ذوات الاذناب التي يقال لها ترى حول الشمس المنكسفة وقد اتضح من العلم الطبيعي انها دخانات ترتقي الى حيث تلتهب في الهواء الحار المجاور للنار.

**THE FIXED STARS**

In the total absence of any evidence of the proper motions of the stars, detected in a few cases by our modern Astronomers with the help of their new instruments and intricate methamatical computations and other physical phenomena, it was impossible for the Astronomer of the former times to imagine or treat them except as fixed points in the Heavens serving as useful background and points of reference for determining the movements of the Planets etc.

Al-Bīrūnī knew that the skies were full of innumerable bodies of various magnitudes and it was impossible to determine their number by sight even in a small part of the sky.
He admits that the instruments of his times were unable to help the eyes in ascertaining their numbers.

The ancient astronomers had tried to fix the positions of a number of the more brilliant ones visible to the bare eyes up to the sixth degree of their apparent magnitude.

The foundations of the science of placing the heavenly bodies on the celestial hemisphere were laid amongst the Greeks by Hipparchus, who is believed to have prepared a catalogue of more than 1000. Ptolemy's catalogue in his *al-Magest* rests a great deal on that of Hipparchus and al-Biruni has rightly remarked that it is not at all certain if Ptolemy himself carried out his own observations or intentionally left them out considering the matter as a mere branch (p. 991).

During the Muslim period when the whole field of Astronomy was being checked afresh, Abdu'r-Rahmaan b. Ibnul-Sufi, the court-astronomer of Azdu'd-Dawla of the Buwayhid dynasty, a great lover and patron of sciences, devoted his entire life to this single branch. Al-Biruni has rightly placed his confidence in Abdu'r-Rahmaan's unrivalled performance and considered him as a specialist to be the best informed of all the angles and minute of his subject.

واما ابو الحسين فا كان يحمل من العلم ما كان يحمل بطليوس وانما اتميزه عرة في هذا الفن حتى عرف به وقاصر الهمة على شيء واحد
al-Bīrūnī frankly admits that he himself never undertook a complete charting of the Heavens, except in a restricted manner, and has contented himself in al-Qānūn to rest his list of stars on Ptolemy’s as revised by Ibnul-Ṣufi, resorting to such corrections as were necessary to bring their position up-to-date according to their apparent progress in Heavens to the further extent of some 13 degrees as computed by al-Bīrūnī himself (p. 1012). But for this purpose he claims to have compared all the available copies of Ptolemy’s text and its Arabic translations available to him.

In his catalogue, however, he has dropped such descriptions as colours, considering the matter to be better suited for physics. He was not much impressed by the prevalent theories about the causes ascribed by the physicists about such matters. At best they were surmises of uncertain nature.

On the Nebulæ and the milky-way he has some striking remarks in a small chapter (p. 992). I quote him in extenso.

“...In the skies we have some objects not resembling the stars in their roundness and light. They are the white patches called the Nebulæ. Some of these are considered
to be composed of the clusters of the stars”.

He disagrees with Aristotle and his supporters’ opinion about the position of the Milky Way being below the sphere of the planets and rightly believes them to belong to the highest sphere of the stars.

(فيلم أنها تعلوها علّ الكواكب الثانية إياها (ص 992).)

Similarly he has discarded the views held in Astrology and supported by Aristotle that they injured the sight and caused sorrow and misfortune.

THE EASTERN MOVEMENT OF THE FIXED STARS

Al-Bīrūnī holds that all these stars moved to the East on a central axis and parallel to the Zodiac line.

The nature and extent of this revolution could be ascertained by observations spread over long periods and al-Bīrūnī has tested the matter by comparing his own restricted observations with those in Ptolemy’s catalogue.

His gauge year is 400 of Yezdgerd Era, which corresponded with Sultan Mas’ud’s return to Ghaznah after his father’s death in A.H. 422. He found that the stars had moved to the extent of 13 degrees as compared with Ptolemy’s time.

(قد اثبت في هذه الجداول ما في كتاب المجسطي من مواطع الكواكب بزيادة ثلاث عشرة درجة على أطوالها (ص 103).)

He adopted the revised magnitudes of Ibnus Şüfi.

(و الذي سنورده من أعطامها مع الذن في المجسطي منها فهو حسب اعتبار أبي الحسين (ص 991).)

Every nation, he says, (p. 1020), had given the stars different names in their languages and ascribed imaginary
figures to their groupings and even assigned some traditions and stories suited to the early stages of civilization (p. 1010).

The Arabs, for instance, had their own system of nomenclature, but al-Bīrūnī had preferred the Greek system of 48 figures and 12 constellations arranged on a belt, remarking at the same time that these resemblances are seldom accurate enough to comprehend all the stars, and in fact leave a number of them outside their ranges.

Al-Bīrūnī has discarded all such descriptions as their tempers resting on colours and more or less other superstitious and Astrological notions. The scientific value of such descriptions is mainly the concern of Astrophysics, which enters into the question of their composition, age, evolution and even distances etc. But it would take us on a discursion hardly pertinent to our present study.

Ptolemy had calculated that the sphere of the stars moved in 100 years to the extent of a single degree out of a total of 360 degrees (p. 998). All the preceding Muslim Astronomers except Ibn Yunus were in agreement that it took only 66 years to make a complete revolution.

In *At-Tafhim* al-Bīrūnī, relying on al-Battani, had stated that each of the fixed stars as well as the apogees of the Planets moved at the rate of 66 years for a single degree (p. 135, Persian edition) and 23,760 years for the complete belt. The ancients had made it 36,000 years (p. 132). al-Bīrūnī and Ibn Yunus, however, independently, calculated that it took more than 70 years to complete the revolution. They only differed in the additional fraction, $\frac{1}{4}$ according to Ibn Yunus and $\frac{1}{3}$ according to al-Bīrūnī. This is in
complete accord with the modern researches which makes it about 72 years for a single degree and 25,867 years for the complete circle.

All the subsequent leading Astronomers like Naṣīru’d-Din Tūsī, Qutbu’d-Din Shirazi and Ulugh Beg computed it as 70 years.

Thus al-Bīrūnī’s result is the nearest approach to our modern calculations, next best being that of Ibn Yunus, who, however, had preceded him by many years and in point of time can claim priority for correct valuation.

I have discussed this subject a little more in detail to show that al-Bīrūnī’s list of the stars’ positions is not a mere copy of any one of his predecessor’s catalogues. For this purpose, taking Ptolemy’s catalogue for his basis, he worked out his own results and there is no doubt that judging from the value assigned by him to the precession of the stars in his times, his revised computation of their positions has to be taken on its own merit and should not be considered to be a mere second-hand affair. This, however, is not intended to belittle al-Battani or Ibnus Şüfi’s valuable researches, as such matters, in the words of al-Bīrūnī, depend on many minute observations spread over long periods.

اما درستی از نادرستی نتوان دانستن مگر برصد های بسیار و باریک و مدتهای. سخت دراز (کتاب الالفهیم ص 132).

and, we may add, the exceptional genius of persons like al-Bīrūnī and Ibn Yunus.

THE ANWA

The Anwa (the plural of Nau, a star) mean certain atmospheric phenomena like the rains, winds, heat, cold
and moisture etc. which were supposed to be subject to the influence of the stars. Strictly speaking Nau initially concerned the rains.

The art of recognizing the Anwa formed a special science with the Arabs. They closely connected the Anwa with the Moon’s mansions. The Indians had their own system of connecting the lunar mansions with their astrological system. The Muslims, who had inherited both the systems, combined them and compiled annual calendars forecasting the meteorological, agricultural and even medico-hygienic aspects for the various periods.

This information, based on long observations general experience and popular ideas, inherited from the past, could not be of a strictly scientific order and as pointed out by al-Bīrūnī varied from place to place. The seasons and the natural conditions produced by the former are really the result of the relative position of the Sun in the sky. All such forecasts were, therefore, of a tentative nature.

For instance, winter starts at various times in various places. He points out that the whole system reflects an analogy to the results arising out of the Sun’s movements in the Zodiac.

الاحوال الطبيعية الدائرة في السنة منصرفية إلى انتقال الشمس في المنازل (ص ١١٣٦)

AL-BĪRŪNĪ’S LUNAR THEORY

The theory of the Lunar motions has always formed an important part of Astronomy and al-Bīrūnī has devoted wholly the Seventh Maqala and parts of the next to this subject.
The Moon does not revolve in a perfect circle and its maximum and minimum distances appreciably differ. Its mean distance is estimated between these two limits.

