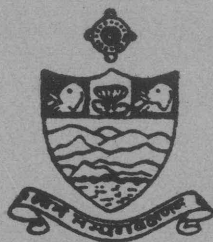


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**TRANSLATION OF SCIENTIFIC TEXTS
INTO SANSKRIT UNDER
SAWAI JAI SINGH**

1.1 Translation played an important role in almost all encounters between cultures. A comprehensive account of this role has yet to be written. Some aspects of this are very well known, in others our knowledge is still fragmentary.

When China discovered Buddhism, a large corpus of Buddhist texts in Sanskrit and Prakrit was translated into Chinese during the first millennium after Christ, by Chinese as well as Indian monk-scholars. In his *Catalogue of the Chinese Translation of the Buddhist Tripiṭaka* (Oxford 1883), Bunyiu Nanjio listed as many as 1662 texts thus translated. A later catalogue by Sylvain Lévi and J. Takakusu entitled *Hobogirin* (Paris 1929 ff) raises this number to 2184 texts.¹ According to Professor P.C. Bagchi, "some of these translations also had great literary value and came to be looked upon as classics in Chinese literature".²

Tibetans took to Buddhism somewhat later – in the seventh century under the reign of King Sron-bstan-gam-po (b. 617 A.D.). His courtier Thon-mi Sambhota is said to be the first translator of Buddhist texts into Tibetan. From his time to the fourteenth century, some 4566 texts were translated into Tibetan, by Tibetans and Indians. These were arranged by Bu-ston (1290-1364) into two groups called respectively *Bkaḥ-ḥgyur* or *Kanjur* (the Word of the Buddha) and *Bstan-ḥgyur* or *Tanjur* (the Treatises).³ Tibetan translations were not only more numerous than the Chinese, they were also more accurate, so accurate that the original can be reconstructed from the Tibetan without any loss in nuance or in verbal flavour.⁴ Many of these Buddhist texts survive today only because they have been thus translated into Chinese or Tibetan.

1.2 Thus oftentimes translation was not just a tool for exchange of ideas; it was also an indispensable means of preservation. A notable case in this sense is the preservation and later dissemination of Greek science through Arabic translations in the eighth and ninth centuries A.D. under the Abbasids. This momentous enterprise in the history of ideas was well chronicled by De Lacy O'Leary.⁵

Arabs had a parallel encounter with Indian scientific ideas about the same time or a little earlier. This encounter gave rise to the Sindhind school of astronomy, to the dissemination of the Indian number system and Indian mathematics, and so on. This has been discussed often enough, but there are still many grey areas in the historiography of this encounter.

1.3 Nearer home, the history of translation within India has had an abysmally poor documentation, although literary composition in many regional languages began with translations from Sanskrit. An important milestone in the history of translation in India is the translation of texts from Sanskrit into Persian and vice versa. The last phase of this activity took place under the auspices of Sawai Jai Singh (1688-1743).

2.1 Sawai Jai Singh's majestic astronomical instruments⁶ overshadow his achievements in other realms of intellectual activity which also merit attention. One such activity is the translation into Sanskrit of scientific texts from Arabic and Persian, and to a lesser extent also from European languages.⁷ In this programme, Jai Singh had the support of two long traditions. First, the eclectic approach of the Indian *vyākhyāṇīs* who did not hesitate in borrowing extensively from diverse sources like Mesopotamia, Greece, the Islamic World, and later also from the modern West. The second tradition that supported Jai Singh's translation programme emanates from the Islamic culture area where scientific texts were more systematically rendered into Arabic from the eighth century onwards. The translation or adaptation of Sanskrit astronomical and medical texts at Baghdad under Caliph al-Mansur in the eighth century and somewhat later of Greek astronomical texts, and subsequently their transmission to Europe is too well known to be reiterated here.

2.2 In India also Muslim kings sponsored transfer of knowledge from Sanskrit before Jai Singh undertook similar work. Notable among these are Firūz Shāh Tughluq (reign: 1351-1388) and Jalāluddīn Akbar (reign: 1556-1605).

