

should be read between Euclid's *Elements* and Ptolemy's *Almagest*. As for the author of the Arabic translation, the manuscripts propose different names: Thābit b. Qurra, Ḥunayn b. Ishāq and Qusṭā b. Lūqā. A more detailed description of the process of translation is to be found in the recension of the *Sphaerica* (1253) by Naṣīr al-Dīn al-Ṭūsī, who states that Caliph al-Mustaʿīn (862-866) commissioned the translation of the book to Qusṭā b. Lūqā, who reached proposition five of the third book. The task was finished by another scholar and Thābit b. Qurra revised the translation.

The edition of the Arabic text is based on three manuscripts of which one (the aforementioned Lahore ms.) was copied in 1158, in Mosul from another copy belonging to a direct descendant of Thābit b. Qurra. The colophon of the same manuscript states that al-Ḥasan b. Saʿīd (the author of the notes edited on pp. 313-315) thoroughly revised all the figures in the treatise, in 1030, because they were corrupt in the manuscript he was copying (see pp. 3-4 and 310-312). In the same colophon, the copyist says that the three books of the *Sphaerica* contain 59 propositions (*ashkāḥ*): but in the edited text there are 11 definitions and 22 propositions in Book I, one definition and 22 propositions in Book II and, finally, 14 propositions in Book III: the total number of propositions should, therefore, be 58, instead of 59.

The Latin translation has been edited using 11 manuscripts and it

seems entirely accurate and faithful to the Arabic original. I have only been able to find the use of one Arabic word in the Latin text: *meguar* for *miḥwar* (axis) on p. 13. This implies that the technical Latin vocabulary had reached a standard level by the time of Gerard of Cremona. The only peculiar characteristic of the Latin text is the systematic use of *equidistans* and related terms to translate "parallel" (*muwāzin*): see pp. 87, 99, 103, 105 etc.

To summarize: both the Arabic and the Latin critical editions of Theodosius' work are excellent examples of good scholarship. The texts are very well edited and printed and are a pleasure to read. During the last few years a number of Arabic scientific texts have been edited with their corresponding Latin translation: this is precisely the kind of materials we need in order to have a clear picture of the techniques used by medieval translators.

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Jafar Aghayani-Chavoshi, *Ketāb al-nejārat (Sur ce qui est indispensable aux artisans dans les constructions géométriques)* Tehran: Written Heritage Research Centre & Institut Français de Recherche en Iran, 2010. 79 + 136 pp. (Persian) and 279 pp. (French). Introduction by Bernard Vitrac. Bibliothèque Iranienne 71.

Several years ago, Jafar Abhayani-Chavoshi's *Taḥrīr-e Mutawasiṭāt*, a facsimile edition of the collection of redactions of Greek mathematical works by Naṣīr al-Dīn al-Tūsī (Tehran: Institute for Humanities and Cultural Studies, 2005), made available in one volume the entire corpus of important treatises. Now Aghayani-Chavoshi has published a second substantial contribution to the history of mathematics and to our understanding of geometry in Islamic cultures. The work provides an edition of a previously unstudied Persian translation of the *Kitāb al-Nijāra* of Abū'l-Wafā' al-Buzjānī (328-388 / 940-998), together with a French translation of the text. Although various features of al-Buzjānī's treatise have been discussed by several scholars since the middle of the nineteenth century, but now for the first time Western historians have the entire treatise available to them in an easily accessible form.

Abū'l-Wafā' originally composed his treatise *Kitāb al-Nijāra* (also known under the title *That Which it is essential for Artisans to Know concerning the Construction of Geometric Figures*) in Arabic. Two Persian translations were made of this Arabic treatise. The first and apparently older (judging from its technical vocabulary and rhetorical features) is preserved in an anonymous unique manuscript in Tehran University Library (manuscript 2876). It is this version that Aghayani-Chavoshi has now edited and translated into French. The

second, by Abū Ishāq al-Kuhbanānī al-Yazdī (fl. 9th century AH), is preserved in a unique manuscript in the Bibliothèque Nationale de France (Persan 169). Both these manuscripts are now incomplete. Two commentaries on the treatise of Abū'l-Wafā' are also known – one in Arabic by Kamāl al-Dīn ibn Yūnus (fl. 12. century AD), extant in Mashhad 5357, and one in Persian by Moḥamad Bāqir al-Yazdī (fl. 17th century AD), preserved in Mashhad 5371.