Moreover, the Moon is always changing its path and its motions are subject to variations. Astronomers and Mathematicians have always been much perplexed by its irregularities and their combined efforts have not yet been crowned with perfect success in computing and predicting its exact positions at different times. Thanks to continuous improvements in the Lunar theory these inequalities have been gradually reduced to the minimum. Exact records of the past observations, specially of the Lunar eclipses are, therefore, of immense value.

Hipparcucus discovered a considerable inequality in the Moon’s course and Ptolemy detected a second inequality and tried to cover it by means of an epicycle. When the Muslim Astronomers took up their observations they appear to have realized that even Ptolemy’s theory did not fully account for the Moon’s motions. It is, for instance, claimed that a third inequality was detected by Abul-Wafa, but his claim was disputed by some modern scholars in favour of Tycho Brahe’s. But with reference to al-Bīrūnī the point is not so difficult to settle. As the matter has enjoyed some importance I would like to give al-Bīrūnī’s views a little in detail to show that he certainly knew the inadequacy of Ptolemy’s theory and tried to remove its defects.

al-Bīrūnī points out that the Moon’s movements very much differ from those determined by the ancient
Astronomers of Greece and India and believes that Ptolemy had missed some of its motions in the same way as he did in the case of the Sun.

He further remarks that it is not difficult to observe the Moon's return to its former place with reference to the fixed stars, but over long periods it is always altering its path and eventually the minute differences accumulate and cause the difficulty. (p. 785). The solution suggested by him is to keep a constant watch over it and collect reliable data from generation to generation. "The Moon's movements," says al-Bīrūnī, nay, those of all the moving bodies in the heavens are not ascertainable in a single attempt, as they vary from time to time. So they are at first determined in a larger and more approximate manner. When we repeat our observations second time we come nearer to the true value, and as we keep comparing our later results with the previous ones we arrive at a greater precision. This method should go on ad infinitum and that is all that is required of an original worker in this field. (p. 776).

Even a bare outline of his discussions relating to the complicated motions of the Moon would land us into the very depths of Mathematics and we confine ourselves here only to a few of his important results of general interest.
First of all, he has tried to determine the length of the ordinary Lunar month corresponding to the period of the Moon's movement from one phase to the same phase again, technically known as the Synodic month, (i.e., referring to its position to the Sun), and, relying on previous accounts of ancient observations, he has computed it as a little more than 29 $\frac{1}{2}$ days, (to be exact 29° 31° 50″ 8″ 9″ 20″ 13″). He has determined its daily average to be 13° 10° 35″ 2″ 6″ (or in the alternative 7″ 10° 4″) (p. 730).

In the next chapter he has undertaken to rectify the Mean and the Anamolistic daily movements of the Moon. The latter has reference to the nearest point of the Moon's approach to the Sun (perihelion) and back to the same, which takes a bit longer than its movement from one star and back to the same. The extreme pains that he has taken in fixing both may very well be judged from the minute results of his investigation. According to him the first is 13° 10° 34″ 2″ 7″ 5″ 17″ 8″ 25″ 25″ 57″ 25″ 42" and the second 13° 5″ 13° 35″ 54″ 3″ 8″ 5″ 32″ 31″ 32″ 9″ 25″ 44″. He had obtained these values after comparing the results of his own three consecutive Lunar observations in A.H. 393 & 394 (p. 746) carried out after the most careful precautions (p. 745).

Just to illustrate al-Bīrūnī's advance we may point out that according to al-Battani the mean daily motion amounted to 13° 10′ 35″ and the Anamolistic to 13° 3′ 54″. Now al-Bīrūnī’s mean motion is the closest approximation to the modern researches which compute it as 13°
In respect of the mean Obliquity of the Moon’s Ecliptic he has accepted the more accurate value of 5 degrees, as determined by Ptolemy, against 4\(\frac{1}{2}\) of the Indian Astronomers and al-Battani and 4\(\frac{2}{3}\) of al-Mamun’s Astronomers, Yahya b. Abi Mansnr & Habash and later on the sons of Musa. In this particular matter he frankly admits that he did not know the way to ascertain and check it (p. 776).

The Moon looks larger when nearer to the Earth and smaller when more distant. Its apparent diameter, therefore, varies relative to its distance from the Earth (p. 865).

Al-Birûni’s researches established that its Longest distance was 63° 52’ 40″ times of the Earth’s radius and the shortest 31° 55’ 5″ (p. 844). As to its diameter he rejected al-Battani’s calculation of 33° 33’ 20″ of the Earth’s diameter remarking that it was not noticeable at any one of the Moon’s distances from the Earth. He points out that howsomuch the Moon’s diameter may appear to differ at various distances its real diameter should be a constant value. He has preferred Ptolemy’s value of 31’ 20″ as compared with the Earth’s diameter, and this very much corresponds to the mean apparent diameter 31’ 7″ as determined by the modern researches. Similarly he prefers the ratio between the Earth’s shadow on the surface of the Moon during the Lunar eclipse as bearing a \(lvi\)
relation of $2\frac{3}{5}$ to 1. This corresponded equally with the results obtained by Ptolemy as well as al-Battani.

**THE DISTANCE OF THE SUN FROM THE EARTH**

Al-Bīrūnī had serious misgivings about Ptolemy’s calculation of the Sun’s distance from the Earth, as it was based on total eclipses and in complete disregard of the annular eclipses, which implied much larger distances. (pp. 868-870).

وقد أوضح أن القمر في أبعد بعدو عن الأرض يقصر عن كشف الشمس بكلها وهي عند أوجها واما أقصيه عن ذلك إذا كانت هي عند حصيته وما حكاه عن الإيراني لى في كسوف الشمس يشهد الخلاف ما بني عليه بطيوس وان الكسوف التام لا يمكن الشمس إلا في بعد هو الى الوسط أقرب منه الى الأبعد (ص 870-879)

According to Ptolemy the Sun’s distance amounted to 286 times of the Earth’s radius (p. 874). Al-Bīrūnī confesses his inability to check or correct Ptolemy’s calculations. Unfortunately he never happened to observe a total Solar eclipse nor possessed precise record about them to rely upon. (p. 874).

و لا لم يكن وضع الينا كسوف للشمس تام مرصود في وقت معلوم ولا من الارصاد المتقدمة مما يمكن به الوصول الى هذا الباب من غير تسلم ما أسسه بطيوس (ص 873)

That al-Bīrūnī was perfectly justified in his doubt is lvii
borne out by the researches of our modern Astronomers. The ancients had hopelessly erred in determining the distances and the magnitudes of the heavenly bodies, except in the case of the nearest of them, the Moon, which was amenable to the operation of the instruments they possessed. "But the Sun," says al-Bīrūnī, "is still immeasurable by our instruments and remains an object for conjectures." (p. 857).

وأما الشمس فهو كالأثرون لا يضبط الآلات مقداره ... فلن يتمكن الحساب منه ...

THE DISTANCES AND MAGNITUDES OF THE STARS FROM THE EARTH

Al-Bīrūnī admits that it was not possible to ascertain their distances and magnitudes, as there was no real way known to detect the parallax of the fixed stars (p. 1303). The way suggested by the Greek Astronomers was to place the stellar sphere next to the most distant Planet, i.e., according to Ptolemy 19, 666 times of the Earth's radius (p. 1310).

Similarly he calculated the diameter of the stars of the first magnitude and of Mars to be $\frac{1}{2}$ of the Sun's diameter. A Muslim Astronomer Abu-Jafar al-Khazin in his book on the distances and sizes of the heavenly bodies (الأبعاد والأجرام) had stated that the stars of the first magnitude had $\frac{1}{7}$ of the Sun's diameter, those of the second $\frac{1}{4}$, the third $\frac{1}{21}$, the fourth $\frac{1}{24}$, the fifth $\frac{1}{27}$ and the sixth $\frac{1}{36}$. He did not mention if he had himself determined them nor did he explain the method by which he had arrived at his results.

lviıı
Al-Birūnī then quotes the various values by the Indian and some other Astronomers. Those who are interested in his detailed exposition of Ptolemy’s results are referred to the Persian edition of the Kitabut Tafhim wherein he has worked out complete figures in the Earth’s radius as ascertained by al-Mamun’s Astronomers. The learned editor claims to have taken pains to check the table. In the light of modern advances in Astronomy such figures have only antiquarian interest, as all the ancient and medieval Astronomers lacked the necessary equipment for the precise computations.

We now know that the Sun is nearly 300 times more distant than what those former scientists had thought. The nearest star is at least 300,000 times the distance of the Sun and for the purposes of measuring such vast distances not even the Earth’s orbit is sufficiently large. And the nearest Nebula is supposed to be at a distance of 7 million light years! Words are wholly powerless to evoke even a remote idea of the scale of our Universe.