3.1 In the second half of the fourteenth century, Fīrūz Shāh Tughluq gathered at his court at Delhi a number of Muslim, Hindu and Jaina scholars and attempted a systematic exchange of ideas. The names of some of these scholars and the texts they translated are available if not always the translations themselves. A booty of 1300 Sanskrit manuscripts from the Jvālāmukhī temple in the Nagarkot kingdom in Kangra Valley aroused Fīrūz's interest in Hindu learning.⁸ From these manuscripts he got translated into Persian the following six works, as reported in the *Sīrat-i-Fīrūz Shāhī*, an anonymous but contemporary chronicle:⁹

- i. Varāhamihira's *Bṛahatsamhitā* was translated by 'Abdul 'Azīz Shams.¹⁰
- ii. Another Sanskrit work of identical content was rendered into Persian under the title *Dalā'il-i Fīrūz Shāhī* by 'Izz al-Dīn Khālid Khānī.¹¹
- iii. A Sanskrit work dealing with good and bad omens for hunting was translated with the title *Shikārnāma Fatah Khān*.
- iv. Likewise, the *Sārāvalī*, obviously of Kalyāṇavarman (A.D. 800), was also rendered into Persian.
- v. So also the *Haramekhalā* which "deals with various kinds of miracles and many wonders of prophecy."¹²
- vi. An astrological text was translated but its name cannot be deciphered from the expression "*dāstāhā*" used in the *Sīrat-i-Fīrūz Shāhī*.

Of these six titles, only the first two appear to be extant. The translation of the *Bṛahatsamhitā* is available in several manuscripts. Eight chapters dealing with idol

worship and the like were not translated as repugnant to Islam. However a proper study is still wanting on the accuracy and quality of translation of the remaining chapters.

3.2 Two Jaina monks, Mahendra Sūri and his pupil Malayendu Sūri were at Fīrūz's court. These two must have helped in the translation of the Sanskrit texts. They were also responsible for the transfer of knowledge in the reverse direction, namely, from the Islamic world to Sanskrit. In 1370 Mahendra Sūri composed the first Sanskrit manual on the astrolabe, a versatile astronomical instrument which enjoyed a great reputation among the Muslims, after consulting, as he says, the ocean-like vast literature produced by the Yavanas on this subject.¹³ We do not know exactly what these Islamic texts on the astrolabes may have been. Perhaps they included the various works Al-Bīrūnī wrote on the astrolabe.¹⁴ But it is certain that both Mahendra Sūri and his pupil Malayendu Sūri, who wrote a commentary on his teacher's work around 1382, were helped from the Muslim side by persons like the anonymous author of the *Sīrat-i-Fīrūz Shāhī*, which contains an interesting chapter on Fīrūz's experiments with the astrolabe. A comparison of this chapter with Mahendra Sūri's manual is essential in order to understand the level of interaction between the Muslim and Indian scholars at Fīrūz's court.¹⁵

4.1 More details are available from the reign of Akbar on the nature of exchanges of ideas through translation. Akbar desired that the Muslim intelligentsia be made familiar with the classics of Hindu thought so that they have a better interaction with Hindus and therefore established the *Maktabkhānā* or bureau of translation.¹⁶

This is not the place to discuss the Sanskrit texts that were rendered into Persian in this *Maktabkhānā*,¹⁷ although it will be quite instructive to know which works from the vast Sanskrit literature aroused the interest of the Muslims. What is immediately relevant for our purpose is the procedure of translation, as reported by two of the chief participants, viz. Abul Fazl and Abdul Qādir Badāyūnī.

