SCIENTIFIC WORKS IN SANSKRIT, TRANSLATED INTO FOREIGN LANGUAGES AND VICE-VERSA IN THE 18TH AND 19TH CENTURY A.D.*

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India, due to her peculiar geographical position, has been maintaining active cultural relations with her neighbouring and far-flung countries since prehistoric and early historic times. Intellectual exchange of ideas, not infrequently involving translations of texts, took place in ancient and medieval times in a rather sporadic fashion whenever cultural contacts were established through trade channels, political missions and travels. Instances of transmission of Indian medical prescriptions and theories in Hippocratic collections, Plato's *Timaeus* and in the writings of Roman physicians and of Babylonian astronomical parameters in Varāhamihira's *Pañcasiddhāntikā* are mentioned. The case of a Greek astrological treatise translated into Sanskrit by one Yavaneśvara is cited. In the days of Sino-Indian religious and cultural contacts, extensive efforts in translating Sanskrit scientific texts relating to astronomy, mathematics, pharmacy and other subjects are known from the records of the Sui and the Thang dynasties. Sanskrit works played an important role in the foundation of Arab scientific literature. Brahmagupta's *Brāhmasphuṭasiddhānta* and *Khaṇḍakhādyaka* passed into Arabic translations several times, and through such efforts Indian astronomical parameters and rules and mathematical procedures found their way into Arabic literature, which had considerable influence in medieval Spain and Latin Europe. Perhaps in serious indological studies no one surpassed al-Bīrūnī who alone produced more than twenty works on India, including translations from Sanskrit into Arabic and from Arabic into Sanskrit. The paper then gives a brief history of the development of Sanskrit philological studies during the 18th and the 19th centuries, beginning with the efforts of Jesuit missionaries and individual scholars and ending with the establishment of flourishing indological schools in India and Europe. These philological researches and the development of critical apparatus for effectively handling the Sanskrit language paved the way for intensive efforts at translating Sanskrit scientific texts in modern European languages. These efforts are illustrated with reference to astronomy, mathematics, astrology and medicine and a table showing Sanskrit works, names of translators, language of translation and references is appended. In astronomy, mathematics and astrology, the efforts of Cassini, Le Gentil, Bailly, William Jones, Ruben Burrow, Colebrooke, Strachey, Taylor, Whish, Burgess, Wilkinson, Bāpudeva Śāstrī, Weber, Kern, Jacobi and Thibaut are recalled, which enabled non-Sanskritic scholars to read in modern European languages the *Sūryasiddhānta*, the works of Varāhamihira, Brahmagupta and Bhāskara II, the *Vedāṅga*

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Jyotiṣa, the Jaina works on astronomy and several extracts from a large number of commentators. In Medicine, commendable efforts were made by Hessler, Vullers, Roth, Kaviraj Avinash Chandra Kaviratna, Uday Chand Dutt, Aghore Chunder Chattopadhyay, Cordier and Hoernlé. In this study, the contributions of scholars who sought to interpret and clarify important concepts, methods and points have not been generally taken into consideration although such studies have greatly contributed to our understanding of these sciences. Regarding the translation of works in Sanskrit during the period under study, the works of Samrāṭ Jagannātha who translated the *Almagest* and the *Elements* of Nayanasukhopadhyaya and of a few others are noticed.

From prehistoric times as also from early historic periods, India, due largely to her peculiar geographical position, has been maintaining active cultural relations with her neighbouring as well as far-flung countries. It is not therefore surprising that she has been destined to play from a very early date an important role in the transmission and diffusion of scientific ideas. In the sixth century B.C., the Achaemenian Empire and the Graeco-Bactrian Kingdoms provided an effective bridge between India and the Mediterranean world.[1, 2] A little before or about the beginning of the Christian era, thriving commercial relations were established between India and Ptolemaic Egypt and Rome's Eastern Empire. Instances of transmission of Indian medical prescriptions and theories have been noticed in the Hippocratic collections, Plato's *Timaeus*, and in the writings of Roman physicians and encyclopaedists such as Celsus, Scribonius Largus, Pliny and Dioscorides. The Babylonian astronomical parameters turned up in Varāhamihira's summary of five astronomical systems. Although evidence of direct translations of ancient texts is rare, it has come to light that in A.D. 150 one Yavaneśvara translated into Sanskrit prose a Greek astrological text which had been written in Alexandria in the preceding century.[3] The original translation is lost, but a versification of it made in the third century A.D. by Sphujidhvaja has been preserved in Nepal in a thirteenth-century palm-leaf transcription.

An abundant literature exists on the subject of Sino-Indian religious and cultural interchange beginning from the time of the Yueh-Chih Dharmarakṣa (3rd–4th century A.D.) and the Kashmirian Kumārajīva (4th–5th century A.D.). In the course of this interchange, several Buddhist scholars, Indian as well as Chinese, were actively engaged in the translation of canonical as well as non-canonical texts, including a large number of works concerning Brahminical (po-lo-mên) astronomy, mathematics, pharmacy and logic. Most of the non-canonical works translated from Sanskrit into Chinese have not survived, but the records of these activities and titles of some of these works have been preserved in the catalogues of the Sui and the Thang dynasties. The records of the Thang dynasty indicate the existence of an active school of Indian astronomers at Chang-Nan engaged in the teaching and propagation of the Indian *Nava-graha* system of astronomy. The records also

mention a number of Chinese astronomers all bearing the name of Chhüthan, a Chinese transcription of the Hindu name Gautama, who compiled astronomical treatises based on Indian elements and even translated Sanskrit calendrical works in Chinese, of which notable examples are the *Chiu-chi-li* and the *Tai-yen* calendars. Needham observed that, paradoxical as it might appear, the Chinese owed to Indian Chhüthan Hsi-Ta the greatest collection of their ancient and medieval astronomical fragments.[4]

Sanskrit works are also known to have played an important role in the foundation of the Arabic literature between A.D. 750–850. Indian works on fables, military and veterinary science, medicine and astronomy were in this way incorporated into the corpus of the Arabic literature. Arabic astronomical renaissance was possibly brought about by the translation of Indian *siddhāntas*, with which the names of al-Fazārī (*c.* A.D. 750) and Ya'kūb ibn Ṭāriq (*c.* A.D. 770) are intimately associated. Al-Fazārī was possibly the earliest translator of the *Brāhmasphuṭasiddhānta* and Ya'kūb ibn Ṭāriq of the *Khaṇḍakhādyaka*, though this question of the preparation of the earliest *Sindhind* and *Arkand* zījes is by no means settled.[5] Besides direct translations, several Arabic astronomical tables made use of Indian astronomical elements side by side with those derived from Greek works. Al-Khwārizmī's famous astronomical tables were of this nature and, in their revised versions as prepared by Maslama al-Majritī, exerted considerable influence among medieval astronomical circles in Spain. These tables were translated into Latin by Adelard of Bath in the twelfth century, and have come down to us only in this Latin version. Likewise, al-Khwārizmī's arithmetic based on Indian sources of which the Arabic version was long since lost has survived only in a Latin translation under the title *Algoritmi de numero Indorum*, discovered in the Cambridge University Library by Prince Baldassare Boncompagni and published by him in his *Trattati d'Arithmetica*, Rome, in 1857.[6]

