Sanskrit Translations of Arabic and Persian Astronomical Texts at the Court of Jayasiṃha of Jayapura

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Between about 1725 and 1735 a substantial number of Arabic and Persian texts were translated into Sanskrit at the court of Jayasiṃha (1687-1743), first at Amber and then at the new city of Jayapura which the Mahārāja founded in 1727. Among these were:

1. Naṣīr al-Dīn's *Taḥrīr kitāb Uṣūl al-handasa* (Euclid's *Elements*), translated by Jagannātha Samrāṭ, Jayasiṃha's guru, in or shortly before 1727 as the *Rekhāgaṇita*.[1]

2. Naṣīr al-Dīn's *Taḥrīr al-Majisṭī* (Ptolemy's *Almagest*), translated by Jagannātha in, allegedly, 1732 as the *Samrāṭsiddhānta*.[2]

3. Naṣīr al-Dīn's *Taḥrīr Ukar* (Theodosius' *Spherics*), translated by Nayanasukhopādhyāya with the assistance of Muḥammad Ābidda in 1729

[1] See D. Pingree, *Census of the Exact Sciences in Sanskrit* (henceforth *CESS*), Series A, vols. 1-5, Philadelphia 1971-1994, A3, 56a-57a; A4, 95a; and A5, 113b-114a. It was edited by H. Dhruva and K. Trivedin, 2 vols., Bombay 1901-1902. Manuscript 35605 in the Sarasvatī Bhavana at Benares was copied for Jagannātha by Lokamaṇi on June 1727.

[2] See *CESS*, A3, 57a-58a; A4, 95a; and A5, 114a. It was edited by R. Sharma, 2 vols., New Delhi 1967-1969. Two manuscripts of the Arabic *Taḥrīr* acquired by Jayasiṃha in 1725, numbers 19 and 20 of the Arabic and Persian collection in the Mahārāja of Jaipur Museum Library, are described by G. N. Bahura, *Catalogue of Manuscripts in the Maharaja of Jaipur Museum,* Jaipur 1971.

as the *Ukāra*.[3]

4. Chapter 11 of book 2 of Naṣīr al-Dīn's *Tadhkira* with the *Sharḥ* of al-Birjandī, translated by Nayanasukhopādhyāya with the assistance of Muḥammad Ābidda in 1729 as the *Śarahatajkara varjandī*.[4]

5. Naṣīr al-Dīn's *Bīst bāb dar usṭurlāb,* apparently also translated by Nayanasukhopādhyāya as the *Yantrarājarisāla*.[5]

6. A treatise on the use of al-Zarqāllu's universal *ṣafīḥa*, entitled *Sarvadeśīyajarakālīyantra:* it may have been translated by Nayanasukhopādhyāya.[6]

7. A treatise on the retrograde motions of the planets said to be derived from chapter 9 of the Khākānījīca that is, from the *Zīj-i-Khāqānī* of Jamshīd al-Kāshī; it is entitled *Vakramārgavicāra*.[7]

8. The *Yantraprakāra* contains descriptions of the construction of various astronomical instruments translated from Arabic (or Persian) sources, such as Naṣīr al-Dīn's *Taḥrīr al-Majisṭī*. It was completed by

[3] See *CESS* A3, 132a; A4, 122a; and A5, 159a. It was edited by V. Bhaṭṭācārya, Vārāṇasī 1978. The earliest manuscript of the Sanskrit translation, number 44 in the Jaipur Museum, was copied by Lakṣmīdhara in 1729.

[4] See *CESS*, A4, 122a. An edition is being prepared by T. Kusuba and D. Pingree. Two Arabic manuscripts of the *Sharḥ al-Tadhkira* of Mullā Niẓām Ḥasan al-Nīshābūrī, both acquired in 1725, are numbers 21 and 22 in the Arabic and Persian collection in the Mahārāja of Jaipur Museum Library. In the same library Sanskrit manuscript 46, copied by Kṛpārāma in 1729, is the unique copy of Nayanasukhopādhyāya's translation.

[5] See *CESS* A3, 145a, and A4, 125a under Naṣīr al-Dīn, and A5, 159a under Nayanasukhopādhyāya. Edited by V. Bhaṭṭācārya, Vārānasī 1979. Manuscript 42 in the Sanskrit collection of the Mahārāja of Jaipur Museum Library was copied by the Kṛpārāma who copied Nayanasukhopādhyāya's translation of the *Tadhkira* in 1729.

[6] See *CESS* A5, 159a-159b, and S.R. Sarma *The Ṣafīḥa Zarqāliyya in India,* in *From Baghdad to Barcelona,* ed. J. Casulleras and J. Samsó, Barcelona 1996, vol. 2, pp. 719-735. The beginning of the Sanskrit text, on constructing the instrument, is based on the text published by R. Puig in *Los Tratados de Construcción y Uso de la Azafea de Azarquiel,* Madrid 1987, but after the first chapter it diverges considerably.