4.2 According to these writers, translation was not performed by single scholars proficient in both source language and the target language, in this case, Sanskrit and Persian. Rather the task was accomplished by teams of scholars, some proficient in Sanskrit and others in Persian. They did the work in three stages. First, Hindu or Jaina scholars prepared a paraphrase in Hindi of the Sanskrit text to be translated. In the second stage, this Hindi paraphrase was translated into Persian by one of the several Muslim courtiers. Finally, the Persian translation was polished and put into elegant prose and verse by one of the more accomplished scholars, often the emperor himself supplying the felicitous phrase. The Hindus who prepared the Hindi paraphrase were known as *ma'barān* (interpreters) and the Muslims who rendered the paraphrase into Persian were styled *mutarajjimān* (translators).¹⁸

What resulted in this process cannot be termed an exact translation but rather a Persian paraphrase into which often the mediator's explanatory sentences crept in. Francis Gladwyn says of the *Razmnāma*, the Persian version of the *Mahābhārata*, that "it was nothing more than an extract, very indifferently executed, many beautiful descriptions and episodes being entirely omitted".¹⁹

4.3 One scientific work was also translated in this manner. It was Bhāskarācārya's *Līlāvati* on arithmetic, which Faizi, Abul Fazl's brother, rendered into Persian.²⁰ Faizi is said to be a scholar of Sanskrit but John Taylor who studied the Persian version says that it has many omissions, and departs in some passages so far from the original as to "induce the suspicion that Faizi contended himself with writing down the verbal explanation afforded by his assistant".²¹ Besides the *Līlāvati*, one more scientific text appears to have been translated into Persian. Unfortunately, its name is variously misspelt as *tājak* or *nājak*; perhaps it is some work on *jātaka*, i.e. horoscopy.²²

4.4 In the reverse direction, at least one scientific work was translated into Sanskrit, namely Ulūgh Beg's *Astronomical Tables*. While Abul Fazl and Fatullah Shirāzī explained the meaning of the original text, Kishan Joshī, Gaṅgādhar and Mahesh Mahānand wrote it down in Sanskrit.²³ This translation seems to have been made use of by *jyotiṣīs* like Kamalākara and Nityānanda later on.

But many more Sanskrit works appeared outside the confines of the *Maktabkhānā*, which betray a knowledge of Islamic astronomy. These have been studied by David Pingree in his "Islamic Astronomy in Sanskrit".²⁴ In this context, the following questions arise, for which we do not yet have adequate answers. Who were the Muslim interlocutors of these Hindu *jyotiṣīs*, especially in Varanasi? What were the Islamic texts that were made accessible to Hindu *jyotiṣīs* through oral explanation?

4.5 A number of Hindu astrologers were, of course, officially connected with the Mughal court at Agra and

later at Fatehpur Sikri and Delhi. As I have shown elsewhere,²⁵ Akbar introduced a system of appointing Hindus as royal astrologers with the title Jotik Rāi (from Sanskrit *Jyotiṣarāja/rāya*). The *Akbarnāmā* reports that the Jotik Rāi prepared the horoscopes of Akbar, his heir apparent Salīm and also of other sons. The identity of this astrologer is not revealed but it is quite probable that he was *Nīlakaṇṭha*, the author of the *Tājikanīlakaṇṭhī*, the most popular work on the *Tājika* (i.e. 'Islamic' system of astrology).

Jahāngīr had two Jotik Rāi-s; perhaps one succeeded the other. These were Keśava and Paramānanda. The latter composed *Jahangīra-vinoda-ratnākara* in honour of his patron. Kṛṣṇa Daivajña, who wrote learned commentaries on Bhāskara's *Bījagaṇita* and Keśava's *Jātakapaddhati*, was a favorite of Jahāngīr. He must be identical with the Kishan Joshi who took part in the translation of Ulūgh Beg's astronomical Tables into Sanskrit.

Shāh Jahān's royal astrologer Śrīmālajit enjoyed a more bombastic title *Vedāngarāya* instead of the mere *Jotik Rāi*. This tradition was continued by the feudatories also. For example, Kevalarāma received the title *Jyotiṣarāya* at Sawai Jai Singh's court. These Hindu astrologers and astronomers who were patronized by the Mughal rulers and by other Muslim noblemen had the opportunity of exposure to Islamic astronomy and astrology and may have disseminated this knowledge to their kinsmen and colleagues at Varanasi and other places.