Among ancient and medieval scholars interested in translating Sanskrit technical works the most outstanding was without doubt Abū Raiḥān Muḥammad b. Aḥmad al-Bīrūnī (973–1050). Besides his *Description of India* (*Kitāb fī Taḥqīq mā li'l-Hind*), Bīrūnī composed more than twenty books on India which included a number of works representing direct Arabic translations of Sanskrit texts. These translations included astronomical calculations found in the *Brahmasiddhānta*, Varāhamihira's *Laghu Jātaka*, astronomical tables of Vijayānanda (*Karaṇatilaka*), *Puliśa Siddhānta*, book of Sāṅkhya, and the book of Patañjali. Bīrūnī is also known to have prepared a Sanskrit version of Ptolemy's *Almagest*, Euclid's *Elements* and one of his own works on astrolabe. He spent about ten years in North-West India, collected a large number of Sanskrit manuscripts and learnt enough Sanskrit to undertake such ambitious programmes of translation himself with the aid of Pandits and dictionaries. In fact, we hardly come across another indologist of the

stamp of al-Bīrūnī until Sanskrit learning and schools of serious indological studies became firmly established in the nineteenth century.

The foregoing brief account of efforts at translating Sanskrit texts as also of making available foreign materials in Sanskrit shows that efforts, albeit sporadic, were made by isolated scholars whenever cultural and intellectual contacts were established through trade channels, political missions and enterprising travellers. During later medieval periods such contacts ceased, and cases of such activities also became few and far between. Windisch, in his excellent study on the history of Sanskrit philology and ancient Indian studies, has traced the development of European interest in Indian studies from the seventeenth century when isolated travellers and Jesuit missionaries going round different places in India started learning Sanskrit and other Indian languages, collecting manuscripts and building up manuscript libraries in important centres of Europe.[8] In 1651, Abraham Roger, a Dutch preacher who lived in Paliacatta in North Madras, gave an account of the Brahmanical literature in his *Open Deure tot het verborgen Heydendon* (Open Door to the hidden Heathendom). In 1699, Father Johann Ernst Hanxleden, a Jesuit missionary working for the Malabar Mission, produced his *Grammatica Granthamia seu Samscrdumica*, possibly the first ever Sanskrit grammar to be composed by a European. This work was never published, but inspired the researches of another missionary Austrian Fra Paolino de St. Bartholomeo, credited with his *Systema Brahmanicum* (Rome, 1792) and his *Reise nach Ostindien* (Berlin, 1798). While some of the missionaries were thus labouring in India with their literature, grammar, languages and religion, Giovanni Dominique Cassini, the celebrated French astronomer in Paris, received a curious astronomical manuscript in Sanskrit sent to him from the French mission in Siam and published an account of it in the *Mémoires de l'Academie Royale des Sciences*, 1699, which may be taken to be the starting point of the modern European interest in Hindu astronomy.

Warren Hastings provided further fillip to oriental studies by authorizing translations of ancient Indian law books with the help of Pandits and by establishing the Calcutta Madrasah in 1781 and the Sanskrit College of Benares in 1791. Charles Wilkins studied Sanskrit at Benares and produced English translations of the *Bhagavadgītā* in 1785, the *Hitopadeśa* in 1787 and the Śakuntalā episode of the *Mahābhārata* in 1795. His Sanskrit grammar, in which Devanāgarī scripts were used for the first time, was published in 1808. These activities were further invigorated by the arrival in 1783 of the English orientalist William Jones and by the founding by him of the Asiatic Society the following year. Jones' translations of Kālidāsa's *Śakuntalā* in 1789, *Ṛtusaṃhāra* in 1792 and the law book of Manu received wide acclamation; their German translations were primarily responsible for the great enthusiasm created in men like Goethe and Herder for the Sanskrit literature. Jones

was quite alive to the importance of the study of Sanskrit technical literature, but himself could do no more than draw attention to a number of important topics such as the Hindu conceptions of the zodiac, chronology, plant science and other matters. The real pioneer in the field of the study of scientific and technical literature of the Indians was Henry Thomas Colebrooke who, at the instance of William Jones, seriously took up the study of Sanskrit and produced a series of essays covering practically the whole range of Indian thought.

In the mean time, in Europe, following the recrudescence of a new interest in indology, sanskritic studies came to be organized on a firm footing through the creation of chairs in a number of universities and institutions. At the beginning of the 19th century, the Collège de France provided for a professorship in Sanskrit, which attracted a line of distinguished scholars such as A. L. Chézy and Eugène Burnouf. With the leadership of such distinguished scholars and a fine collection of Indian manuscripts which, according to a catalogue prepared by Hamilton and Langlès, totalled over two hundred, Paris served as the cradle of Sanskrit learning and trained young scholars who were later on to set up active centres of studies in other parts of Europe. Such was the case with the Schlegel brothers and Franz Bopp who received their first training in Sanskrit at Paris under Chézy and laid the foundation of the study of Sanskrit philology in Germany. Unlike German translations of Indian books, made from English in the previous generation, Friedrich Schlegel's *Über die Sprache und Weisheit der Indier—Ein Beitrag zur Begründung der Altertumskunde* contained direct translations from Sanskrit of passages from the *Rāmāyaṇa*, the *Bhagavadgītā*, Manu's law-book etc. Franz Bopp initiated studies in comparative philology through a series of publications such as *Über des Conjugations-system der Sanskritsprache in Vergleichung mit jenem der griechischen, lateinischen, persischen und germanischen Sprache* (1816), his Sanskrit grammar (1827–34) and his *Glossarium Sanscritum* (1830). Eugène Burnouf and some of his pupils from Germany and England, of whom the most notable were Rudolph Roth and Max Müller, were responsible for Vedic and Buddhistic studies. Roth who initiated Vedic studies in Germany collaborated with Otto Böhtlingk in producing the monumental Sanskrit dictionary, the *Sanskrit-Wörterbuch*, published from St. Petersburg in seven volumes during the years 1852–75.

The importance of these philological researches and the perfection of the critical apparatus necessary for translating into modern European languages difficult and obscure Sanskrit texts in various branches of science and learning need hardly be overestimated. The Sanskrit scientific literature generally comprises grammar, lexicography, philosophy, *dharmaśāstras*, *arthaśāstras*, architecture, *saṅgītaśāstra*, *kāmaśāstra*, astronomy, astrology, mathematics and medicine. During the eighteenth and the nineteenth centuries

a bewildering volume of literature representing translations in modern European languages of such scientific texts was produced, and it will be an almost impossible task to record these activities in the course of a single paper. Accordingly, an attempt will be made in this paper to give an idea of this effort made in two distinct and established groups of sciences, namely (*a*) astronomy, mathematics and astrology, and (*b*) medicine. For the sake of convenience and ready reference, it has been thought desirable to append a chronological table showing sanskrit works, names of translators, languages of translations, references, etc.; all numbers within parentheses refer to serial numbers of this table.