The short introduction by Bernard Vitrac discusses the relation of Abū'l-Wafā' to the philosophy of geometry in the ancient world, and especially the role of construction in the science of geometry, the distinction between problem and theorem. For example, questions about the comparison of figures in terms of magnitude reveal two basic approaches. One is "algorithmic" and embodies specific instructions and operations which are propounded without explicit justification. This approach developed into the practical geometry of the Roman agrimensores tradition. The other approach utilized proportion theory of Eudoxus as developed in the geometry of Euclid and Archimedes. This approach carried an implicit if not explicit demonstrative component and can be said to complement or complete the algorithmic approach. The *Kitāb al-Nijāra* of Abū'l-Wafā' can be seen as representing the algorithmic part of the Greek tradition.

Aghayani-Chavoshi's lengthy preface or introductory essay helps to put al-Buzjānī's work in its historical and intellectual context. (The French version of this introduction follows the Persian although the ordering of some topics has been rearranged.) The introduction begins with a brief biobibliographical introduction to al-Buzjānī and his oeuvre. It is followed by a description of the manuscript resources available for the study of *Kitāb al-Nijāra*, including commentaries on the text and Persian translations from the Arabic. The identification of the two Arabic manuscripts preserved in Cairo seems to have been based on an outdated source. The current classification of these manuscripts is Dār al-Kutub, riyāḍa 260/1 and riyāḍa 366. The only edition of the Arabic text is by Ṣālah Aḥmad al-'Alī (Baghdad, 1979), whose work is unavailable to me.

Since the only known manuscript of the Persian translation being edited by Aghayani-Chavoshi is incomplete and undated, he next undertakes a linguistic analysis – comparing elements of syntax and vocabulary found in the Persian translations to other Persian texts that can be firmly dated. Based on this evidence, he concludes that the translation of this anonymous commentary dates from the 4th or 5th centuries of the Islamic era. Like many other Persian translations in the mathematical sciences, its technical mathematical vocabulary remains largely Arabic.

The second Persian translation, by Abū Ishāq al-Kuhbanānī (fl. 845–875 AH), was the version studied by Woepcke in the mid-nineteenth century. Aghayani-Chavoshi subjects this translation to a similar linguistic analysis, showing that al-Kuhbanānī tends to replace the Arabic linguistic constructions of al-Buzjānī with Persian equivalents, often derived from the literary tradition. The results of this analysis also support the general conclusion of Aghayani-Chavoshi concerning dating of the anonymous commentary.

Woepcke had raised a question concerning the authenticity of the *Kitāb al-Nijāra*. There exists in Uppsala University Library (ms. 324) a treatise on practical geometry ascribed to Abū Naṣr al-Fārābī (died ca. 339 / 950) with the title *Kitāb al-ḥiyal al-ruḥāniyya*. Its content and logical structure shares many parallels with the *Kitāb al-Nijāra*. Based on rhetorical features of al-Kuhbanānī's Persian translation of al-Buzjānī's treatise and the observation that the treatise contained some technical mathematical errors not expected in the work of a mature geometer, Woepcke wondered whether the *Kitāb al-Nijāra* was really composed by Abū'l-Wafā'. Aghayani-Chavoshi considers the issue and concludes that (1) the attribution of *Kitāb al-Ḥiyal* to al-Fārābī is probably a later forgery and (2) since the writings of other geometers of high repute also exhibit some egregious errors, the existence of such errors cannot in itself militate against the authorship

of al-Buzjānī. Moreover the preponderance of manuscript and bibliographical evidence supports the conclusion that the *Kitāb al-Nijārah* is indeed a genuine work of Abū'l-Wafā'.

The last third of the introduction discusses Abū'l-Wafā' and the mathematical content of his *Kitāb al-Nijāra*. In this section, Aghayani-Chavoshi summarizes the important contributions that the work makes to practical geometry (Euclidean constructions, non-Euclidean constructions, regular polygons, and regular polyhedra) and to theory of numbers, concluding with a few remarks on the epistemology underlying the treatise.