4.6 This interaction at the Mughal Court, coupled with Todar Mal's introduction of Persian as the bureaucratic

language, gave rise to a new kind of literature. These are hand-books for learning Persian through the medium of Sanskrit. These contained generally bilingual vocabularies in verse, though one or two provide also grammatical rules couched in the sūtra style. Notable among these are Bihāri Kṛṣṇadāsa's *Pārasīkaprakāśa*, which contains both grammar and vocabulary and was dedicated to Akbar,²⁶ and Śrīmālaḥit Vedāṅgarāya's *Saṃskṛta-pārasīka-padaparakāśa* which was composed in the reign of Shāh Jahān and aims to teach Islamic calendar and technical terms related to Islamic astronomy and astrology.²⁷ About fifteen such works are extant today.²⁸

Thus, already before Jai Singh's time, some ground was laid for translation of texts, both scientific and non-scientific, from Arabic/Persian to Sanskrit and vice versa.

5.1 But Sawai Jai Singh aimed higher. Realizing the superiority of Islamic observational astronomy, he wished to have accurate and full translations of Islamic texts on astronomy and not just a paraphrase. Therefore, he collected many Islamic texts²⁹ and gathered Hindu, Muslim, and – later on – European astronomers at his court.³⁰

5.2 The translations that emerged from the joint endeavors of these astronomers are as follows:

- i. *Rekhāgaṇita*, a Sanskrit translation of Euclid's *Elements* from the thirteenth century Arabic version of Naṣīr al-Dīn al-Ṭūsī by *Jagannātha* in about 1727.³¹
- ii. *Ukarā* or *Kaṭara*, a Sanskrit translation of the *Spherica* of Theodosius from the Arabic version of Qusṭā

ibn Lūqā al-Ba'abakī by Nayanasukha Upādhyāya in 1729.³²

- iii. *Śaraha-tajkara Varjandī*, Sanskrit rendering of chapter 11 of the second book of Naṣīr al-Dīn's *Tadhkira* together with the extensive commentary (*Sharh*) of al-Barjandī by Nayanasukha also in 1729.³³
- iv. *Samrāṭsidhānta* or *Siddhāntasārakaustubha*, translation of Ptolemy's *Almagest* from Naṣīr al-Dīn's Arabic recension by Jagannātha in about 1732.³⁴
- v. *Yantrarāja-risālā bīsa bāba* or *Yantrarāja-vicāra-viṃśādhyāyī*, Sanskrit translation of Naṣīr al-Dīn's Persian manual on the astrolabe, *Risālat al-Uṣṭurlāb* in twenty chapters.³⁵ At the end of the manuscript copy of this work, no. 81865 of Varanasi Sanskrit University, there occurs the following sentence:

*iti nayanasukhopādhyāyakṛtā yantrarāja-
vicāravimśādhyāyī arabīṭaḥ saṃkṛte nitā/*

"Thus [ends] the Nayanasukha Upādhyāya's composition, the *Yantrarāja-vicāra-viṃśādhyāyī*, which has been rendered into Sanskrit from the Arabic."

This sentence led to the erroneous ascription of this translation to Nayanasukha. However, this sentence does not merit credence as it is clearly a late addition, in a different hand writing, by one who was unaware of the fact that, unlike Naṣīr al-Dīn's other works, this tract was originally written in Persian and not in Arabic. Other manuscripts do not contain this sentence. Therefore this translation has to be treated as anonymous, at least until other evidence is available.

- vi. *Dṛkpaṣasāraṇī*, supposed to be a Sanskrit rendering of La Hire Tables, by Kevalarāma.³⁶

Besides these, there are some anonymous works which may partly be translations or adaptations from Islamic sources, such as the following:

- vii. *Yantraprakāra*, on the construction of various astronomical instruments.³⁷
- viii. *Sarvadeśīya-jarakālī-yantra* on the construction and use of the universal astrolabe invented by Ibn al-Zarqālluh in Spain in ca. 1075.³⁸
- ix. *Hayatagrantha*, a Sanskrit rendering of the Persian *Risālā dar hay'at* by al-Qūshjī, translated for Jai Singh (?).³⁹

At the Sawai Mansingh II Museum at Jaipur, there exist several manuscripts containing astronomical tables such as *Phiraṅgi-candra-vedhopayoginī sāraṇī*⁴⁰ (tables useful for observing the moon according to Europeans) and *Laiyaravedhapatrāṇī*⁴¹ (La Hire Tables). These

must be translations from European sources. In early 1998, Professor David Pingree has catalogued these manuscripts. When this catalogue is published, we would know the full extent of such translations and their sources.