Astronomy, Mathematics and Astrology

As already mentioned before, the modern study of Hindu astronomy may be said to have commenced with the publication by Giovanni Dominique Cassini of the results of his study of a Sanskrit manuscript in the *Mémoires de l'Academie Royale des Sciences* (1). The manuscript had been brought to Paris in 1687 by M. de la Loubère who had been sent to Siam on an embassy by Louis XIV. The manuscript contained rules for calculating the motions of the sun and the moon. Cassini gave exact translations in French of several rules given in the manuscript along with an excellent commentary possible only for a great astronomer of his calibre. He showed that the Hindus had taken their year-length to be 365 days 6 hours 12 minutes and 36 seconds, that astronomical constants were given for the epoch which started on Saturday, March 21, 638 A.D., that the period of the revolution of the moon's apsis was 3232 days, and that the greatest equations of the centre for the sun and the moon were 2° 12′ and 4° 56′ respectively. From the ratio of the length of a *tithi* to a civil day as 692 : 703 and from 703 lunar months containing 20,760 days, Cassini calculated the length of a synodic month to be 29 days 12 hours 44 minutes and 2·39 seconds. To give an example of Cassini's treatment of the rule for finding *ahargaṇa* as given in this manuscript, the following is cited after Bailly (5):

> 'Posez le *maasaken*: multipliez par 30; joignez les jours du mois courant; multipliez tout par 11; ajoulez-y 650; divisez tout par 703; gardez le numerateur que vous appelerez *anaamen*; prenez le quotient de la fraction trouvez article VI et soustraiez le du nombre trouvé art. III, le veste fera l'horoconne (C'est à dire, le nombre des jours de l'ère) que vour gardez.'

That is,

> 'Set forth the number of months; multiply by 30; add to it the days of the current month; multiply the whole by 11; add to it 650; divide the whole by 703; keep the numerator which you call

anaamen; take the quotient of the fraction found in article VI and subtract it from the numbers found in art III; the remainder will be the *ahargaṇa* (that is to say, the number of days in the era), which you keep.'

The ratio of 7/228 is taken to be the ratio of intercalary months to saura months in a luni-solar *yūga*, which implies the use of the Metonic cycle. James Burgess conjectured that the Siamese manuscript was probably based on the *Pauliśa Siddhānta*.[9]

The next important work was due to Le Gentil, another distinguished French astronomer, who visited India in 1769 to observe the transit of Venus and utilized this opportunity in studying Hindu astronomy. He obtained his information from Brahmin astronomers and faithfully recorded them along with his own explanations and mathematical calculations (2). The work is important for the earliest exposition, in an European language, of the Vākyam process for the computations of solar and lunar eclipses. Some of the elements of the *Sūryasiddhānta* and the *Laghu Āryasiddhānta* are incorporated in this work. In 1777, Robert Barker of the Bengal Military Service described the masonry astronomical instruments of the Benares observatory with drawings (3). Descriptions of Jai Singh's observatories at Jaipur, Delhi, Ujjain and other places also appeared in Bernouille's German and French translations of Tieffenthaler's *Description of India* (4).

In 1787 appeared Jean Sylvain Bailly's *Traité de l'Astronomie indienne et orientale* which summarized the earlier findings of Cassini and Le Gentil and utilized new manuscript materials which had accumulated in Paris and remained unnoticed (5). One such manuscript was entitled the *Pañcāṅga Śiromaṇi* which had been sent from India in 1750 to M. Joseph de Lisle by the French Jesuit Father Patouillet. Another manuscript used by Bailly was collected in India by Father Xavier du Champ and transmitted to the noted Jesuit astronomer Father Gaubil in China who, unable to study it himself, sent it to M. de Lisle. Bailly's study showed that the equations of the sun and the moon agreed with those given in the *Sūryasiddhānta*, that the constants fitted with the year 499 A.D. and the epoch used started from March 10, 1491. His commentaries and calculations were marked by high scholarship and good understanding of Hindu astronomical procedures, but the work suffered from the author's exaggerated notions regarding the high antiquity of Indian astronomy. But the great merit of the work lay in the interest it was able to generate among astronomers in Europe and elsewhere. This is evident from the series of articles which appeared in 1790 in the *Transactions of the Royal Society of Edinburgh*, Vol. 2 and the *Asiatick Researches*, Vol. 2 published by the Asiatic Society of Bengal. In two articles, William Jones discussed the chronology of the Hindus (6) in which the astronomical elements were

pressed into service as Bailly had done before him and the high antiquity of the Indian zodiac (7) giving translations of relevant passages from Hindu astronomoical texts. John Playfair, a mathematician, geologist and natural philosopher, published a long dissertation on the astronomy of the Hindus (8), based largely on the works of Cassini, Le Gentil and Bailly. He summarized his own estimate of Hindu astronomy as follows. 'The constructions and these tables imply a great knowledge of geometry, arithmetic and even of the theoretical part of astronomy. ... But what, without doubt, is to be accounted the greatest refinement in this system, is the hypothesis employed in calculating the equations of the centre for the sun, the moon and the planets, viz. of a circular orbit having a double eccentricity, or having its centre in the middle between the earth and the point about which the angular motion is uniform. If to this we add the great extent of geometrical knowledge requisite to combine this, and the other principles of their astronomy together, and to deduce from them the just conclusions, the possession of a calculus equivalent to trigonometry, and lastly, their approximation to the quadrature of the circle, we shall be astonished at the magnitude of that body of science, which must have enlightened the inhabitants of India in some remote age, and which, whatever it may have communicated to the Western nations, appears to have received nothing from them.' This reflects the general attitude to Indian astronomy and mathematics towards the end of the 18th century which, however, underwent revision later on with the increase in our knowledge of ancient astronomy.

In 1789, Samuel Davis undertook a study and analysis of a copy of the *Sūryasiddhānta* he obtained through the courtesy of Sir Robert Chambers and published his results in the *Asiatick Researches* (10). In this study he utilized a commentary and noticed a number of Hindu astronomical works, including the *Brahmasiddhānta* forming part of the *Viṣṇudharmottarapurāṇa*, *Pulastya-Soma-Vaśiṣṭha-Ārya-Romaka-Parāśara-Ārṣa-siddhānta*, *Sākalya Saṃhitā*, *Graha Lāghava*, *Siddhānta Rahasya* and *Makaranda Sāraṇī*. Applying Lagrange's formula, he showed that the Hindu value of 24° for the obliquity of the ecliptic answered for the year 2050 B.C. Two years later Davis came out with another important paper dealing with the twelve-year cycle of the Jupiter in which he used the statements contained in the *Sūryasiddhānta*, *Siddhānta Śiromaṇi*, *Jyotiṣatattva*, Varāhamihira's works and other texts. About this time, Ruben Burrow, an able mathematician and astronomer then working as an assistant in the Surveyor General's establishment, drew attention to the mathematical acumen of ancient Indians (9). With the help of a Pandit, he translated part of the *Bījagaṇita* and the *Līlāvatī* of Bhāskara II, but never completed the work for publication.