Undoubtedly our old Astronomers had a very limited notions of the dimensions of the world. Al-Birūnī, however, knew that they had not yet even satisfactorily ascertained the Sun’s distance. He himself never ventured to hazard any theory of his own where he was not certain of his grounds.

THE PLANETS

The Tenth Maqala deals with the planetary movements. In this part of the book al-Birūnī follows Ptolemy implicitly and considers him almost inspired, crediting
with having perfected the theory of planetary motions in the best possible manner (p. 1161). Herein al-Bīrūnī lays claim to no original contributions of his own, except the modifications in the Eastern movements of their apogees to the same extent as that of the Sun’s apogee—i.e., one degree in 70 3/4 instead of 100 years suggested by Ptolemy (p. 1166).

Al-Bīrūnī remarks that although the earlier Muslim Astronomers had not taken the trouble to explain the mathematical processes in their calculations, yet the positions of the Planets’s apogees mentioned by al-Mamun’s Astronomers, Yahya and Habash very much agreed with his own (p. 1197).

In chapter sixth of the maqala he strikes an original note, doubting the accepted order of the Planets that placed the Sun between the Moon and the two so called inferior Planets. Venus and Mercury, adding that it was quite possible that the Sun is below all the other Planets except the Moon, as it is equally possible that some Planets intervene between the Sun and the Moon (p. 1301).

Later on in Spain Jabir b. Aflah (c. 1140) held it more probable that Mercury and Venus were above the Sun.

THE ECLIPSES AND THE APPEARANCE OF THE NEW MOON

The Eighth Maqala deals with the Lunar and the Solar eclipses and the appearance of the New Moon. It is marked by a masterly exposition of their theory in all its aspects. I donot propose to enter into the details, as there is apparently nothing very much novel to mention,
except two topics, one relating to the appearance of the New Moon, and the other, in the last chapter, relating to the Indian theories of eclipses called Khayalai-ul-Kusufain, “the images of the eclipses” which pass on the faces of the Sun and the Moon and do not really affect their bodies. In his list dated A.H. 427 he mentions a treatise of his own specially devoted to this subject.

و عملت كتابا في المدارين المتحدين والتماسون وسمته بخيال الكسوفين عند الهند، وهو معنى مشتهر فيها بينهم، لا يخلو منه زين من ازياجهم؛ وليس معلوم عند أصحابنا (الفرست، ص 31).

“And I have prepared a book on the two united and equal axes and entitled it as the idea of the eclipses according to the Indians. It is a subject well-known to them and none of their Astronomical treatises is devoid of its treatment, but it is not known to our Muslim Astronomers.”

He has summarized the theories and adduced the requisite proofs in their support, relying on Paulis, the Greek, and Brahma Gupta’s Khandakhandayaka. As the English translations of the latter, with necessary notes and appendices by Mr. P. Gangoly, and of the Suryasiddhanta by Burges and edited and annotated by the former, and both published by the Calcutta University, are easily available, I refer the readers to the chapters five and six of the former and chapters fourth to seventh of the latter work for the Indian treatment of the Lunar and the Solar eclipses.

The appearance of the New Moon, says al-Biruni, is an altogether uncertain affair and predictions do not some-
times come to be true. Ptolemy and other Astronomers did not concern themselves with any theory about the Moon's appearance. But the Muslim Astronomers like al-Fazārī, Ya'qūb b. Ṭāriq, and al-Khwārazmī on the one hand and Ḥabash-ul-Ḥāsim and al-Battānī on the other made it a subject of their special study and devised laws concerning the appearance of the New Moon. al-Bīrūnī has relied on the researches of Ḥabash, which he says were the best on this subject.

DAWN AND SUNSET

This subject enjoyed sufficient importance with the Muslim scientists, as the two phenomena helped in determining the times for some prayers, and fasting. We know that the greatest Muslim writer on Optics, Ibn-ul-Ḥaitham, determined that the twilight begins or ceases when the sun is 19 degrees below the horizon, and attempted thereby also to measure the height of the atmosphere. In Chapter XIII of the VIII Maqala al-Bīrūnī deals with the subject, and it is remarkable that he was cognizant of still better results, for he informs us that both these phenomena occurred when the Sun was 18 degrees below the horizon. He adds that some people determined it as 17 degrees. The former result corresponds exactly with the best modern researches. Evidently both the results, slightly different from Ibn-ul-Ḥaitham's, are based on independent researches. We know that Optics was one of al-Bīrūnī's favourite subjects in which he left some original researches of his own. It is a pity that none of his books on this subject are available now, although
at least one of them, al-Lam‘āt, was known and utilised in our country by the author of the Jāmi‘-i-Bahādur Khānī, an Encyclopaedia of Mathematics, produced in the beginning of the last century.

AL-BĪRŪNĪ AND THE THEORY AND PRACTICE OF ASTROLOGY

In al-Bīrūnī’s time Astrology, already a fully developed system, had a strong hold on people’s mind. Muslim theologians and philosophers were generally opposed to its claims, but the Astronomers commonly supported its theory and adopted its practice as part and parcel of their profession. Many Muslim rulers believed in its efficiency and patronized their Astronomers equally for their knowledge of Astrology. So generally speaking both Astronomy and Astrology went hand in hand in those days.

The Muslims, however, enriched their system of Astrology by combining and harmonizing the various elements derived from the Iranian, Indian, Greek and other sources. This is not a place to write the interesting history of Astrology amongst the Muslims or in the Medieval Europe, which borrowed its entire system from the former. Only one point needs stressing. The Muslims appear to have taken Astrology rather seriously and almost in a scientific spirit and given it a respectable form, by pressing in its service their knowledge of Spherical Trigonometry and Mathematics. In their hands it thus became a highly complicated and technical system.

There is absolutely no doubt that al-Bīrūnī was thoroughly versed in the theoretical and practical aspects of
Astrology and wrote a number of times on it. The titles of his books in this particular line may be gleaned from his own list of A.H. 427. *Kīlābu’l-Tashīm*, (extant both in the Arabic and Persian versions), is the best surviving work, the latter half of which is devoted to Astrology, while his *Tamhīdu’l-Mustaqarr*, published by the Daira, deals exclusively with a single topic of Astrological import called *mamarr, i.e.*, the passage of one Planet over the other, which also forms in a brief manner the subject matter of Chapter X of the last *Maqala*. In *al-Qānūn*, al-Bīrūnī confines himself to the methods of Spherical Trigonometry and Mathematics, deemed indispensible for determining the movements and relative positions of the heavenly bodies, on which are based all the results of Astrological import. In this limited range also he claims several new methods of his own.

Of all the Muslim Astronomers his attitude to Astrology is most clear and definite. He repeats his views again and again in his various books. The last section of *at-Tashīm* pertaining to Astrology opens with the remark that for most people it is the highest product of the whole Mathematical science. He, however, ranges himself with the minority—*i.e.*, those who do not hold this opinion (p. 316).

وَنَزَادَكَ يَشَّرِّرُ مَرَّدَمَ اَحْكَامَ نَجُومَنَّ ثُمَّرَهَ عَلَمَهَا يَدُ رِياضِيَّ اَسْتٖ،

هرچندک اعتقد ما اندرین گردی و اندرین صناعت ماند اعتقد کهترین مردمان است

In other places in the same book he is very hard upon those who practised Astrology and preyed on the
ignorance of the people. It also appears that he did not consider most of them as even fully informed in their difficult subject and warns the people to be on their guard against their sharp practices (p. 360).

اصل این حديث و مستند مقدمات این صناعة و آشفتگی قیاسهاش،
و اما حشیان منجان که تمویه و زرق دوست تر دارند از راه راست.

He had a special book on this topic called

كتاب التبيه على صناعة التمويه.

In his Kitābuʿt-Tahdīd (p. 324), he pronounces a similar verdict against the whole system itself.

فان صناعة الإحكام على وهي اصولها وضعف فروعها، و اختلاف
قياساتها، و غلبة الظن فيها على اليقين.

"The system of predictions in Astrology rests on totally absurd principles, weak deductions, contradictory guesses and merest assumptions, opposed to certainties".

It is, therefore, certain that, like his illustrious contemporary and friend Ibn Sina, al-Bīrūnī was totally opposed to Alchemy and Astrology. The most eloquent testimony of the views on the latter is, however, available in the opening passage (p. 1354) of the last Maqala where al-Bīrūnī says:

"This science (of Astronomy) to which this book is devoted is absolutely self-sufficient in its own excellent principles. But the heart of those people, who cannot conceive of any joy except in the things that can save them from bodily pain, and of any gain except in the worldly boons, are not attracted and are even inimical to it and its votaries. This was the reason that led the ancient
thinkers to connect the events of the world with the Astronomical propositions and thereby establish the influence of the heavenly bodies in a delusive manner, and thus devise the bases for the principles governing the forecast of the future occurrences and persuade the people to accept Astrology as the very fruit (of Astronomical science). This those thinkers did to gain their following, knowing that the masses are greedy to learn the means whereby they can derive benefit, avoid harm, ward off disgrace and avert biting calamities”.