The Persian edition fills 135 pages and the French translation occupies almost the same amount of space. The text is edited from a unique manuscript, so Aghayani-Chavoshi limits his intrusion into the text to correcting obvious errors or explicating obscure statements. He has also added copious footnotes explaining the geometrical underpinning of the constructions described. The French translation is a faithful reproduction of the Persian edition, including its explanatory notes. The text is divided into 11 chapters (*bāb*). The first chapter deals with basic construction tools and their use. The remaining ten chapters detail various construction techniques. The 160 constructions (some include also one or more alternative construction methods) are numbered consecutively through the text. In the Persian section, the

running header identifies what chapter we are currently reading. The French translation section does not have this feature, so the only way to find which chapter one is looking at is to page forward or backward. Fortunately, both Persian and French sections include the construction numbers, so it is not difficult to find corresponding sections should one wish to compare the French and Persian text.

Tehran University Library, ms. 2876, from which the text is edited, is now incomplete. Aghayani-Chavoshi uses the commentary of al-Yazdī to complete the missing lacuna. In chapter 10, because the text has become too corrupt to reconstruct, the editor has recourse to the Persian translation of al-Kuhbanānī to reconstitute its meaning. Following accepted editorial practices, he has clearly indicated these procedures in his footnotes, so that his edition does not contain hidden problems or assumptions. These editorial notes, of course, are repeated in the French translation.

There are two points that might have made Aghayani-Chavoshi's work more useful to readers. First, the diagrams that accompany the manuscript have obviously been redrawn in this edition and translation. Although such re-drawing of the diagrams is sometimes useful to make the figures more accessible to modern readers (and I must add that the drawings used in this edition / translation are very well done and the use of shading and dashed lines – neither being found in traditional

manuscripts – makes them even easier for modern students to read and understand), presenting a “sanitized” diagram also serves to distance the reader from the complexities of the sources. Within this treatise of Abū’l-Wafā’, for example, there can sometimes be considerable variation from one Arabic manuscript to another for the same diagram. How do these Arabic diagrams compare to those in the Persian translation? I would have preferred at least an explicit discussion of the diagrams in the original Persian manuscript, similar to the discussion of parallel passages in Arabic and Persian translations. Such a discussion should provide at least some examples taken from the manuscripts to illustrate the style of the diagrams. I believe that such examples would increase the transparency of the editing / translating process and allow readers to reach more informed conclusions about the text, its diagrams, and their historical significance.

Second, anyone who tries to compare the French translation with the Persian edition is likely to be frustrated that the labels for the geometrical points used in the French translation and its diagrams do not always match the labels used in the Persian edition and its diagrams. These inconsistencies between French and Persian labels occur despite the inclusion of a table of transliteration at the beginning of the introduction. The Persian translation, following the patterns of the Arabic Euclidean tradition,

usually assigns labels to the diagram points following the conventional Arabic *abjad* ordering, although sometimes “waw” and “yā” are used and sometimes letters are simply skipped. The French translation follows (sometimes) the order of the Latin alphabet and routinely transliterates the letter “jīm” with C. G is often omitted from the French labels, but in construction 18 it appears as the equivalent of “rā” while in construction 28 it appears as the equivalent of “hā”. At the same time, in the Persian diagrams what would typically be “zay” in Arabic is routinely written as “rā”. (The difference is only a dot, and manuscript copyists are notoriously inconsistent about inserting dots.)

Moreover, in some cases we find that the diagrams given in the Persian edition appear very different from those in the French translation (for example, the diagrams of chapter II, construction 1). And the differences in labeling between the Persian and French diagrams for this construction only add to the confusion of the reader. Although on close reading, the logic of the construction turns out to be the same in both Persian and French, the use of differing diagrams may confuse and frustrate readers unfamiliar with the intricacies of medieval geometry manuscript sources.

A bibliography follows the French translation. I found this section to be somewhat unsatisfying. The bibliography is explicitly limited to works discussing the career and mathematics of al-Buzjānī.

Thus some material cited in footnotes, such as discussions of regular and semi-regular solids or sources on the intellectual and political context are not included. Even within this limited framework, the choice of materials to include in the bibliography is sometimes puzzling. Although older bio-bibliographical sources such as Brockelmann and Sezgin are cited in the bibliography, the more recent and more comprehensive work of Rosenfeld and Ihsanoglu is not listed. (Rosenfeld and Ihsanoglu assert the existence of another Arabic manuscript of *Kitāb al-Nijāra* (Mashhad 5357) which Aghayani-Chavoshi has identified (p. 35) as an Arabic commentary composed by Kamāl al-Dīn ibn Yunus.) Equally puzzling is why the brief survey of the scientific work of Abū'l-Wafā' in George Sarton's old *History of Science* is cited in the bibliography. In addition to these limitations, it is also confusing that sources written in Arabic and Persian are cited in Arabic script in the footnotes, but appear in the bibliography only in transliteration.