John Bentley's enormous labours with Indian astronomical texts were primarily directed to criticizing Bailly's assumption of the high antiquity of

Indian astronomy (12). Basing on certain statements contained in Śatānanda's *Bhāsvatī-karaṇa*, he placed Varāhamihira and the *Sūryasiddhānta* in the eleventh century A.D. He, furthermore, showed that the planets were not in conjunction at the beginning of the *Kaliyūga* era (February 17–18, 3102 B.C.), the Sun, Mercury, Venus, Mars, Jupiter and Saturn deviating from the initial point of the Hindu ecliptic by as much as $-7°51'48''$, $-41°3'26''$, $+24°58'59''$, $-19°19'26''$, $+8°36'36''$ and $-28°1'13''$ respectively. He calculated the gradual decrease of errors from 3102 B.C. and found on an average the date of planetary conjunctions around A.D. 1091 which accordingly was suggested as the approximate date for the compilation of the *Sūryasiddhānta*. Although his approach and some of his arguments deserved considerations, his methods and generalizations were open to serious criticism and failed to receive the acceptance of the scholarly world.

From the beginning of the 19th century, greater emphasis was placed on the search for new manuscripts and their translations and critical studies with a view to attaining a deeper understanding of the Indian methods and procedures. Playfair had suggested such endeavours years back in 1792, but it was left to Strachey, Taylor and Colebrooke to carry out this important task. Strachey's English translation of Bhāskara's *Bījagaṇita* appeared in 1813 (14) and John Taylor published his *Līlāvatī* in 1816. The following year Colebrooke came out with his *magnum opus* the *Algebra with Arithmetic and Mensuration* etc. (17) containing English translations of considerable portions of the *Brāhmasphuṭasiddhānta* of Brahmagupta and Bhāskara II's *Līlāvatī* and *Bījagaṇita*. His opening dissertation in which he measured the Indian achievements in algebra and arithmetic with those of the Arabs and the Europeans of ancient and medieval times was a model of high scholarship. Colebrooke's earlier notices on the Indian Arabian zodiac (13) and the Hindu corrections for the precession of the equinoxes (16) were marked by a similar critical appraisal of astronomical texts and penetrating analysis.

In 1825, John Warren, an assistant of Col. Lambton in the Trigonometrical Survey of India, produced his *Kala Sankalita* (18), a work compiled on the basis of information supplied to him by Indian astronomers and calendar makers of South India in somewhat the same manner as Le Gentil had done more than fifty years before him. In the preface, Warren explained the object of the work as follows: 'The whole collectively taken, was denominated by some learned friends *Kala Sankalita*, a Sungscrete word signifying the doctrine of times. It presents (as far as the author knows) the first attempt that was made in India to investigate and explain the elements of Hindu Astronomical chronology, and to disclose to Europeans the contents and structure of those humble annual Kalendars which, written on palmyra leaves, have, during nearly two centuries, been sold under their eyes without ever suspecting the skill and labour which their computations required.' This

work discussed, among other things, the method of computing eclipses by means of arranging shells on the ground and with the help of certain tables and a few symbolical words and syllables. In 1952, Neugebauer studied these methods as reported by Warren and discovered in them Babylonian procedures.[10]

In 1827, C. M. Whish revived the old question of the antiquity of the Hindu zodiac, examined the works of Varāhamihira, particularly his *Bṛhajjātaka*, Śrīpati's *Ratnamālā* and a commentary on it, and demonstrated Sanskrit transliteration of Greek zodiacal names as also Greek names of a large number of astrological-astronomical technical terms (19). In the 18th century, Father Pons had reported in the *Letteres edifiantes* (**26**, 236–37, 1743) the existence of such words as *horā* and *kendra* in Sanskrit astrological texts. Colebrooke had occasionally referred to such terms, but it was Whish who made the most exhaustive study of the subject to prove Indian borrowings from Greek astrological sources. Equally important was his work on Hindu quadrature of the circle for which he examined a number of medieval Sanskrit astronomical texts such as the *Tantrasaṃgraha*, *Karaṇapaddhati*, *Yuktibhāṣā* and *Sadratnamālā* (20). These texts contained rules and procedures for obtaining trigonometrical and π series not known in Europe before Gregory.

From 1837 onwards we notice progressive intensification of translation efforts. Although the *Sūryasiddhānta* and the *Siddhānta Śiromaṇi* were quoted time and again in astronomical discussions, complete translations of them had remained a desideratum. From a Marathi translation of the *Siddhānta Śiromaṇi* appeared in 1837 (21), E. Roer published a Latin translation of parts of the text in the *Journal of the Asiatic Society of Bengal* (23), and the translation of the chapter 'Golādhyāya' by Lancelot Wilkinson and Bāpudeva Śāstrī appeared during 1861–62 in the *Bibliotheca Indica* series. As regards the *Sūryasiddhānta*, Bengali translation appeared in 1842 (22), Guerin, in his *Astronomie Indienne*, gave a French translation of parts of chapters 1 and 8 (26), and finally Rev. Ebenezer Burgess, an American missionary who had lived for 15 years in the Bombay Presidency, produced an English translation of the whole text in 1860 (27). Burgess procured three manuscripts of the *Sūryasiddhānta*,—one of them with the commentary *Gūḍhārthaprakāśaka* by Raṅganātha, made the first draft of his translation in India with the assistance of Pandits and the professor of mathematics at the Poona Sanskrit College and finalized the work on his return to the U.S.A. where he received valuable suggestions from the distinguished orientalist and Sanskritist Prof. W. D. Whitney and mathematical assistance from Hubert A. Newton of the Yale College. Moreover, in preparing elaborate notes and commentaries which greatly added to the value of the work, he fully utilized the astronomical researches of his predecessors. Burgess' translation of the *Sūryasiddhānta*, which has ever since remained a standard and model work of its class,

demonstrated the necessity of cooperation among Sanskritists, orientalists and professional scientists in translating and annotating scientific works of this nature.