5.3 However, what concerns us here is the methodology of the translation and its accuracy. On the first question, Nayanasukha and the above-mentioned *Yantraprakāra* offer some clues.

At the beginning of his Sanskrit rendering of Theodosius' *Spherica*, Nayanasukha explains how he made the translation:

*seyam mahamada-ābida-saṃjñena kathitā
nayanasukhopādhyaiḥ nibadhyate.* ⁴²

"This [text] was explained by one named Muhammad Abid and is being rendered [into Sanskrit] by Nayanasukha Upādhyāya."

The same fact is repeated at the end of the book:

*idam arabībhāṣātaḥ ābida-saṃjñaiḥ kathitaṃ
nayanasukhopādhyaiḥ saṃskṛte grathitaṃ.* ⁴³

"This [text], which was explained by one named Abid from the Arabic language, is composed in Sanskrit by Nayanasukha Upādhyāya."

Again, at the conclusion of his translation of Naṣīr al-Dīn's *Tadhkira*, Nayanasukha informs:

*idaṃ mahamadaa-ābida-saṃjñaiḥ kathitaṃ nayana-
sukhopādhyaiḥ saṃskṛtaśabdair nibaddham.* ⁴⁴

"This [text] was explained by Muhammad Abid and was put into Sanskrit words by Nayanasukha Upādhyāya."

Thus the procedure adopted was somewhat similar to that in Akbar's *Maktabkhānā* and perhaps at other Muslim courts as well. At Jai Singh's court also there were interpreters (*ma'barān*) like Muhammad Abid and translators (*mutarajjimān*) like Nayanasukha. But there are two essential differences. First, both the interpreter and the translator at Jaipur were well versed in astronomy; they only had to cross the linguistic barrier

through a third language which must have been some form of Hindi. At Akbar's *Maktabkhānā*, the mythological and theological implications of the Sanskrit texts were not easy to understand and were often repugnant to persons like *Badāyūnī*.⁴⁵ Again, at the *Maktabkhānā* what were translated were not full Sanskrit texts but short paraphrases in Hindi.

Jai Singh's translators, if at all, erred on the other side. After comparing Nayanasukha's rendering of the *Tadhkira* with the Arabic original, David Pingree concludes that 'Muhammad Ābida and Nayanasukha did not simply render the Arabic into Sanskrit literally, but expanded those passages that they found particularly difficult'.⁴⁶ Modern translation theory would call this semantic as well as communicative translation; 'semantic' because it is faithful to the original in the source language and 'communicative' because it addresses itself to the needs of the audience in the target language by providing explanation of difficult concepts.⁴⁷

5.4 Furthermore, the *Yantraprakāra*, which contains descriptions of several astronomical instruments culled from diverse sources, demonstrates that occasionally first drafts of translations were prepared by junior pundits which were later polished and edited by accomplished scholars like Jagannātha or Nayanasukha who then gave their name to the translation.

At the beginning of his astronomical investigations, Jai Singh seems to have got only those portions of the *Almagest* translated which dealt with instruments and collected such passages in the *Yantraprakāra*. Thus this manual contains, among others, translation of passages

of the *Almagest* dealing with the following five instruments:

- i. *Yāmyottara-yantra* (solstitial armillary)
- ii. *Yāmyottara-bhitti-yantra* (mural quadrant)
- iii. *Dhāt al-Halaq* (armillary sphere)
- iv. *Dhāt al-Shu'batayn* (triquetrum)
- v. *Dhāt al-Thuqbatayn* (dioptr).