From a personal anecdote in his *al-Fihrist* we learn that at the time of his serious illness in A.H. 422 he consulted the Astrologers to find out the remaining years of his life, but, to his utter disappointment, they hopelessly differed amongst themselves and produced altogether conflicting and even impossible results (p. 41).

It is, however, very curious that in subsequent times he was rated as the greatest Muslim Astrologer and some evidently false anecdotes, like those in the Persian work *Chahar Maqalah*, (written in the middle of the 6th. century), were invented to show his greatness as a most wonderful Astrologer.

I do not propose to enter here into further details of the various topics relating to the calculation of the 12 celestial domus (پرتوت), the juxtaposition with reference to the signs of the Zodiac, the contiguity of the planets in their longitudes and latitudes, the casting of horoscopes, the ascension, and declension of the planets and the passage of one planet over the other etc. These matters
were too difficult and complicated to find place in the earlier and more elementry book, *at-Taḥnīm*, which is very much suited for those who are interested in Astrology as a profession. But you could never know his greatness even as a perfect master of Astrology, unless you have studied his last Maqala, wherein he has undertaken to enunciate the universally admitted bases on which was raised the enormous structure of Astrological practices.

We sample out here two themes of general interest forming the subject-matter of the last chapters of the book.

The first deals with the theory of the Qīrans (قراءة), the conjunction of the Planets, an idea which had originated in the land of ancient Iran. The Astrologers set a great store by this theory, which, they claimed, helped them in predicting important public events and careers of men born under such conjunctions. Of these, the conjunction of Saturn and Jupiter were considered as the most auspicious.

The Qīrans were of three kinds, the smallest (*الأصغر*), the middle (*الأوسط*) and the largest (*الأعظم*); the first was supposed to take place at the end of twenty years, the second, more in use, 240 years and the third 960 years. al-Bīrūnī points out that even according to the works of the ancient Persian Astronomers, who carried out their calculations on the basis of 360 days for a year, the first should take place, not in 20 years, but in 19 years, 3 months and 26 days, and even much less, according to the solar year of more than 365 days, as calculated by *lxvii*
Ptolemy and the Indian Siddhantas.

“This,” says al-Bīrūnī, “I mention to warn you against the ravings and patchings of these Astrologers on account of their love of the number ‘12’ in respect of the conjunctions”.

وأما ذكرت هذا ليكون للناظر مانعاً عرب. الهذيانات والتلفقات فلا يشتغل بالاثنى عشرية في القرآن (ص 1469).

These Astrologers were, of course, extremely displeased by his criticism of their favourite theory, but, as rightly remarked by al-Bīrūnī, ‘truth does not follow our wishes.’

والحق لا يتبع الهوى (ص 1429)

The last chapter deals with the Millenia and other Astrological periods. Here he has offered some very pungent remarks, which are, perhaps, equally applicable to our times, in which there is no dearth of hypothesis relating to the beginning of our universe and its other component parts.

He makes no secret of his views that the Iranian and Indian systems of calculating the beginnings of the Universe, the Earth and the Human race and assigning them cycles of thousands or other specified periods, are all uncertain guesses, based on no demonstrable data. On the other hand he believes that such beginnings are altogether unknown and the human reason is incapable of precisely determining or describing such events.

ومندأ العالم متي كان مجهول الوضع، جال العقل في مبدهه، ولم ينهذ الى تميةه (ص 1471)

Traditional lore and religious books differ hopelessly
and even the *Qura’n* is silent on this particular point. The Indian system of periodic revolutions of the heavenly bodies is full of inconsistencies and rests merely on the ancient traditions. The same is true of the theory of conjunction of all the heavenly bodies in the beginning, and previous to all the subsequent events in the Universe.

He, therefore, rejects all such speculations one by one and contents himself in the end to narrate what the Iranians and Indians had to say on this subject:—

و على كل حال فساحكي في هذا الفن ما عرفته من طرقهم، و سمعته من أقاربههم.

**CONCLUDING REMARKS**

In a work of such vast dimensions and rich contents it is not easy to pick and chose. I do not claim to have exhausted or even copiously utilised the inexhaustible store of materials in this work. My main idea has been to demonstrate the value of this book even to a layman. I have, therefore, avoided the more complicated or technical matters which I thought belong to the domain of a highly specialised scholar. I, however, believe that the best course for any one would be to select a limited theme at one time and work on it in a detailed and exhaustive manner, e.g., by taking up the Prolegomena dealing with the first principles, or anyone of the subsequent parts relating to Chronology and Calendar, Geography, the Solar, Lunar or Planetary theories, the stars and so forth. The space and time at my disposal have permitted me only a very brief treatment of the themes chosen for this study, which was being carried out the same time that the book

*lxix*
was passing through the press. I, therefore, earnestly beg my readers to overlook its imperfections and shortcomings. However, I hope, in the words of Ibn Sina in the preface of his al-Qānūn on Medicine:

وَانِ أُجُرَّ اللَّهَ فِي الْأَجْلِ وَسَاعِدُ الْقُدرُ أَتَصَبَّ اضطُبْ ثَانِيًا .

to renew in the near future my labour on a much larger scale, if God spares me life and good luck favours me to do so.

After its publication the most important thing in my opinion would be al-Qānūn’s translation and annotation in some modern language of international status on the lines of the great Italian savant C. Nallino’s unrivalled performance in the Latin language in connection with al-Battānī’s work. In al-Bīrūnī’s case a still wider knowledge of the sciences, languages and history would be necessary, besides the fact that he is rather a difficult writer who, while on his part does everything to furnish the required proofs, demands at the same time an extremely careful and exacting devotion to his work, specially in this one intended for the most advanced scholars.

This brings us to some of the most distinguishing and original features of this work mentioned by the author himself towards the end of his Preface, i.e., the particular care he has taken to unravel the basic principles, to demonstrate the propositions enunciated in the book, to adduce the proofs of his deductions and to indicate his personal observations and researches. These features, says al-Bīrūnī, were very much lacking in his predecessor’s
works and in his opinion, were indispensible to enable the scholars to judge and check the results. For in a growing science like Astronomy it is well nigh impossible to overlook the work done by the former scholars. So he gratefully benefited himself by the previous researches and theories, but freely and fearlessly criticised where he thought they had missed the mark or gone astray. The whole passage on pages 4 and 5 is a true exposition of his scientific method, consistently pursued in all his works. He had already written very extensively to furnish the missing proofs for the researches of the leading Astronomers like al-Khwārazmī, Ḥabash, al-Farghānī and Abū-Maʿshar, and the Indian compilers of the Siddhantas, Karana-Khand-Khandayaka etc. (cf. his al-Fihrist, pp. 30,32 & 43). His firm belief in the laws of nature, his insistence on continuous observations and collection of reliable data and the successful application of all these principles, mark him out as one of the greatest exponents of the true scientific method.

Another important aspect of this work needs emphasis. During the five or six years that had elapsed after the completion of his Indica in A.H. 422, al-Bīrūnī had gone further ahead with his Indian studies. His most exhaustive work of 1100 pages exclusively devoted to the Indian Astronomy:

جوامع الموجود لخواطر الهندوس، في حساب التنجيم جاء ما تم منه في 500 ورقة

is apparently lost. It would, therefore, be necessary to elucidate his special debt to the Indian Astronomers, for

lxvi
there is no doubt that in some parts, like the Solar and Lunar theories and the Eclipses, they had worked independently and even surpassed the Greek Astronomers. On the other hand it would be worth-while, although not so easy, except by indirect reasoning, to trace the influence that his own works in Sanskrit exerted on the contemporary or subsequent Indian Astronomy. For, while seeking enlightenment from the Indian sources, he on his part loved to pay back his debt by introducing the Indians to the principles of Muslim Astronomy at its best period.

If al-Bīrūnī was lucky in his life in having some enlightened and even learned patrons, he is no less lucky now after his death in having an illustrious patron of his works in Maulānā Abu'l-Kalām Azād, to whose worthy name the present edition of the book has been rightly dedicated. For I know from my personal experience the unlimited admiration he has got for al-Bīrūnī and his works and even found time during his busy life as the Education Minister of India to contribute some appreciative articles of his own on al-Bīrūnī.