After the appearance in 1845 of J. B. Biot's paper on lunar mansions in which he favoured a Chinese origin of the system, the old controversy regarding the antiquity and origin of the zodiac was fully revived, and the indianists like Whitney, Burgess and Weber came forward to defend the case of the *nakṣatras*. Albrecht Weber who had already distinguished himself for his Vedic studies by editing the *White Yajurveda* and the *Śatapatha Brāhmaṇa* and by his numerous contributions to the *Indische Studien* delved deep into the Vedic texts to establish the high antiquity of the *nakṣatras*. The results were his *Die vedischen Nachrichten von den Naxatra* (30) and *Über den Vedakalendār, Namens Jyotisham* (29), both published in 1862. The *Vedakalendar* discussed the astronomical elements of the *Vedāṅga Jyotiṣa* which received further treatment at the hands of George Thibaut (39) who gave English translation of a considerable portion of the text. Thibaut also became interested in Vedic mathematics and published an English translation of Baudhāyana's *Śulbasūtra* (36), (39), with extracts from the commentary of Dvārakānātha Yajvā, demonstrating Indian acquaintance with irrational numbers, the so-called Pythagorean theorem and related matters in the sixth-fifth century B.C. Following Weber's notice of the *Sūryaprajñapti*, a Jaina astronomical work based largely on the *Vedāṅga Jyotiṣa*, Thibaut published an account of it, with translation of several passages, in the *Journal of the Asiatic Society of Bengal* (42).

Varāhamihira's works which never ceased to attract interest received fresh treatment at the hands of H. Kern who edited the *Bṛhat Saṃhitā* for the *Bibliotheca Indica*, 1864–65, and published an excellent preface of considerable historical value regarding astronomers mentioned by Varāha and finally translated the whole text serially in the *Journal of the Royal Asiatic Society* (32). A Hindi translation was made by Bālā Śāstrī (43) and another English translation was due to Chidambaram Iyer (47). Weber and Jacobi produced German translations of his *Laghujātaka* (33), (34). George Thibaut again rendered a unique service by first giving an account of Varāhamihira's *Pañca-siddhāntikā* (46), of which a manuscript was discovered by G. Bühler, and then publishing, in collaboration with Sudhākara Dvivedī, a full translation and a Sanskrit commentary (48).

Another important event of this period was the publication by H. Kern from Leiden in 1874 of the *Āryabhaṭīya*, with the commentary *Bhaṭadīpikā* by Paramādīśvara,—the work which was hitherto known only in quotations and excerpts from other astronomical texts and commentaries. In 1879, Leon Rodet translated into French the chapter '*Gaṇitapāda*' (41), containing mathematical rules essential for performing various astronomical computa-

tions. The great progress achieved in the understanding of Hindu astronomy, astrology and mathematics during the last two centuries was admirably summarized in a paper 'Astronomie, Astrologie und Mathematic' by George Thibaut who had himself advanced this knowledge to a great extent by his researches referred to above.[12]

Medicine

Sanskrit medical texts such as the *saṃhitās* of Caraka and Suśruta were translated into Arabic in the 8th century A.D., according to the evidence of Ibn al-Baiṭār, al-Bīrūnī and Abu Usaibiah. Hindu physicians are also known to have worked in the hospitals of Baghdad and translated from Sanskrit into Arabic books on medicine, pharmacology, toxicology and other subjects.[13] That Indian physicians were held in high esteem is corroborated by the repeated mention of Caraka in the Latin translations of Ibn Sīnā, al-Rāzī and Ibn Serabi.[14] Modern notices on Indian medicine, however, started appearing from the early part of the 19th century, when Ainslie published his *Materia Medica of Hindostan* in 1813; Wilson in 1823 reported on the medical and surgical sciences of the Hindus in his *Essays on Sanskrit Literature*; Royle in 1839 published *An Essay on the Antiquity of Hindoo Medicine*; and Wise produced his *Commentary on the Hindoo System of Medicine*.[15] Interest in Indian medicine was kept alive by similar notices and articles by Stenzler, Lassen, Weber, Lietard and several others. Another contributing factor was the opening in 1826 of Medical Classes at the Sanskrit College, Calcutta with the express purpose of training physicians according to the Hindu system of medicine and surgery.

The first edition of a medical text, that of *Suśruta Saṃhitā*, was prepared by Madhusudan Gupta and published from Calcutta during 1835–36. A Latin translation of this medical text was produced by Hessler during 1844–52 (24), followed shortly by a German translation by Vullers (25). The Latin translation became soon obsolete. For a reliable translation of the *Suśruta Saṃhitā* one had to wait till 1883 when Uday Chand Dutt commenced translating the text into English in the *Bibliotheca Indica* and Aghore Chunder Chattopadhyaya continued the work up to 1891 (45); even then the work remained incomplete. In 1897, Hoernlé translated the book up to 1, 14, which was published in the *Bibliotheca Indica*. In 1876, A. M. Kunte edited Caraka giving at the same time a translation of a few chapters of Suśruta. The complete translation was made available only in the beginning of the present century by Kaviraj Kunja Lal Vishagratna. Cordier's *Nāgārjuna et Uttaratantra de la Suśruta Saṃhitā* is an important contribution to the subject (51).

The same story is repeated with regard to the translation of the *Caraka Saṃhitā*. An edition of Caraka was started by Gangadhara Kaviraj in Calcutta during 1868–69 but could not be completed by him. Mahendralal

Sircar published a translation of a few chapters in English in 1870 (31) and Roth published a German translation of sections 3, 8 and 1, 29 in the ZDMG (35). The complete English translation of this voluminous compendium was due to Kaviraj Avinash Chandra Kaviratna and his son Pareshnath Sarma-Kavibhusana; these two physicians really acted as editors, the real translator being Kisori Mohan Ganguly (49). The translation, in the opinion of Jolly, is involved and not always reliable.

In 1890, Lt. H. Bower discovered in a Buddhist stūpa in Kutcha in Kashgar some old Indian medical manuscripts written in incorrect Sanskrit mixed with Prākṛt. The Bower Manuscripts known after the name of their discoverer were edited and translated into English by Hoernlé (50) and also became the subject of intensive scholarly discussions by Hoernlé, Bühler, Jolly, Oldenberg and others.

During the 19th century, following a growing practice in Āyurvedic medicine, a large number of works on materia medica, in Sanskrit and English, were published. The most important of them was Uday Chand Dutt's *The Materia Medica of the Hindus* (40), compiled from Sanskrit medical works and published from Calcutta in 1877. Of medico-botanical glossaries, the 13th chapter of Narahari's *Rājanighaṇṭu*, dealing with minerals, was translated into German by R. Garbe under the title *Die indischen Mineralien*, Leipzig, 1882.