At a later stage when Jagannātha translated the entire *Almagest*, he incorporated into it the already translated passages, after editing them.⁴⁸ This becomes evident from the following facts:

In the *Yantraprakāra*, the description of the *Dhāt al-Thuqbatayn* is followed by a marginal gloss explaining the literal meaning of the Arabic name of the instrument:

*jātuḥ-śabdena sāhebaḥ svāmī. śuka-śabdena
chidram. tadvayam śukavataina-śabdenocyate.
tayoḥ svāmī chidradvayasya svāmīty arthaḥ.*⁴⁹

The word *jātuḥ* means 'lord' (*sāheb*) or 'owner' (*savāmī*); *śuka* means 'aperture'; 'two apertures' is denoted by the expression *śukavataina*; 'their owner', i.e. 'the owner of two apertures' is the meaning [of the Arabic name of this instrument].⁵⁰

Note the word *sāheb* in the explanation here. This must have been the word used by the Muslim interpreter while explaining the Arabic *dhāt*. The pundit rendered it as *svāmī* but retained the *sāheb* also. This explanation of the name is, of course, not part of the text of the *Almagest* – it was just given by the Muslim interpreter to the Hindu pundit – and Jagannātha dropped it from

the translation of the *Almagest*,⁵¹ for such an explanation is necessary only when one encounters the foreign word for the first time.

Had Jagannātha himself translated the passage in question, he would not have made the clumsy construction 'lord of two apertures'. With his reputed mastery of Sanskrit and alleged familiarity of Arabic, he could have drawn upon the analogy of Sanskrit compounds of the *Bahuvrīhi* class and explained the name as 'that which has two apertures'.

In another instance, the etymology of the name given is clearly off the mark; either the mediator did not know the history of the instrument well enough to explain its name or the *jyotiṣī* did not understand the explanation. This is the etymology of *Suds Fakhri* given in the *Yantraprakāra*:

*asmin yantra vṛttaṣaṣṭhāṃśasya daśaghaṭi-
kāyāḥ prayojanam. tasmāt phakarīnāmakaś ca
tatprabhuḥ. sudas nāma ṣaṣṭhāṃśaḥ. tena
ṣaṣṭhāṃśayantram kṛtam. tasya nāma sujasa-
phakarīti.*⁵²

In this instrument, a sixth part of the circle, i.e. ten *ghatikās*, is made use of. Hence he who is named *Fakhri* is its lord. *Sujas* means 'sextant'. He made this sextant instrument and its name is *Suds Fakhri*.⁵³

In actual fact, however, Abū Maḥmūd al-Khujandi invented this instrument in 994 and named it after his patron *Fakhr al-Dawla*.⁵⁴ Probably the mediator was explaining that the expression 'Fakhri' refers to the patron/lord of the maker, and the translator may have confused between the maker and his patron.

Be that as it may, a comparison of the description of this instrument as given in the *Yantraprakāra* on the one hand and in Jagannātha's *Yantrādhyāya* on the other will show that Jagannātha polished the former version considerably.⁵⁵ The same is the case with the description of the instrument called *Jayaprakāśa*.⁵⁶

Does that mean that the entire *Almagest*, as well as other texts, were translated by hacks with the help of Muslim interpreters and that Jagannātha, Nayanasukha and others edited the translations subsequently? It is difficult to answer this question but such possibility cannot completely be ruled out.

5.5 Regarding the accuracy of translation, I have compared the description of the five instruments in the *Samrātsiddhāta* with those in the English translation of the *Almagest*. In spite of the fact that the Sanskrit version was made from an Arabic translation of the Greek *Almagest* and that the English translation was made directly from the Greek, there does not exist great divergence. But this has yet to be established for the entire text. Indeed, other texts too need to be studied from the viewpoint of accuracy of translation and the terminology must be compared in the three versions, viz. source language, mediate language and the target language.