The publication of this marvellous work would indeed be an event in the field of scientific studies. It was the ambition of many savants and learned bodies to bring out a complete edition of this book. More than 40 years ago, when I published the First edition of my "Life of al-Bīrūnī," in Urdu and some 12 years after, its Second edition, M.A.O. College, Aligarh was hoping to bring out the text and translation of al-Qānūn. But unfortunately
nothing came out of those labours, except the preparation of a transcript from the beautiful and precious \textsuperscript{1)} manuscript of A.H. 562, then belonging to the Imperial Library, Calcutta, and the careful comparison with the photostat of the oldest,\textsuperscript{1)} [Or. 516 Bodl.] but incomplete manuscript in Oxford, and a much more recent copy which originally belonged to Syed Maḥmūd, the illustrious scion of Sir Syed Aḥmed Khān, the founder of that famous institution. The transcript then prepared and some abortive attempts at its translation in Urdu, should still be in the keeping of the University Library.

The Dāiratu‘l-Ma‘ārif-Il-Osmania at Hyderabad-Dn deserves to be congratulated for bringing out a standard edition of the whole text, which, I hope, should serve as a basis for all the future researches relating to this book.

A word of caution is, however, necessary to add here for the benefit of those who would like to undertake the study of the parts or the whole of \textit{al-Qānūn} or even a single topic therefrom. They should as a rule compare the text of the printed parts of this edition with some of the best available \textsuperscript{1)} manuscripts, and go even a step further to check the results, for in a work like this where the author has generally resorted to the system of numeration by means of the Arabic letters, and very sparingly by the Indian numerals, no text of such a big magnitude, full of innumerable minutiae, can, inspite of the care bestowed by its editors, remain totally immune from errors and misprints. In his times al-Bīrūnī himself had to face

\textsuperscript{1)} See supra for descriptions "Conspectus of the Extant Mss of the Qānūn" p. 14
and tackle similar difficulties in the manuscripts. And, moreover, even the best Mathematicians commit mistakes in their calculations and we know that al-Birûnî was no exception. See, for instance, the various corrections of this kind that the learned editor and translator of the Indica had to make in his English notes with the help of a great Mathematician of his times.

Some other valuable works of al-Birûnî exist in good manuscripts and deserve early publication. To one of these, I would particularly draw attention here. It is the autograph, or at least a contemporaneous copy of al-Birûnî's Kitābu't-Taḥdīd, dated A.H. 416, which in my opinion should be published in photographs, for it would serve as a beautiful palaeographical souvenir of the early 5th century of the Muslim era. I am really very much indebted to the learned Director of the Daira and the Chief-Editor of al-Qānūn for procuring for me its microfilm from the Fateh Library in Istanbul. The work by itself constitutes one of the smaller masterpieces of al-Birûnî, written soon after his arrival at Ghaznah in A.H. 410, i.e., after his release from detention in the fort of Nandna.

Another minor work of special interest is al-Īstī‘āb on Astrolabes, which exists in several good manuscripts in Iran and other countries.

These and all other available works of al-Birûnî may, one after the other, be taken up by the Daira under the care of its present Director, Dr. M. Nizāmu’d-Dīn, whose knowledge and experience are only equalled by his love of learning, specially where the East is concerned. As for
myself, I am further indebted to him for furnishing me with the instalments of the book in the course of its printing, suggesting some excellent formal and verbal modifications in the typed copy of my article and eventually relieving me to a large extent in correcting its proofs for the press.

And above all I thank God that I have been able to complete this work which I had undertaken as a labour of love in honour of an author whom I have always considered as one of the greatest and best that the world has produced or would produce in the future. For as we know more and more of his works we are bound with the passage of time to bestow on him still greater honours that are reserved only for the elite of our human race.

Hasan Manzil,  
Bulandshahr, U.P.,  
Friday, the 15th June, 1956  

Syed Hasan Barani
كتاب
القانون المسعودي
(الجزء الأول)
للحكيم الفيلسوف الكبير و المؤرخ الفلكي الشهير
أبي الريحان محمد بن أحمد
البيروني
المتوفي سنة 445 هـ/1052 م

* * *

صحح
عن النسخ القديمة الموجودة في المكتبات الشهيرة
تحت إعالة وزارة معاشر الحكومة العليا الهندية

الطبعة الأولى

 سنة 1372 هـ / 1954 م
الإهداء

إلى فضيلة صاحب المعالي العلامة اللمع
مولاًنا أبي الكلام آزاد وزير معارف الهند

تقديراً لمساهمته في تحرير الهند ورفعته معلم التعليم وتحقيقات العلمية فيه، وإعلاء منزلة ثقافة الهند بين الأقطار وإجلالاً له تبجره في العلوم والفنون الشرقية وطبقيته المتكررة، وذلك إنه أوعز إلى دائرة المعارف العثمانية بحيدر آباد الدكن (المستر) أن ينشر وتطبع هذا الكتاب الذي هو آية من آيات الكتب في الحكمة الشرقية، ألا وهو القانون المسعودي للفياسوف الشهير والفلسفي الكبير

إلي الرغم محمد بن أحمد البيروني
الذي لم يستف في ظل مله وقد بقي في عالم الخفاء لم يطبع إلى الآن مع أن كثيراً من الفضلاء والحكام والإدارات العلمية والمعاهد البحتية في الشرق والغرب كانوا هريصين على نشره منذ الف سنة.

* * * *
متن
الجزء الأول
من
القانون السعودي
(المستقبل على المقالات الأربع الأولى)
تأليف
الحكيم الفيلسوف الكبير والمؤرخ الفلكي الشهير
أبي الريحان محمد بن أحمد البيروني
المتوفي سنة ٤٤٠ هـ = ١٠٤٨ م

يرجى تقديم النص المطلوب للقراءة الطبيعية.
نسخ القانون المسعودي ورموزها

قد عثرنا على النسخ القديمة الموجودة في المكتبات المشهورة
للكتاب القانون المسعودي لأبي الريحان محمد بن أحمد البيروني وعملنا على
أكثرها خصوصاً على النسخ السبع الآتي ذكرها:

(1) الأولى منها أقدم النسخ وأصحها في مكتبة بادلين، أكسفورد
[ورينتل 1019] نسخت في سنة 475 هـ/1082 م، و[رمزها 10].
(2) والثانية منها نسخة في المكتبة الألمانية باريس، فرنسا [عربي 2764]
نسخت في سنة 501 هـ/1108 م، و[رمزها 20].
(3) الثالثة منها نسخة في مكتبة الملكة، استانبول [هار الله 1498]
نسخت في سنة 531 هـ/1136 م، و[رمزها 0].
(4) الرابعة منها نسخة في مكتبة بايبرد استانبول [ولي الدين 2272]
وقد نسخت قبل سنة 536 هـ وهي أساس الطبع، وعلي هذه
النسخة أقصى المستشرق الألمانى الدكتور ماكس كروهوس الاستنساخ
منها وتصحيحها، وعارضها على اربع نسخ ولم يؤكد له تكيلها
لأجل وقته في باريس، فامبروك في سنة 1944 م، و[رمزها 0].
(5) والخامسة منها نسخة برلين [ورينتل 12136]
نسخت قبل سنة 573 هـ/1167 م، وهي المحفوظة في مكتبة جامعة توبنجن
ألمانيا، و[رمزها 9].
(6) والسادسة منها نسخة في المتحف البريطاني لندن [ورينتل 1997]
نسخت في سنة 570 هـ/1164 م، و[رمزها 0].
(7) والسبتمبر منها نسخة في دار الكتب المصرية بالقاهرة، مصر
[مقياس 828] نسخت في سنة 376 هـ/1074 م، و[رمزها 0].
# محتويات