Moreover, there exists a considerable secondary literature studying Arabic investigations of regular polygons, Archimedean solids, and various semi-regular polyhedra. Several of these secondary works appear in the footnotes, but others have been omitted. Such omissions limit the usefulness of both the footnotes and the bibliography for anyone who might wish a broader understanding Abū'l-Wafā' and the

intellectual and craft context of his work on practical geometry.

The bibliography is followed by indices of personal names and topographic names. These indices seem to me to be of limited usefulness. The indices appear intended to include every person or place named in the introduction (but not in the footnotes). In practice, there are omissions. An occurrence of the name al-Quhi (p. 19) is not included in the index (and the accompanying mention of the Observatory at Baghdad is similarly missing from the topographical index) nor does the name Sa'adi (p. 61) appear. Leonardo da Vince, Albert [sic] Dürer and Tartaglia are mentioned in the same sentence (p. 102). Leonardo does not appear in the index, although both Dürer and Tartaglia are present. Ibn Sahl (p. 104) is in the index, but al-Kindi, mentioned in the same sentence, is not. There are similar omissions in the Topographic Index. "Damas", mentioned as the site of the Zaheriya Library (p. 25), is not in the index, but "Massachusetts", mentioned as the location of Harvard University (p. 117), is included. "Turquie" (p. 27) is included in the index, but Iran (p. 31) is not. It is also unclear why nearly all diacritics have been omitted in these indices although they are generally present in the text and footnotes.

Inconsistencies in transliteration of names could also prove confusing: "Ali Qushchi" (p. 27) becomes Ali Qoushchi in the index and similarly "Ulug Beg" (p. 27) becomes

Ouloug Beg. Topographic names sometimes also shift spelling: "Samarcande" (p. 27) becomes Samarkand and "Istanbul" (p. 28) becomes Istambul in the index.

More frustrating is the inconsistency of presentation in the Personal Names Index. For example, we find "al-Farabi, Abu Nasr" but "Abu Bakr al-Razi". Similarly, we find "Ahmad Jam" but "Aram Ahmad" (the comma has been omitted here, adding to the confusing situation). Nor is this inconsistency limited to Arabic names: we find "Kennedy, E. S." but "Matila D. Ghyka" and "Albert Durer" (Albrecht has been changed to Albert and the umlaut is missing as are most other diacritics). In the text, we find "M. Mustafa" (p. 23) but in the index his name is given as "Mawaridi, Mustafa". Although such inconsistencies do not necessarily imply that the indices are completely useless, in general I do not think that the indices add significantly to the introduction.

The introduction is concluded with a Persian / French glossary or "Lexique" which, we are told, includes the important ideas and technical terms used in the two Persian versions of *Kitāb al-Nijāra*. The terms are arranged alphabetically according to the Persian terms. I think the usefulness of the glossary might have been increased if there were an indication of which Persian version uses the term (if the term differs from one version to the other). It would also be helpful to include references indicating where

in the text an idea or technical term is specifically discussed / defined so that interested readers can see these terms in their context, rather than in isolation, especially since in a few cases the French equivalent appears different from the usual Arabic meaning of the terms. (The term "ahl al-ṣinā'at" for example is rendered as "artisan" although the Arabic construction would more commonly refer to a "(collective) group of artisans".)

Even though readers may at times find the inconsistencies of both the diagrams and the supplementary material accompanying the introduction rather frustrating, these features do not detract significantly from the overall value of the work. The scholarly community owes a vote of thanks to Professor Aghayani-Chavoshi for making this important work available in an accessible and easy to understand form. Historians of mathematics who have too often been cut off from the ancient and medieval sources by linguistic constraints now have a major new resource in hand.

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Jerzy Dobrzycki, *Selected Papers on Medieval and Renaissance Astronomy*. With a Foreword by Owen Gingerich. Edited by Jarosław Włodarczyk and Richard L. Kremer. Institute for the History of Science. Polish Academy of Sciences. Coperni-