[7] Sanskrit manuscript 33 in the Mahārāja of Jaipur Museum Library is the only copy known to exist; it was transcribed by Lakṣmīdhara, who copied the Jaipur manuscript of the *Ukāra* in 1729.

Jayasiṃha in about 1729.[8]

The Jaipur copies of some of these seven versions of Arabic and Persian treatises and of the *Yantraprakāra* were produced in a uniform format imitative of Persian manuscripts - their writing is parallel to the shorter edge of the page; they are often still bound in cloth with a flap covering the opening; and they are all about 22 by 16 cm. These manuscripts are:

1(3) Mahārāja of Jaipur Museum 44. *Ukāra* of Sāvajūsayūsa (Theodosius). 1 blank f.; ff. 1-46; and 3 blank ff. 23×17.5 cm. 23 lines per page. Bound in cloth. Copied ⟨by Lakṣmīdhara Lekhaka⟩ [9] on Thursday 13 *śuklapakṣa* of Kārttika in Saṃ. 1786=23 October 1729. After the post-colophon, on the next page (f. 45v), is written: *idam arabībhāṣāta āvidasaṃjñaiḥ kathitaṃ na(ya)nasukhopādhyāyaiḥ saṃskṛte grathitam* - "This was told (in a vernacular) by Ābida (translating) from the Arabic language, written down in Sanskrit by Nayanasukhopādhyāya". Acquired in 1730.

2(4) Mahārāja of Jaipur Museum 46. *Śarahatajkara varjandī* of Naṣīr al-Dīn al-Ṭūsī and al-Birjandī. Ff. 1-56. 20.5×16 cm. 16/17 lines per page. Bound in cloth. Copied by Kṛpārāma on Tuesday 8 *śuklapaksa* of Pauṣa in Saṃ. 1786, Śaka 1651 = 16 December 1729. Between the colophon and the post-colophon on f. 56 is written: *idaṃ mahammadābid-dasaṃjñai⟨ḥ⟩ kathitaṃ nayanasukhopādhyāyaiḥ saṃskṛtaśabdair vibad-dham* - "This was told (in a vernacular) by Muḥammad Ābidda, encompassed by Sanskrit words by Nayanasukhopādhyāya". Acquired in 1730.

3(5) Mahārāja of Jaipur Museum 42. *Yantrarājarisāla* of Naṣīr al-Dīn al-Ṭūsī. 2 blank ff; ff. 1-28; and 2 blank ff. 22×16.5 cm. 16 lines per page. Copied by Kṛpārāma. After the colophon of manuscript 81865 in the Sarasvatī Bhavana in Benares was written by a second scribe: *iti nayanasukhopādhyāyakṛtayaṃtrarājavicāraviṃśatyādhyāyī aravītaḥ saṃskṛtaṃ nītā* - "Thus the *Investigation of the Astrolabe* in twenty chapters composed by Nayanasukhopādhyāya was brought from Arabic into Sanskrit."

4(6) Khasmohor 5483 of the City Palace Library in Jaipur.

[8] See *CESS*, A5, 118a. It was edited by S.R. Sarma, New Delhi 1986/7.

[9] Information from Bahura's catalogue.

Jarakālīyantra. Ff. 1-9, ⟨10⟩, 11-12 and ⟨13⟩; and 3 blank ff. 20×15 cm. 16 lines per page. Copied by a scribe whose script is similar to Kṛpārāma's.

5(7) Mahārāja of Jaipur Museum 33. *Vakramārgavicāra* of Jamshīd al-Kāshī. Ff. 1-11; and 3 blank ff. 23.5×16.5 cm. 19/20 lines per page. Bound in cloth. Copied by ⟨Lakṣmīdhara Lekhaka of Sarakāra⟩[9].

6(8) Mahārāja of Jaipur Museum 31. *Yantraprakāra* of Jayasiṃha. 27 ff.; and 2 blank ff. 22×16 cm. 24 lines per page.

7. Mahārāja of Jaipur Museum 24. *Hayatagrantha,* a Sanskrit translation of ᶜAlī al-Qūshjī's *Risālah dar hay'at*[10]. Ff.1-60. 20×16 cm. 17 lines per page. Bound in cloth. Copied ⟨by Ṭīkārāma Jyotiṣī[9]⟩ in Saṃ. 1785, Saka 1650 = A.D. 1728. Acquired in 1738.

From among the manuscripts in this small library of texts translated into Sanskrit from Arabic and Persian -by no means all of such translations represented by copies that once belonged to Jayasiṃha- I shall in this paper concentrate on one of the rarest texts; in fact, its manuscript is unique. This is the *Vakramārgavicāra, "Investigation of Retrograde Motion",* said to exist in the ninth *adhyāya* of Jamshīd al-Kāshī's *Zīj-i-Khāqānī*[11]- *atha vakramārgavicāraḥ khākānījīcasya navamādhyāyastho*. In fact, al-Kāshī's *zīj* consists of just six *maqālas*. Kāshī's discussion of retrogression presumably is to be found in *maqāla* 3, *dar maᶜrifat-i-mawāḍiᶜ-i-kawākib dar ṭūl uᶜarḍ*. Through the kindness of E.S. Kennedy I have been able to examine ff. 79v-81v of the London manuscript of the *zīj*, India Office Library Persian 430 (now in the British Library), which contain *faṣl* 5 on the theory of retrogressions and the stationary points; this must be from the first *bāb*. The second *bāb* should have the proofs in accordance with the

[10] See *CESS* A4, 57a-57b, and A5, 43b. It was edited by V. Bhaṭṭācārya, Vārāṇasī 1967. Judging from the lost manuscript which belonged to Śivasahāya of the Unao Zila in 1875 and which is dated A.D. 1694, one must conclude that this translation from Persian was made in the seventeenth century.