الجزء الأول
من كتاب القانون المصري

لي محمد بن أحمد البيروني

---

<table>
<thead>
<tr>
<th>مقدمة المصنف</th>
<th>صفحة</th>
</tr>
</thead>
<tbody>
<tr>
<td>مقالات القانون المصري و أبوابه في جداول لتسهيل الوجود</td>
<td>1</td>
</tr>
<tr>
<td>أبواب المقالة الأولى، وذلك اثنا عشر بابا</td>
<td>6</td>
</tr>
<tr>
<td>أبواب المقالة الثانية، وذلك اثنا عشر بابا</td>
<td>7</td>
</tr>
<tr>
<td>أبواب المقالة الثالثة، وذلك سبعه أبواب</td>
<td>8</td>
</tr>
<tr>
<td>أبواب المقالة الرابعة، وذلك سبعه عشر بابا</td>
<td>9</td>
</tr>
<tr>
<td>أبواب المقالة الخامسة، وذلك إحد عشر بابا</td>
<td>10</td>
</tr>
<tr>
<td>أبواب المقالة السادسة، وذلك إحد عشر بابا</td>
<td>11</td>
</tr>
<tr>
<td>أبواب المقالة السابعة، وذلك إحد عشر بابا</td>
<td>12</td>
</tr>
<tr>
<td>أبواب المقالة الثامنة، وذلك سبعه عشر بابا</td>
<td>13</td>
</tr>
<tr>
<td>أبواب المقالة التاسعة، وذلك سبعه عشر بابا</td>
<td>15</td>
</tr>
<tr>
<td>أبواب المقالة العاشرة، وذلك ثلاثة عشر بابا</td>
<td>16</td>
</tr>
<tr>
<td>أبواب المقالة الحادية عشرة، وذلك اثنا عشر بابا</td>
<td>18</td>
</tr>
</tbody>
</table>
متن الكتيب
المقالة الأولى
الباب الأول: في أخبار عن هيئة الموجودات الكلية
في العالم بأجمال و إنجاز للنبوطة
العالم بكلته جرم مستدير الشكل
الأنير العالم المتحرك و أثرات الحركة
العناصر الأربعة
إكرالسيارات
الباب الثاني: في ذكر الدلائل على مبادئ الصناعة
باختصار و إنجاز
المباحث السئة من كتاب المجسطى
الأصل الأول: السياك كرية الشكل و الحركة
ادلة بطليموس
الأصل الثاني: الأرض كرية الشكل حسنا
الكسوف، ادلة بطليوس
الأصل الثالث: موضع الأرض من الكل هو
وسط السياك، ادلة بطليوس
الإصل
<table>
<thead>
<tr>
<th>المقالة الأولى</th>
<th>الصلة الرابع</th>
<th>قدر الارض عند السماء غير محسوس به</th>
</tr>
</thead>
<tbody>
<tr>
<td>الباب الثاني</td>
<td>الصلة الخامس</td>
<td>بطلان حركة الأرض المكانية</td>
</tr>
<tr>
<td></td>
<td>الصلة السادس</td>
<td>الحركات الأولى في السماء صنعان</td>
</tr>
<tr>
<td></td>
<td></td>
<td>الباب الثالث : في اقتصاص الدوام السياووية وصفة ألقابها للتعريف في الاستعمال</td>
</tr>
<tr>
<td></td>
<td></td>
<td>البروج والدرجات</td>
</tr>
<tr>
<td></td>
<td></td>
<td>عرض البلد و مقدار العروض</td>
</tr>
<tr>
<td></td>
<td></td>
<td>الباب الرابع : في تحديد الايام والليل منها والنها</td>
</tr>
<tr>
<td></td>
<td></td>
<td>تعين ابتداء اليوم</td>
</tr>
<tr>
<td></td>
<td></td>
<td>الباب الخامس : في ذكر الشهر والسنة الطبيعتين والوضعيتين</td>
</tr>
<tr>
<td></td>
<td></td>
<td>الباب السادس : في ذكر السن الامام وشهورهم مرحلة ومعطية</td>
</tr>
<tr>
<td></td>
<td></td>
<td>جدول اسياه الشهور وكيديات ايامها</td>
</tr>
<tr>
<td></td>
<td></td>
<td>اسياه ايام كل شهر فاري</td>
</tr>
<tr>
<td></td>
<td></td>
<td>أصحاب سنة القمر</td>
</tr>
<tr>
<td></td>
<td></td>
<td>أصحاب سنة الشمس</td>
</tr>
</tbody>
</table>
|              |                | ج
الباب السابع: الساعات صنان

الباب الثامن: في تحويل هذه الأجزاء من جنس إلى آخر

الباب التاسع: في جمعة السنين المطلقة التي بسبب الكثيرة وغيرها

الباب العاشر: في الجماعات التي بسبب كبس السنين الشمسية

المقالة الثانية

الباب الأول: في نقل التواريخ الثلاثة بعضها إلى بعض

معرفة أوانِل سنى الهجرة في أيام الأسبوع

معرفة أوانِل شهور العرب في أيام الأسبوع
<table>
<thead>
<tr>
<th>المقالة الثانية</th>
<th>معرفة أواكل سنی الهجرة وشهر العرب بالجدول</th>
</tr>
</thead>
<tbody>
<tr>
<td>الباب الأول</td>
<td>جدول أواكل شهور العرب</td>
</tr>
<tr>
<td></td>
<td>معرفة أواكل سنی يزدجرد في أيام الأسبوع</td>
</tr>
<tr>
<td></td>
<td>معرفة أواكل شهور الفرس</td>
</tr>
<tr>
<td></td>
<td>معرفة أواكل سنی يزدجرد وشهر الفرس بالجدول</td>
</tr>
<tr>
<td></td>
<td>جدول أواكل شهور الفرس</td>
</tr>
<tr>
<td></td>
<td>معرفة أواكل سنی الإسكندر في أيام الأسبوع</td>
</tr>
<tr>
<td></td>
<td>معرفة أواكل شهور السريانيين</td>
</tr>
<tr>
<td></td>
<td>معرفة السنة السریانية كیسیة هی ام مطلقة</td>
</tr>
<tr>
<td></td>
<td>معرفة أواكل سنی الإسكندر وشهر السریانین</td>
</tr>
<tr>
<td></td>
<td>جدول أواكل شهور السریانین والروم</td>
</tr>
<tr>
<td></td>
<td>السبب الداعی إلى تعرف أواكل السنین</td>
</tr>
<tr>
<td></td>
<td>والشهور</td>
</tr>
<tr>
<td></td>
<td>اول يوم من سنة الهجرة</td>
</tr>
<tr>
<td></td>
<td>أواكل سنی يزدجرد</td>
</tr>
<tr>
<td></td>
<td>أواكل سنی السرینین</td>
</tr>
<tr>
<td></td>
<td>ترتیب جدول سنی السریانین</td>
</tr>
<tr>
<td></td>
<td>بسط تاريخ الهجرة ایاما</td>
</tr>
</tbody>
</table>
من القانون السعودي

تحويات الجزء الأول

فهرست المقالات والباب

الباب الأول: بسط تاريخ يزدجرد إياما

الباب الثاني: بسط تاريخ الآسكندر إياما

الباب الثالث: بسط التواريخ الثلاثة إياما بالجدول الجامع

الجدول الجامع

جدول شهور العرب

ادلة طريق البسط للتواريخ الثلاثة

الضرب الثالث وهو طي ايام التواريخ وتصيرها سنين شهورا

طي ايام التواريخ بالجدول الجامع

الباب الثاني: في تمييز ما يفرض من التواريخ مختلط الأجزاء

طريق استخراج التواريخ

الباب الثالث: في ذكر تأييل في التواريخ الثلاثة المستعملة

تنصل منها الشبهة العارضة فيها

بيان في تاريخ الآسكندر

بيان في تاريخ الهجرة

بيان في تاريخ يزدجرد

الباب الرابع: في تواريخ آخر غير الثلاثة المستعملة في هذه الصناعة

معرقة تاريخ يختصر وفيلس من تاريخ يزدجرد

معرقة
<table>
<thead>
<tr>
<th>محتويات الجزء الأول من القانون المسعودي</th>
</tr>
</thead>
<tbody>
<tr>
<td>فهرست المقالات والإبواب</td>
</tr>
<tr>
<td>المقالة الثانية</td>
</tr>
<tr>
<td>معرفة تاريخها من تاريخ الهجرة</td>
</tr>
<tr>
<td>الباب الرابع</td>
</tr>
<tr>
<td>معرفة تاريخها من تاريخ الإسكندر</td>
</tr>
<tr>
<td>معرفة تاريخ أغسطس و دولفيانوس</td>
</tr>
<tr>
<td>معرفة تاريخ المجوس من تاريخ يزدجرد</td>
</tr>
<tr>
<td>معرفة كبسة المعتضد من تاريخ يزدجرد</td>
</tr>
<tr>
<td>معرفة تاريخها من تاريخ الهجرة</td>
</tr>
<tr>
<td>معرفة تاريخها من تاريخ الإسكندر</td>
</tr>
<tr>
<td>تاريخ فيلفس</td>
</tr>
<tr>
<td>تاريخ الهجرة</td>
</tr>
<tr>
<td>تاريخ الإسكندر</td>
</tr>
<tr>
<td>تاريخ أغسطس</td>
</tr>
<tr>
<td>تاريخ المجوس</td>
</tr>
<tr>
<td>كبسة المعتضد</td>
</tr>
<tr>
<td>الباب الخامس: في سائر التواريخ المشهورة بعد المذكورة قبل 145</td>
</tr>
<tr>
<td>جدول الآباء من لدن آدم إلى الملكين الذين بهم اتصل التاريخ</td>
</tr>
<tr>
<td>تفرق الكلمة و تحرر الناس احرازا دعت الى</td>
</tr>
<tr>
<td>الرياسة والملوك</td>
</tr>
<tr>
<td>النظام الامر بملوك الكلدانين النازلين ارض</td>
</tr>
<tr>
<td>بابل قبل الطوفان</td>
</tr>
<tr>
<td>الصفحة</td>
</tr>
<tr>
<td>134</td>
</tr>
<tr>
<td>134</td>
</tr>
<tr>
<td>135</td>
</tr>
<tr>
<td>136</td>
</tr>
<tr>
<td>137</td>
</tr>
<tr>
<td>137</td>
</tr>
<tr>
<td>138</td>
</tr>
<tr>
<td>139</td>
</tr>
<tr>
<td>139</td>
</tr>
<tr>
<td>140</td>
</tr>
<tr>
<td>142</td>
</tr>
<tr>
<td>142</td>
</tr>
<tr>
<td>145</td>
</tr>
<tr>
<td>148</td>
</tr>
<tr>
<td>149</td>
</tr>
</tbody>
</table>
المقالة الثانية: الطوفان في ستة النواحى. الابن العاشر والابناء

