

AN ARABIC COMMENTARY ON AL-TŪSŪ'S *AL-TADHKIRA* AND ITS SANSKRIT TRANSLATION

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Naṣīr al-Dīn al-Ṭūsī (1201-1274) composed his *Tadhkira* at Marāgha in 1261 and altered it with his students and produced his "final version" at Baghdad in 1274. The Baghdad version with all its differences from the Marāgha version was published by Ragep [1993]. That the *Tadhkira* was considered important by astronomers writing in Arabic is amply attested to by the fact that Ragep [1993] can list fourteen commentaries and supercommentaries as well as refer to numerous other derivative texts.

'Abd al-'Alī b. Muḥammad b. Ḥusain al-Bīrjandī (d.1525-26) wrote his commentary on the *Tadhkira*, titled *Sharḥ al-Tadhkira* (Commentary on the *Tadhkira*) in 1507. The *Tadhkira* we reconstructed from his Arabic commentary has many variants similar to those of the Marāgha version appeared in the apparatus in Ragep [1993]. Bīrjandī referred to some names and texts. As far as his commentary on the eleventh chapter is concerned, he referred to the following: author (Ṭūsī) *Risāl Mu'iniyya*, *Taḥrīr al-majistī* in 1247; Ptolemy *Almagest*; Ibn al-Haytham; Euclid *Elements*; Shīrāzī *Tuhfa*, *Nihāya*; Theodosius, Menelaus, Autolycus. For example, when he comments on the so-called spherical or curvilinear version of the Ṭūsī couple he explains that the path produces a 8-shaped curve using Menelaus' *Spherics* book 1, proposition 11 (see below). Bīrjandī might know that the Ṭūsī model did not work. Toward the end of the commentary on chapter eleven he introduces a lemma and models for the Moon and the five planets devised by Shīrāzī in the *Tuhfa*.

At Jayasimha's court at Jayapura in the 1720's and the 1730's an effort was made to translate Arabic and Persian versions of Greek mathematical and astronomical treatises into Sanskrit. The two leading translators were Nayanasukha and Jagannātha (Pingree [1981.64]). The latter made the Sanskrit translation of the *Elements* based on the Ṭūsī version. The former translated Bīrjandī's commentary on the *Tadhkira*. However, he did not translate the whole of the commentary, but only that of the eleventh chapter. From the colophon of his translation we learn that a Persian, Muḥammad Ābida, dictated and Nayanasukha composed in Sanskrit. Nayanasukha also translated an astronomical Arabic work of Naṣīr al-Dīn to Sanskrit at the dictation of Ābida. That is the Arabic version of the *Spherics* of Theodosius. The *Spherics* was translated from Greek to Arabic by Qusṭā ibn Lūqā, corrected by Thābit ibn Qurra, and commented by Naṣīr al-Dīn. Nayanasukha translated also the *Risālat al-uṣṭurlāb* of al-Ṭūsī in Persian. In the Sanskrit translation Nayanasukha keeps Persian grammatical forms.

The figures Bīrjandī used appear in the Sanskrit manuscript, which we have used. The translator adds one more figure, which is of the configuration of spheres of the Moon presented by al-Shīrāzī in the *Tuhfa*.

The *Tadhkira* is not a book of mathematical astronomy, but of cosmology ('ilm al-hay'a). The *Tadhkira*, especially its eleventh chapter of the second volume, draw much attention of historians of astronomy. We do not know how influential Nayanasukha's translation on Indian astronomy was. Here we want to investigate how Bīrjandī comments, and what Nayanasukha omits and what he adds more.

As Ragep mentions (p.421 com.on II.8[1]1-2) Ṭūsī uses pronouns excessively. Bīrjandī explains what each pronoun means. Sometimes he gives different readings. This is an example. At II.11.[3] (Ragep [1993.199]) Ṭūsī absentmindedly assumed what he is trying to prove. Bīrjandī explains what the pronoun should mean. Nayanasukha omitted this kind of discussion.

Bīrjandī introduces an objection to the Ṭūsī couple such that it is impossible for the celestial bodies

to move descending and ascending without rest. Nayanasukha again omitted this part. He often omits physical or grammatical explanations.

Nayanasukha did not give a literal translation. For example for an Arabic phrase ما بين المركزين (what is between the two centers), meaning usually the eccentricity, he mentioned *prativṛttabhūken-drayor antaram* (the distance between the centers of the eccentric and of the Earth). He employs the traditional Sanskrit astronomical terms. For example the translation of the word تدوير, which means epicycle, is *nācoccavṛtta*, circle of the perigee and the apogee. However he transliterated some Arabic technical terms phonetically even though Sanskrit has its counterparts. In those cases he explained their meaning. Characteristic words are *kabīra* and *sagīra*, which are transliterations of the words meaning large and small respectively. These words are used for two circles of the Tūsi couple. When Bīrjandī discusses the couple in the mathematical explanation Nayanasukha uses the Sanskrit terms *mahad* or *bṛhad* and *laghu*. In the discussion on the physical application Nayanasukha does not use those Sanskrit words, but transliterates the Arabic words. When the couple is applied in the spheres of a planet, two spheres, represented by the two circles, are inadequate. In order to keep the diameter containing the apex and perigee of a given planet coincident with the diameter of the large sphere, Tūsi proposes another sphere, called محيطة, enclosing, or حافظة, sustainer. In his translation of this discussion Nayanasukha gives phonetical transliteration such as *kabīra* or *sagīra*, not *mahad* or *laghu* as he used for the mathematical explanation.

References

- Pingree, [1981] *Jyotiḥśāstra: Astral and Mathematical Literature*, Wiesbaden
 F.J.Ragep [1993] *Naṣir al-Dīn al-Tūsi's Memoirs on astronomy*, Springer-Verlag

واعترض صاحب التحفة على هذا البرهان بأنه يبيّن على أن الزاوية الخارجة من
 المثلث مساوية لمقابلتها الداخليين وهذا إنما يصح في المثلثات المستقيمة الخطوط
 ولا يستقيم في المثلثات الحادة عن قسي دوائر عظام فإن الخارجة منها اصغر
 من المقابلتين الداخليتين على ما بينه مالانوس في الحادي عشر من أولى كراته

atha tuhuphāgranthasyācāryeṇātra pūrvapakṣakṛtaḥ/ tad yathā/ atra yo
 'yaṃ vicāraḥ kṛtas tasyopapattis tribhujasya bahirgatakoṇo 'ntargatakoṇa-
 dvayayogatulyo 'stīty asyopari darsitā/
 param ceyam upapattis teṣu tribhujēṣūpapaṇṇā yeṣāṃ bhujāḥ saralarekhāḥ
 santi/ yathokllīdase upapaṇṇam/ teṣu tribhujēṣu meyam upapaṇṇam yeṣu
 trijyāvṛtacāpāni bhujāni bhavanti/ yata eṣu tribhujēṣu bahirgatakoṇāntargata-
 koṇayor yogān nyūno bhaviṣyati yathā manālāpūseṇa svakiyokare dṛḍhikṛtam/