[11] Concerning the *Zīj-i-Khāqānī* see E.S. Kennedy, *A Survey of Islamic Astronomical Tables,* Philadelphia 1956, pp. 42-44; *idem.*, "Spherical Astronomy in Kāshī's Khāqānī Zīj", *ZGA-IW* 2, 1985, 1-46; and *idem,* "Treatise V of Kāshī's Khāqānī Zīj: Determination of the Ascendent", *ZGA-IW* 10, 1995/96, 123-145.

general arrangement of the *zīj*.

It is the proofs that the Sanskrit version offers. These are ultimately derived from Ptolemy's *Almagest* 12, 1-6, who in turn, for the fundamental theorem, draws upon Apollonius. The Sanskrit mentions Ablūnayūsa and faithfully repeats the third figure of *Almagest* 12, 1, which is for Apollonius' preliminary lemma. It also reproduces, in somewhat simplified form, the fifth and sixth figures while introducing several other figures not found in Ptolemy. In presenting the geometry it stays remarkably close to Ptolemy's lettering: A=a, B=ba, Γ=ja, Δ=da, E=ha, Z=jha, H=va, Θ=ta, K=ka, and Λ=la. The proof is more prolix than in Ptolemy; nothing is left for the reader to supply. But the language is far simpler than Ptolemy's Greek, consisting of very simple sentences and using a very simple vocabulary.

Instead of computing the retrogressions of each of the five planets as Ptolemy does in *Almagest* 12, 2-6, Kāshī (at least according to the Sanskrit version) calculates them simultaneosly for just one superior planet, Mars, and one inferior planet, Venus. At the beginning of these calculations it is explained: *atha taccihnāntaram uccasthānād vā nīcasthānāt pañcatārāṇāṃ mijistīgranthe dvādaśādhyāye niṣkāśitam asti/ punaḥ sarvajīcagrantheṣu tata eva likhitam/ atha bhaumasya nīcoccavṛt-tavyāsārdhaṃ śukrasya bhūkendraprativṛttakendrayor antaraṃ ca batlma-jūsavedhād yaj jñātaṃ yac ca yalkhānīvedhād āptaṃ tayor mitho 'ntaram asti/ mayā anayor antarayor gaṇitaṃ yalkhānīvedhānusāreṇa kathyate//* "So the difference in that (stationary) point due to the distance or nearness of the five planets is set out in the twelfth chapter in the book *Mijistī (Almagest)*. Moreover, it is copied from that in all the *jīca* (*zīj*) books, Then whatever radius of the epicycle of Mars and distance between the center of the earth and the center of the deferent of Venus is known from the observation of Batlmajūsa (Ptolemy) and whatever is obtained from the observation of Yalkhānī (the *Zīj-i-Īl-khānī*)- there is a difference of those two from each other. The computation of those two distances (i.e., the farther and the nearer) is told by me in accordance with the observation of Yalkhānī." Indeed, the Sanskrit text uses the parameters of the *Zīj-i-Īl-khānī* rather than those of Ptolemy.

However, it is not at all clear why this section of the *Zīj-i-Khāqānī* was chosen for translation. One may guess that this translation was made before

that by Jagannātha, allegedly in 1732, of the *Taḥrīr al-Majisṭī,* where one would learn of Apollonius' theorem and of Ptolemy's calculations of the retrogressions of the planets at furthest and nearest distances[12]. However, even if the *Vakramārgavicāra* preceded the *Samrāṭsiddhānta,* there is still a question of motivation, since the stationary points could be readily computed with either the methods of traditional Indian *siddhāntas* or with the tables of the *Zīj-i-jadīd* of Ulugh Beg, which were available to Jayasiṃha. The motivation, then, must have been the Mahārāja's desire to understand the geometrical models that lie behind such tables- an interest in astronomical models that he manifested on other occasions- e.g., in his fifth question to the Jesuits at Candranagara as reported by Père Calmette on 24 January 1733[13]. "Sur quel fondement M. de la Hire a-t-il établi sa troisième équation des mouvemens de la lune, et de quelle manière pourroit-on la réduire en hypothèse, et la calculer géométriquement?"

[12] *Samrāṭsiddhānta,* vol.2, pp. 949-966.

[13] *Lettres édifiantes et curieuses,* Lyon 1819, vol.7, pp. 503-509.