Translation of Scientific Works into Sanskrit

Our information regarding the efforts made during the 18th and the 19th centuries in translating scientific works in foreign languages into Sanskrit is meagre. At the beginning of the 18th century, Jagannātha, principal astronomer of Jai Singh, the builder of astronomical observatories at Delhi, Jaipur, Ujjain and other places, translated Ptolemy's *Almagest* and Euclid's *Elements* from Arabic into Sanskrit under the titles *Samrāṭ-siddhānta* and *Rekhāgaṇita*. Hunter records that at Ujjain he met a grandson of Jagannātha who had in his possession several Sanskrit translations of European mathematical works, including plane and spherical trigonometry and Napier's logarithms.[16] Jai Singh's own little work entitled *Yantrarāja* dealing with the construction and theory of astrolabes appears to be either a translation of, or based on, some Arabic or Persian work on the subject. Nayanasukhopādhyāya's *Ukārākhya-grantha* is a treatise on spherical geometry translated by him with the help of one Abid from Arabic into Sanskrit.[17] Late Bāpudeva Śāstrī (1821–90) who collaborated with Lancelot Wilkinson in editing and translating *Siddhānta Śiromaṇi* was an enthusiastic translator of European elementary mathematical works into Sanskrit and produced a number of tracts on geometry, trigonometry and astronomy.[18]

The establishment of the Native Medical Institution in 1824 and the opening of Medical Classes in 1826 at the Sanskrit College and the Madrassah at Calcutta created a need for translating European medical text-books into Sanskrit and other Indian languages. Some of the books selected for translation and lithographed at Government expense include the following: (1) Hooper's *Anatomists' Vade-mecum*, *Physicians' Vade-mecum*, and *Surgeons' Vade-mecum*; (2) Thomson's *Conspectus of the Pharmacopoeia*; (3) Fyfe's *Manual of Chemistry*; (4) Twining and Smith's *Tropical Diseases*; (5) Conquest's *Outline of Midwifery*; (6) Thomas' *Plague*; and (7) *A Book of Vaccination*.[19] In 1834, Pandit Madhusudhan Gupta was paid Rs.1,000 for translating Hooper's *Anatomists' Vade-mecum*. The work was completed under the title *Śārīravidyā* and taken up for publication by the Asiatic Society in 1835; but the publication was abandoned after a few pages had been printed on account of a cut in the Society's grant for publication of oriental books as a sequel to the controversy then raging between the Anglicists and the Orientalists.[20]

The early emphasis on the writing of medical books in Indian languages for the students of the Native Medical Institution and the Medical Classes of the Sanskrit College and the Madrassah and the decision to re-establish Bengali medical classes at the Calcutta Medical College soon after its foundation created a congenial climate for the production of medical books in Bengali. Some of the books published in this period include Ram Komul Sen's *Aushadh Sar Sangraha* (1819), Cary's *Videa Haravali* (dealing with anatomy and based on the article of the *Encyclopaedia Britannica*, 5th edition (1820)), Breton's *A Vocabulary of Medical Terms* (1823) (giving Persian, Sanskrit and Bengali medical terms and involving much research), Breton's *Ula Uta Bibaran*—a book on cholera (1826), *Utpati Nirbāha*, an anonymous work on foetus, based on Āyurveda (1826), Prankrishna Biswas' *Ratnabali* or Medical Manual (1833), Iswar Chandra Bhattacharjyea's *Drabyea Guṇa*, qualities of indigenous medicine being translation from Sanskrit works (1835), Madhusudan Gupta's *Aushadh Kalpabali* (1849) (a Bengali translation of the London Pharmacopoeia giving methods of preparations of acids, alkalies, cerates, confections, plasters, infusions, metals, pills, powders, syrups, tinctures, ointments etc.), Raj Krishna Mukarjyea's *Atmarakhya* (1849), Srinarayan Ray's *Ayurveda Darpan* (1852) (giving translations from Caraka and Suśruta on various diseases and their cures), Haladhar Sen's *Chikitsa Ratnakar* (1853), P. Kumar's *Aushadh Byeabahārak*—Bengali translation of Practice of Medicine (1854), and Ananda Chandra Barman's *Sar Kaumadi*—a materia medica, translated from the Āyurveda (1855). For references to further works of this nature, Long's *A descriptive Catalogue of Bengali Works* (1855) is a valuable guide.

TABLE

Table showing Sanskrit Works, Names of Translators, Languages of Translations, References, etc.

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
1	1691–1699	Astronomy	Anonymous	A manuscript of Hindu system of astronomy sent to Paris by M. de la Loubère of the French Embassy to Siam in 1687.	Giovanni Dominique Cassini	French	*Mémoires de l'Academie Royale des Sciences*, 1699, 8, 279–362. The Memoires originally appeared in de la Loubère's *Relation de Siam*, II.
2	1772	Astronomy	—	Based on oral instructions received from Tamil astronomers and calendar-makers.	Le Gentil	French	'Mémoires sur l'Astronomie des Indiens', *Histoire de l'Academie Royale des Sciences*, 1772, 2nde partie, 169–189; 190–214; 221–266.
3	1777	Astronomy	—	Description of astronomical observatory and instruments.	Robert Barker	English	'Bramin's Observatory at Benares', *Philosophical Transactions of the Royal Society*, **67**, 598–607.
4	∫ 1785–1789	Astronomy	—	Description of Jai Singh's Astronomical Observatories.	Father Joseph Tieffenthaler (translated by Jean Bernouille)	Latin	*Das Pater Joseph Tieffenthalers ... historisch-geographische*
						German	*Beschreibung von Hindustan*, Berlin, 3 vols., 1785–87.
						French	*Description historique et geographique de l'Inde*, 3 vols., 1786–89.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
5	1787	Astronomy	—	Based on materials published by Cassini and Le Gentil; two new manuscripts, one of them *Pañcāṅga Śiromaṇi*, other not mentioned.	Jean Sylvain Bailly	French	*Traité de l'Astronomie indienne et orientale*—ouvrage qui peut servir de suite à l'Histoire de l'Astronomie ancienne, Paris, 1787.
6	1790	Astronomy	—		William Jones	English	'On the Chronology of the Hindus', *Asiatick Researches*, II, 111–147; suppl. 389–403, 1790.
7	1790	Astronomy	—		William Jones	English	'On the Antiquity of the Indian Zodiack', *Asiatick Researches*, II, 289–306, 1790.
8	1790	Astronomy		English exposition of the works of Cassini, Le Gentil and Bailly.	John Playfair	English	'Remarks on the Astronomy of the Brahmins', *Transactions of the Royal Society of Edinburgh*, II, 135–192, 1790.
9	1790	Mathematics	—		Ruben Burrow	English	'A Proof that the Hindus had Binomial Theorem', *Asiatick Researches*, II (App. 5), 487–497, 1790.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
10	1790	Astronomy		Based on Sūryasiddhānta.	Samuel Davis	English	'On the Astronomical Computations of the Hindus', *Asiatick Researches*, II, 225–287, 1790. (A critical analysis of the elements of the *SS* in the course of which six astron. MSS previously unnoticed in European languages were mentioned and utilized.)
11	1792	Astronomy		Based on Sūryasiddhānta, Varāhamihira, Siddhānta-tattva-viveka, Siddhānta Śiromaṇi.	Samuel Davis	English	'On the Indian Cycle of Sixty Years', *Asiatick Researches*, III, 209–227, 1792.
12	1799	Astronomy		Based on Sūryasiddhānta.	John Bentley	English	'On the antiquity of the *Sūryasiddhānta* and the formation of the astronomical cycles therein contained', *Asiatick Researches*, VI, 537–588, 1799. (Analytical work with translation of passages as required.)
13	1807	Astronomy	—		Henry Thomas Colebrooke	English	'On the Indian and Arabian Divisions of the