الباب الخامس: بعده إلى وقت الملوك

150: ملوك الكلدان الذين قاموا ببابل بعد الطوفان

151: ملوك أثر الموصل وقضيتها نينوى

152: ملوك بابل وملوك ماداي وهو الخيسك

154: كانوا منهم متعلمين

155: ملوك الفرس بعد ابطال ملوك الجبلين

156: الإسكندر بارض المشرق و الباطالمة بمصر

157: بعده الملقبين بطلبوس

158: ملوك الروم القياصرة و تفسيره من الأفريقية

كما قيل شق عليه

159: ملوك النصرانية ببولنطيا و سرية

161: فونسطنتينيوس و هي القسطنطينية

163: جدول توارخ الخلفاء و الملوك و الأئمة

169: علل التواريخ و ياتها

الباب السادس: في تواريخ الهند واستخراجها من التواريخ الثلاثة واستخراج الثلاثة منها

172: سنة براموية، و نهار برام و ليلة

177: كلجوك

الح (2) في
محتويات الجزء الأول

المقدمة

النقطة الثانية

المقاطعات والابواب

الباب السابع: والتاريخ الثلاثة بعضها من بعض

182

معرفة ميلاد السنة بالجدول

183

جدول ميلاد السنة المذكورة في أيام الأسبوع

185

جدول السنين المبسوطة

187

جدول ميلاد السنين في أيام الأسبوع

190

جدول الحدود لميلاد سنة اليهود

192

جدول البساط

194

جدول العبور.

195

معرفة تاريخ اليهود من أحد التواريخ الثلاثة

196

معرفة أحد التواريخ الثلاثة من قبل تاريخ اليهود

197

جدول اعياد اليهود والصيام وشمساء الأيام

199

تفاصيل أعياد اليهود

201

تفاصيل صيام اليهود

205

تمتل عياض اليهود في التواريخ المختصة

207

عيلة تركيب العبور

208

شهر الكبيس—آذار الثاني

210

حكم للمحم الطيحة
<table>
<thead>
<tr>
<th>الصفحة</th>
<th>المقالة الثانية</th>
<th>في تعرف أول يوم من الشهر</th>
</tr>
</thead>
<tbody>
<tr>
<td>211</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>الباب السابع</th>
<th>طريق احداث الحدود الفاصلة</th>
</tr>
</thead>
<tbody>
<tr>
<td>214</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>في استخراج ميلاد السنة</th>
<th>معرفة ميلاد السنة في الشهر السرياني</th>
</tr>
</thead>
<tbody>
<tr>
<td>221</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>224</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>الباب الثامن</th>
<th>في استخراج صوم النصاري</th>
</tr>
</thead>
<tbody>
<tr>
<td>227</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>جدول صوم النصاري</th>
<th>يان صوم النصاري</th>
</tr>
</thead>
<tbody>
<tr>
<td>228</td>
<td></td>
<td></td>
</tr>
<tr>
<td>231</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>جدول صورة الاتفاق والاختلاف بين المذكور والجيش</th>
</tr>
</thead>
<tbody>
<tr>
<td>235</td>
<td></td>
</tr>
<tr>
<td>238</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>الباب التاسع</th>
<th>في صيام النصاري وأعيادهم وذكاريهم</th>
</tr>
</thead>
<tbody>
<tr>
<td>238</td>
<td></td>
<td></td>
</tr>
<tr>
<td>239</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>جدول اعياد النصاري وصيامهم وذكاريهم</th>
<th>جدول صيام النصاري</th>
</tr>
</thead>
<tbody>
<tr>
<td>245</td>
<td></td>
<td></td>
</tr>
<tr>
<td>249</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>جدول الفرق بين اعياد النصاري وصيامهم</th>
<th>يان مفعى الأب عند النصاري ومراتب</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>سادات هياكلهم</th>
<th>يان الإناجيل الأربعة</th>
</tr>
</thead>
<tbody>
<tr>
<td>252</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>الصفحة</th>
<th>الباب العاشر</th>
<th>في الأيام المنظمة في الإسلام من شهور العرب</th>
<th>جدول الأيام المنظمة في الإسلام من شهور العرب</th>
</tr>
</thead>
<tbody>
<tr>
<td>254</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>255</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>المقالة الثانية</td>
<td>في اعياد الفرس و(by) ايامهم المشهورة</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>في موسیهم</td>
<td></td>
<td></td>
</tr>
<tr>
<td>261</td>
<td>تفاصیل اعياد الفرس</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>فیاً لفیهم من امثاله و (by) ان لم یحقق</td>
<td></td>
<td></td>
</tr>
<tr>
<td>275</td>
<td>تحقق اشكاله</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>جدول الايام المشهورة في شهور السريانين</td>
<td></td>
<td></td>
</tr>
<tr>
<td>276</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>المقالة الثالثة</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>276</td>
<td>الباب الأول : في امئات الاوتار واستخراجها</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وترالثلث</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة الربع</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وترالخمس</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وتر السدس</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وترالتسع</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وترالثمان</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وترالتسع</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وتر العشر</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>معرفة وتر العش</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>يا</td>
<td></td>
<td></td>
</tr>
<tr>
<td>محتويات الجزء الأول</td>
<td>الصفحة</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>المقالة الثالثة : مقدمة الارشميدس مبرهنة بغير برهاه</td>
<td>273</td>
<td></td>
<td></td>
</tr>
<tr>
<td>الباب الأول : شكل (1)</td>
<td>274</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (2)</td>
<td>275</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (3)</td>
<td>276</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (4)</td>
<td>277</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (5)</td>
<td>278</td>
<td></td>
<td></td>
</tr>
<tr>
<td>الباب الثاني : في توابع امهات الاوتوار المقدم ذكرها فيها قبل</td>
<td>279</td>
<td></td>
<td></td>
</tr>
<tr>
<td>معرفة وتر تتمنّ كلي قوس معلومة الورزالي نصف الدائرة</td>
<td>280</td>
<td></td>
<td></td>
</tr>
<tr>
<td>معرفة وتر ضعف كل قوس معلومة الورتر</td>
<td>281</td>
<td></td>
<td></td>
</tr>
<tr>
<td>معرفة وتر نصف قوس معلومة الورتر</td>
<td>282</td>
<td></td>
<td></td>
</tr>
<tr>
<td>معرفة وتر ربع القوس المعلومة الورتر أو أوترار ما بعده من تمنّها وما يؤدي إلى التنصيف</td>
<td>283</td>
<td></td>
<td></td>
</tr>
<tr>
<td>معرفة وتر تناظر كل قوسين معلومتين الورتر وتر جموعهما</td>
<td>284</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (6)</td>
<td>285</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (7)</td>
<td>286</td>
<td></td>
<td></td>
</tr>
<tr>
<td>شكل (8)</td>
<td>287</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) في</td>
<td>288</td>
<td></td>
<td></td>
</tr>
<tr>
<td>الباب</td>
<td>المقالة الثالثة: في التحلل لاستخراج وتر التسع</td>
<td>الصفحة</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>286</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>287</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>290</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

الباب الثالث: شكل (6)

الباب الرابع: في التحلل لاستخراج وتر الجزء الواحد من ثلاثة مائة وستين جزءا

الباب: شكل (11)

الباب: شكل (12)