5.6 – A few more words need to be said about the vernacular translations undertaken at Jai Singh's court. He caused a large quantum of religious and devotional literature translated into Brajabhāṣā and Rājasthānī, and this practice was emulated by his son Madho Singh also. Besides these, a few scientific texts also seem to have been translated. The Khas Mohor collection of Sawai

Mansingh II Museum at Jaipur has two vernacular versions of Bhāskara's *Lilāvati*. The first is the *Lilāvati-pāṭi-parikrama* (sic! read -parikarma; No. 5074) and the second *Lilāvati Bhāṣā* by Lāla Canda (Nos. 3626, 5075).⁵⁷

An interesting case of translation of a book on perspective drawing, probably from the Portuguese, into Hindi was noticed by Virendra Sharma.⁵⁸ Another interesting case of translation into the vernacular can be seen in the plaques attached to some portable instruments in the stores of the observatory at Jaipur. These finely engraved copper plaques explain the function of each instrument in simple vernacular.⁵⁹

5.7 In sum, Sawai Jai Singh understood the value of translation in the exchange of ideas and his pundits achieved a high degree of accuracy in translation. With the scientific knowledge expanding at an ever rapid rate today, Jai Singh's method of transmission of science offers a workable model.

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 26. Ed. Vibhūtibhūṣaṇa Bhaṭṭācārya, Varanasi 1965.
 27. Cf. S.R. Sarma, 'Islamic Calendar and Indian Eras', in: G. Kuppuram and K. Kumudamani (ed), *History of Science and Technology in India*, Delhi 1990, vol. 2, pp. 433-441.
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 29. Cf. David A. King, 'A Handlist of the Arabic and Persian Astronomical Manuscripts in the Maharaja Mansingh II Library in Jaipur,' *Journal for the History of Arabic Science*, 4 (1980) 81-86.
 30. Virendra Nath Sharma, 'Jai Singh, His European Astronomers and the Copernican Revolution', *Indian Journal of History of Science*, 17.2 (1982) 333-344; *idem*, 'Muslim Astronomers at Jai Singh's Court', *Journal for the History of Arabic Science*, 9 (1991) 23-30.

31. *Rekhāganita*, ed. H. Dhruva and K.S. Trivedi, Bombay 1901, 1902.
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33. Pingree 319; CESS, A-4, Philadelphia 1981, p. 122.
34. *Samrāṭsidhānta*, ed. R.S. Sharma, New Delhi 1967-1969; *Siddhāntasamrāṭ*, ed. Muralīdhara Caturveda, Sagar 1976.
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36. Pingree 320.
37. *Sawai Jai Singh's Yantraprakāra*, ed & tr. Sreeramula Rajeswara Sarma, supplement to *Studies in History of Medicine and Science*, 10-11 (1986-87).
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39. Ed. Vibhūtibhūṣaṇa Bhaṭṭācārya, Varanasi 1967.
40. Sawai Mansingh II Museum, Jaipur, Khas Mohor Collection, No. 5609.
41. Sawai Mansingh II Museum, Jaipur, Khas Mohor Collection, No. 5183.
42. *Ukarā* (see n. 25), p. 1, fn. 1.
43. *ibid.* p. 55.
44. CESS. A-4, p. 122.
45. *Ā'in-i Akbarī*, tr. H. Blochmann, p. 111, n. 2.
46. Pingree 319.
47. Cf. Peter Newmark, *Approaches to Translation*, Oxford, etc. 1982, p. 39.
48. Cf. Sreeramula Rajeswara Sarma (ed & tr), *Yantraprakāra*, p. 4.
49. *ibid.* p. 20.
50. *ibid.* p. 61.
51. *Samrāṭsidhānta*, p. 466.
52. *Yantraprakāra*, p. 24.

53. *ibid.* p. 72.
54. *ibid.*
55. cf. *Siddhāntasamrāṭ*, ed. Muralīdhara Caturveda, pp. 7-8.
56. *Yantraprakāra*, pp. 12-15; *Siddhāntasamrāṭ*, pp. 11-13.
57. Cf. Gopal Narayan Bahura, *Literary Heritage of the Rulers of Amber and Jaipur*, Jaipur 1976.
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59. A separate gallery has been built recently within the compound of the Jaipur Observatory to house these portable instruments.

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