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
							Zodiack', *Asiatick Researches*, IX, 323–376, 1807. Also his *Essays*, II, 321–376. (Several Sanskrit texts cited with translations of extracts.)
14	1813	Mathematics	Bhāskara II	Bījagaṇita	E. Strachey	English	*On the Algebra of the Hindus*, 119 p., London, 1813.
15	1816	Mathematics	Bhāskara II	Līlāvatī	John Taylor	English	*The Lilawati or a treatise on Arithmetic and Geometry by Bhascara Acarya*, translated from the original Sanskrit, 161 p., Bombay, 1816.
16	1816	Astronomy			Henry Thomas Colebrooke	English	'On the Notions of the Hindu Astronomers concerning the Precession of the Equinoxes and Motions of the Planets', *Asiatick Researches*, XII, 209–250, 1816. Also his *Essays*, II, 374–416.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
17	1817	Mathematics	Brahmagupta Bhaskara II	Brāhmasphuṭasiddhānta (chapters dealing with gaṇitādhyāya and kuṭṭakādhyāya only), Līlāvatī and Bījagaṇita.	Henry Thomas Colebrooke	English	*Algebra with Arithmetic and Mensuration from the Sanscrit of Brahmagupta and Bhāscara*, London, 1817.
18	1825	Astronomy	—	—	John Warren	English	*Kala Sankalita*, a collection of memoires on the various modes according to which the natives of the southern parts of India divide time, Madras, 1825.
19	1827	Astronomy	Varāhamihira Śrīpati	Vṛhajjātaka Ratnamālā	C. M. Whish	English	'On the Antiquity of the Hindu Zodiack', *Transactions of the Madras Literary Society*, 1837. Translated by Lassen in *Zeitsch. f.d. Kunde d. Morgenl.*, IV, 302 ff. (reproduces from the texts several astronomical-astrological terms originally used in Greek).

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
20	1835	Mathematics		Tantrasaṃgraha, Yuktibhāṣā, Karaṇapaddhati, Sadratnamālā	C. M. Whish	English	'On the Hindu Quadrature of the Circle and the Infinite Series of the Proportion of the Circumference to the Diameter exhibited in the four Shastras, the Trantrasaṃgraha, Yuktibhāṣā, Karaṇapaddhati and Sadratnamālā', *Transactions of the Royal Asiatic Society of Great Britain and Ireland*, **3**, 509–523 (translations of relevant passages given with mathematical interpretations).
21	1837	Astronomy	Bhāskara II	Siddhānta Śiromaṇi, Sūryasiddhānta	—	Marathi	*Siddhānta Śiromaṇi Prakāśa*, Bombay, 1837.
22	1842	Astronomy	—	Sūryasiddhānta	—	Bengali	Sūryasiddhānta, with Bengali translation, Calcutta, 1842.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
23	1844	Astronomy	Bhāskara II	Siddhānta Śiromaṇi	E. Roer	Latin	'Bhascarae Acharyae Siddhanta Shiromani sic dieti operis pars tertia, Ganitadhiam, sive astronomium continens, Latine vertit notasque adjacit, E. Roer', *Journal of the Asiatic Society of Bengal*, **13**, pt. 1, 53–66, 1844.
24	1844–1852	Medicine		Suśruta Saṃhitā	F. Hessler	Latin	Suśrutas, Erlangen, 1844–52, Now obsolete
25	1846	Medicine		Suśruta Saṃhitā	J. A. Vullers	German	Altindische Geburtshilfe aus Susrutas System der Medizin, ubersetzt und erläutert von J. A. Vullers, Giessen, 1846 (from the periodical *Janus*, I, 225 ff., 1846).
26	1847	Astronomy		Śuryasiddhānta	Abbe J. M. F. Guerin	French	*Astronomie indienne*, Paris, 1847 (parts of 1st and 8th chapters only).
27	1860	Astronomy		Sūryasiddhānta	Rev. Ebenezer Burgess	English	'Translation of the *Sūrya-siddhānta*—a Text-book of Hindu Astronomy, with notes and an appendix', *Journal of the American Oriental Society*, VI, 141–498.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
28	1860–1862	Astronomy	Bhāskara II	Sūryasiddhānta Siddhānta Śiromaṇi	Lancelot Wilkinson Bāpudeva Śāstrī	English	*Sūryasiddhānta and Siddhānta Śiromaṇi*, Bibliotheca Indica, No. 32, Calcutta, 1860–62.
29	1862	Astronomy		Vedāṅga Jyotiṣa	Albrecht Weber	German	'Über den Vedakalendar, Namens Jyotisham', *Abhandlung. d. konigl. Akad. der Wissensch. zu Berlin*, 1862.
30	1862	Astronomy			Albrecht Weber	German	*Die vedischen Nachrichten von den Naxatra*, Berlin, 1860–62.
31	1870	Medicine		Caraka Saṃhitā	Mahendralal Sircar	English	Translated a few chapters, *Calcutta Journal of Medicine* (Jolly, *Medicine*, 12).
32	1870–1875	Astronomy-Astrology	Varāhamihira	Bṛhatsaṃhitā	H. Kern	English	'The Bṛhatsaṃhitā or Complete System of Natural Astrology of Varāhamihira', *Journal of the Royal Asiatic Society*, 1870–75.
33	1872	Astrology	Varāhamihira	Laghujātaka	A. Weber	German	Text and translation of chapters I & II, *Indische Studien*, II, 1872.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
34	1872	Astrology	Varāhamihira	Laghujātaka	H. Jacobi	German	Text and translation of chapters III to XII under the title 'De astrologiae Indicae "Hora" appallatae originibus accedunt Laghu-Jatakas capita inedita', III–XII, Diss., Bonnae, 1872.
35	1872	Medicine		Caraka Saṃhitā	Roth	German	Translated sections 3, 8 and 1, 29, *ZDMG*, **26**, 442 ff., 1872.
36	1875	Mathematics		Śulbasūtras	George Thibaut	English	'On the Śulbasūtras', *Journal of the Asiatic Society of Bengal*, **44** (1), 227–275, 1875.
37	1875	Astrology	Pṛthuyaśas	Horāṣaṭpañcāśikā		Bengali	Published with a commentary and Bengali translation, Calcutta, 1875.
38	1874–1875, 1877	Mathematics	Baudhāyana	Baudhāyana Śulba	George Thibaut	English	'Baudhāyana Śulba, with English translations, critical notes, extracts from the commentary of Dvārakānātha Yajvā and a few diagrams', *PANDIT*, old series 9 and 10, 1874–75; new series 1, 1877.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
39	1877	Astronomy		Vedāṅga Jyotiṣa	George Thibaut	English	'Contributions to the explanations of Jyotisha-Vedāṅga', *Journal of the Asiatic Society of Bengal*, **46** (1), 411–437, 1877.
40	1877	Medicine		Materia Medica	Uday Chand Dutt	English	*The Materia Medica of the Hindus*, compiled from Sanskrit medical works, Calcutta, 1877.
41	1879	Mathematics	Āryabhaṭa	Gaṇitapāda	Leon Rodet	French	'Aryabhaṭīye gaṇitapādāḥ, Leçons de Calcul d' Āryabhaṭa', *Journal asiatique*, **13**, 393–434, 1879.
42	1880	Astronomy		Sūryaprajñapti	George Thibaut	English	'On the Sūryaprajñapti', *Journal of the Asiatic Society of Bengal*, **49** (1), 107–127; 181–206, 1880.
43	1880	Astrology	Varāhamihira	Bṛhatsaṃhitā	Bālā Śāstrī	Hindi	Bṛhatsaṃhitā with a Hindi translation, Benares, 1880.
44	1882	Medicine	Narahari	Rājanighaṇṭu	R. Garbe	German	*Die indischen Mineralien*, Leipzig, 1882.