الباب: شكل (13)

الباب: شكل (14)

الباب: شكل (15)

الباب: رأى يعقوب السجري

الباب الخامس: في النسبة التي بين القطر وبين الدور

الباب: شكل (16)

الباب: عمل بطليوس

الباب السادس: في اختيار عدد القطر يكون قطع

البتار: شكل (17)

جدول الجيوب
الفهرست المقالات والابواب

المقالة الثالثة: في التجيب والتقويس

الباب السابع: تقييم القوس

- تجيب القوس على الرسم المعهود
- تدقيق التجيب
- تقويس القوس
- تدقيق التقويس
- تسليم القوس

الباب الثامن: في اطلال الاضحى في الضياء وتعريف

- أنواع الظل واستعماله
- معرفة قطر الظل
- معرفة الارتفاع من الظل المستوى
- معرفة الظل المستوى من الارتفاع
- معرفة الارتفاع من الظل المكوس
- معرفة الارتفاع من الارتفاع إلى الظل المكوس
- معرفة الظل المستوى من ظل السلم
- معرفة يد
<table>
<thead>
<tr>
<th>المقالة الثالثة</th>
<th>معرفة الظل من قبل الارتفاع بالجدول</th>
</tr>
</thead>
<tbody>
<tr>
<td>338</td>
<td>معرفة الظل من قبل الارتفاع بالجدول</td>
</tr>
<tr>
<td>339</td>
<td>تدقيق الظل</td>
</tr>
<tr>
<td>339</td>
<td>تدقيق تظلل القدر</td>
</tr>
<tr>
<td>340</td>
<td>معرفة الارتفاع من قبل الظل بالجدول</td>
</tr>
<tr>
<td>341</td>
<td>تدقيق قوس ظل المستوى</td>
</tr>
<tr>
<td>341</td>
<td>تدقيق قوس ظل المعكوس</td>
</tr>
<tr>
<td>342</td>
<td>جدول الأطلال</td>
</tr>
<tr>
<td></td>
<td>شكل (21)</td>
</tr>
<tr>
<td>348</td>
<td>شكل (22)</td>
</tr>
<tr>
<td>350</td>
<td>شكل (23)</td>
</tr>
<tr>
<td>351</td>
<td>تدقيق قسي الأطلال</td>
</tr>
<tr>
<td>352</td>
<td>تقويس الظل المستوى</td>
</tr>
<tr>
<td>353</td>
<td>تعميم العمل المدقق في جميع الجداول</td>
</tr>
<tr>
<td>الباب التاسع</td>
<td>في التشكيل القطاع الكرتي و النسب الواقعة</td>
</tr>
<tr>
<td>354</td>
<td>بين جيوبه</td>
</tr>
<tr>
<td>355</td>
<td>شكل (24)</td>
</tr>
<tr>
<td>356</td>
<td>شكل (25)</td>
</tr>
<tr>
<td>357</td>
<td>شكل (26)</td>
</tr>
<tr>
<td>357</td>
<td>شكل (27)</td>
</tr>
</tbody>
</table>
من القانون السعودي

المقالة الثالثة: في النسب الواقعة في القطاع بين الجيوب والطلال

الباب العاشر

شكل (28)

المقالة الرابعة

الباب الأول: في مقدار زاوية تقاطع معدل النهر مع منطقة البروج وهو الميل الأعظم

 بيان في تحليل الميل الأعظم

اختلاف مقدار الميل

طريق معرفة الميل الأعظم

بغير ارتفاع المنقلبين

شكل (24)

الباب الثاني: في تقطيع الميل الأعظم ومعرفة حصص درجات البروج منه

شكل (20)

شكل (21)

جدول ميول الدرجات وعرضها

الباب الثالث: في مطالع خط الاستواء. مع فلك البروج

وأكسا بالحساب والجدول

جدول (4)
<table>
<thead>
<tr>
<th>المقالة الرابعة: جدول مطالع البروج في خط الاستواء</th>
<th>الصفحة 379</th>
</tr>
</thead>
<tbody>
<tr>
<td>الفهرست المقالات والبابواب</td>
<td></td>
</tr>
<tr>
<td>المقالة الثالثة: الحمل، الثور، الجوزاء، السرطان</td>
<td>الصفحة 379</td>
</tr>
<tr>
<td>الباب الرابع: في استخراج بعد الكوكب ذي العرض</td>
<td>الصفحة 390</td>
</tr>
<tr>
<td>على معدل النهار</td>
<td></td>
</tr>
<tr>
<td>الباب الخامس: في معرفة الدورة التي تمر مع الكوكب ذي العرض</td>
<td>الصفحة 394</td>
</tr>
<tr>
<td>على خط وسط السماء</td>
<td></td>
</tr>
<tr>
<td>الباب السادس: في معرفة درجة الكوكب وعرضه من قبل بعده عن معدل النهار ودرجة مره إذا</td>
<td>الصفحة 398</td>
</tr>
<tr>
<td>عرفه بالرصد</td>
<td></td>
</tr>
<tr>
<td>الباب السابع: في معرفة عروض البلدان بارتفاعات الأشخاص</td>
<td>الصفحة 401</td>
</tr>
<tr>
<td>الطالة الغارية على فلك نصف النهار</td>
<td></td>
</tr>
<tr>
<td>الباب الثامن: في معرفة عروض البلدان بارتفاعات الأشخاص</td>
<td></td>
</tr>
<tr>
<td>الإبدية الظهور فيها على فلك نصف النهار</td>
<td></td>
</tr>
</tbody>
</table>
من القانون السعودي

الباب التاسع: في معرفة عروض البلدان من ارتفاعات الأشخاص في إفلاك نصف نهارها ونصف نهار بلد آخر معلوم العرض

الباب العاشر: في معرفة الارتفاع في ذلك نصف النهار

الباب الحادي عشر: شكل

الباب الثاني عشر: شكل

الباب الثالث عشر: شكل

الباب الرابع عشر: شكل

الباب الخامس عشر: شكل
<table>
<thead>
<tr>
<th>المقالة الرابعة</th>
<th>شكل (44)</th>
</tr>
</thead>
<tbody>
<tr>
<td>الباب</td>
<td></td>
</tr>
<tr>
<td>الخامس عشر</td>
<td>شكل (45)</td>
</tr>
<tr>
<td>الباب</td>
<td>في معرفة عروض البلدان ميل و الشمس</td>
</tr>
<tr>
<td>السادس عشر</td>
<td>من قبل ارتفاعين لها متواليين مع سنتها</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>الباب</td>
<td>في تعديل النهار وقوس النهار</td>
</tr>
<tr>
<td>السابع عشر</td>
<td>الليل ومعرفة عرض البلد منه</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>الباب</td>
<td>شكل (47)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>شكل (48)</td>
</tr>
<tr>
<td>الباب</td>
<td>في مطالع البروج ومغابها في البلاد</td>
</tr>
<tr>
<td>الثامن عشر</td>
<td>جدول مطالع البروج في عرض غزوة</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>شكل (49)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>شكل (50)</td>
</tr>
<tr>
<td>الباب</td>
<td>في درجة طلوع الكواكب و غروبها</td>
</tr>
<tr>
<td>التاسع عشر</td>
<td>شكل (51)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>شكل (52)</td>
</tr>
<tr>
<td></td>
<td>بطق</td>
</tr>
<tr>
<td>المقالة الرابعة: في معرفة الماضي من النهار من قبل الارتفاع الشمس وعكس ذلك</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td>المقالة الخامسة: في معرفة الشمس أو عكسه</td>
<td></td>
</tr>
<tr>
<td>المقالة السادسة: في معرفة الوقت من الليل بقياس الكواكب الثانية</td>
<td></td>
</tr>
<tr>
<td>المقالة السابعة: في استخرج الاوتاد الأربعة للوقت</td>
<td></td>
</tr>
<tr>
<td>المقالة الثامنة: في استخرج الاوتاد بعرض اقليم الرؤية</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>شكل</th>
</tr>
</thead>
<tbody>
<tr>
<td>(54)</td>
</tr>
<tr>
<td>(55)</td>
</tr>
<tr>
<td>(56)</td>
</tr>
<tr>
<td>(57)</td>
</tr>
<tr>
<td>(58)</td>
</tr>
<tr>
<td>(59)</td>
</tr>
<tr>
<td>(60)</td>
</tr>
<tr>
<td>صفحة</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>497</td>
</tr>
<tr>
<td>498</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>501</td>
</tr>
<tr>
<td>502</td>
</tr>
<tr>
<td>503</td>
</tr>
<tr>
<td>504</td>
</tr>
</tbody>
</table>

**ملاحظة**