TABLE—(*contd.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
45	1883–1891	Medicine ,,		Suśruta Saṃhitā ,,	Uday Chand Dutt Aghore Chunder Chattopadhyaya	English ,,	*The Suśruta Saṃhitā*, Bibliotheca Indica. Continued the translation after U. C. Dutt, Calcutta, 1891.
46	1884	Astronomy	Varāhamihira	Pañcasiddhāntikā	George Thibaut	English	'Notes from Varāhamihira's Pañcasiddhāntikā', *Journal of the Asiatic Society of Bengal*, 53 (1), 259–293, 1884.
47	1884	Astrology	Varāhamihira	Bṛhatsaṃhitā	Chidambaram Iyer	English	Madura, 1884 (Reference, Thibaut, *Astronomie*, 66).
48	1889	Astronomy	Varāhamihira	Pañcasiddhāntikā	George Thibaut Sudhākara Dvivedī	English	*The Pañcasiddhāntikā*, the text edited with an original commentary in Sanskrit and an English translation and introduction, Benares, 1889.
49	1891–1899	Medicine		Caraka Saṃhitā	Kaviraj Avinash Chandra Kaviratna	English	Complete English translation of Caraka Saṃhitā, Calcutta, 1891–99. (Completed by his son Pareshnāth Śarmā Kavibhūṣaṇa in 1911. According to Winternitz, actual translator was Kishori Mohan Ganguli, III, pt. 3, 630, tr. Subhadra Jha.)

TABLE—(*concld.*)

Sl. No.	Year	Subject	Sanskrit Author	Text Title	Translator	Language	Reference to Publication
50	1893–1912	Medicine		Bower Manuscript	A. F. R. Hoernlé	English	The Bower Manuscript Facsimile Leaves, Nāgarī Transcript, Romanized transliteration and English translation with notes, *Archaeological Survey of India*, vol. 22, Calcutta, 1893–1912.
51	1896	Medicine		Suśruta Saṃhitā	P. Cordier	French	'Nāgārjuna et Uttaratantra de la Suśruta Saṃhitā', Anantarivo, 1896.
52	1897	Medicine		Suśruta Saṃhitā	A. F. R. Hoernlé	English	*Suśruta Saṃhitā*, Bibliotheca Indica, 985, up to 1, 14, Calcutta, 1891.

References

[1] Sen, S. N., 'Influence of Indian Science on Other Culture Areas', *Indian Journal of History of Science*, **5**, No. 2, 332–346, 1970.

[2] Sen, S. N., 'Transmission of Scientific Ideas between India and Foreign Countries in Ancient and Medieval Times', *Bulletin of the National Institute of Sciences of India*, No. 21, 8–30, 1963.

[3] Pingree, David, 'Astronomy and Astrology in India and Iran', *ISIS*, **54**, 229–246, 1963.

[4] Needham, Joseph, 'Science and Civilisation in China', III, 203, 1959.

[5] Kennedy, E. S., 'A Survey of Islamic Astronomical Zījes', *Transactions of the American Philosophical Society*, **46**, 123–77, 1956.

[6] Benedict, Suzan Rose, *A Comparative Study of the Early Treatises introducing into Europe the Hindu Art of Reckoning*, being a thesis submitted for the Degree of Doctor of Philosophy in the University of Michigan, 1914.

[7] Khan, Ahmed Saeed, *A Bibliography of the Works of al-Bīrūnī*, presented at the symposium on 'Al-Bīrūni and Indian Sciences', held in Delhi in November 1971 under the auspices of the Indian National Science Academy.

[8] Windisch, E., 'Geschichte der Sanskrit-Philologie und indischen Altertumskunde, I, II', *Grundriss der Indo-Arischen Philologie und Altertumskunde.* This is summarized by Winternitz in his *A History of Indian Literature*, vol 1, pt. 1, 7–21, 1959.

[9] Burgess, James, 'Notes on Hindu Astronomy and the History of Our Knowledge of It', *Journal of the Royal Asiatic Society*, 717 ff., 1893.

[10] Neugebauer, O., 'Tamil Astronomy—A Study in the History of Astronomy in India', *OSIRIS*, **10**, 252–276, 1952.

[11] Biot, J. B., 'Sur les Nacshatras, ou Mansions de la Lune, selon les Hindoux etc.', *Journal asiatique*, 39 ff., 1845.

[12] Thibaut, George, 'Astronomie, Astrologie und Mathematik', *Grundriss der Indo-Arischen Philologie und Altertumskunde*, III, 9, 1897.

[13] Sachau, E., *Al-Bīrūnī's India*, Preface, xxxi–xxxii.

[14] Weber, A., *The History of Indian Literature*, p. 271, 1875.

[15] Jolly, Julius, 'Medicin', *Grundriss der Indo-Arischen Philologie und Altertumskunde*, III, 10, p. 19.

[16] Sen, S. N., 'Astronomy' in *A Concise History of Sciences in India*, Indian National Science Academy, p. 103, 1971.

[17] Sen, S. N., *A Bibliography of Sanskrit Works on Astronomy and Mathematics*, Indian National Science Academy, p. 153, 1966.

[18] Dvivedī, Sudhākara, *Gaṇakataraṅgiṇī*, p. 127.

[19] *Centenary of the Medical College of Bengal*, p. 4.

[20] *Centenary Volume of the Asiatic Society*, Part I, pp. 58–59.