BIBLIOGRAPHICAL NOTES ON ISLAMIC ASTRONOMY, THE RESULTS OF A STUDY OF THE EXACT SCIENCES AMONG THE JEWS OF YEMEN

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Introduction
The people of Yemen as a whole, and the Jews of that country in particular, possess a very rich cultural heritage, including achievements in the field of astronomy. The medieval astronomical sources were the subject of an exhaustive study by David A. King (Mathematical Astronomy in Medieval Yemen, Malibu 1983). Some material concerning Jewish interest in the subject was collected by Bernard R. Goldstein (The Survival of Arabic Astronomy in Hebrew, J. for the Hist. of Arabic Science 3, 1979, 31-39, note 2c.) The author of this paper has recently completed a monograph on the exact sciences among the Jews of Yemen. In this paper we present some discrete items of mainly bibliographic interest which emerged from that study. Note that our sources are all Arabic manuscripts, written in Hebrew characters.

1 The Zijes of al-Farisi
Both King (p. 25, no.6.3) and E.S. Kennedy (Survey of Islamic Astronomical Tables, no. 54) report one zij from Abu Abd Allah Muhammad ibn Abi Bakr al-Farisi, known by three titles: al-Khazaini, al-Muzaffar, and al-Farisi. On the basis of certain remarks of Alu ben Yesha, a Jewish astronomer working at the very end of the 15th century, we learn that, in fact, the Khazaini zij and the Muzaffar zij are distinct from one another and different in their makeup. It also appears that al-zij al-Farisi is a general term which may be applied to either.

In a discussion of the "second correction" for the five planets, i.e. for the epicyclic diameter at mean distance, Alu writes: "the explanation of this in the Maarij and in the tables of the Khazaini zij is clearer than that of the Muzaffar zij." (Ms. Heb 28° 6055, Jewish National and University Library, Jerusalem, f58a). The Maarij is another work of al-Farisi, Maarij al-Fikr al-Wahij fi hall mushkiliat al-zij (King, no.6.24).

More details as to the differences between the two zijes emerge from the discussion on the equation of time. Alu writes (30a): "It is clear from the al-Farisi[ zij that the extremum of this correction is approximately 30 minutes--so it is in the Muzaffar. In the Khazaini it is half of this, and different as well. Up to the present we do not know the reason for this difference."

From this passage we infer that the al-Farisi[ zij may have been a collective title for all the tables of al-Farisi. (In his commentary to Maimonides' Sanctification of the New Moon, however, Alu speaks of al-zij al-Farisi..."
More importantly, we learn that the values for the equation of time tabulated in the Muṣaffarī zij were approximately double those of the Khāzā'īnī. Now this raises several problems. First, we note that in his commentary to Maimonides, Aluḍel notes that the lunar corrections found in the Muṣaffarī zij are double those of the standard zijās. Regarding the second lunar correction, whose maximum is usually about 5°, Aluḍel writes (21a): "The author of the Muṣaffarī zij doubled it, making it approximately 10°, in the same manner that he doubled the first correction." Aluḍel goes on to say: "Even now we do not know the truth regarding some of the matters included in this zij, because in it are things not found in the [standard] tables." In fact, however, this doubling of the values is readily understandable, and the suitable explanation was given in an anonymous note to the copy of the Muṣaffarī zij found in the collection of Rabbi Yosef Kafāh of Jerusalem. Speaking of the first lunar correction, whose maximum is about ±13°, the commentator notes that al-Farīsī subtracted about 13° from all the mean anomalies and doubled the correction, such that the correction would be always positive, and computation simpler.

However, in the case of the equation of time, it is the Muṣaffarī zij which has the standard values (maximum 30°; cf. O. Neugebauer, A History of Ancient Mathematical Astronomy, 985, 1406), while the Khāzā'īnī presents roughly half these values. Moreover, I take the phrase of Aluḍel, "and different as well" (wa-mukhtalifun aydan) to mean that the values in the Khāzā'īnī zij are not consistently half those of the Muṣaffarī, i.e. they may have been calculated in an independent fashion. Finally, we note that Aluḍel has not simply mixed up the two zijās: the same Muṣaffarī zij which has doubled the lunar corrections has also the normal values for the equation of time (e.g. the copy found in BL Or. 4104).

2 Qūṭ al-Dīn al-Shīrāzī (?) Did the writings of the "Marāgha school", with their tremendous innovations, reach Yemen? There is strong, and, to my mind, convincing evidence in the commentaries of Aluḍel that one such work, the Niḥāyat al-Idrāk of Qūṭ al-Dīn al-Shīrāzī, was in fact known to Yemeni astronomers. Aluḍel refers some seven times to an astronomer by the name of al-Shīrānī. Three important points of detail argue for the identification of al-Shīrānī with al-Shīrāzī, and this despite the fact that the name al-Shīrānī is known in the history of Arabic astronomy, and, in particular, it was also the name of al-Fahhād who, in turn, was an important source for al-Farīsī. The three points are the following:

1) The full name of the astronomer. In an interesting passage Aluḍel writes (71a): "It has been said that al-Shīrānī is the author of the Tābsirah, but it is most likely that this is incorrect ... the name of the author of the Tābsirah ... is ʿAbd al-Jabbār al-Kharaqī, but the name of al-Shīrānī is Mahmūd bīn Masūd." Now Mahmūd bīn Masūd is part of the full name of al-Shīrāzī. Moreover, we learn from this passage that there was some confusion regarding al-Shīrānī, a fact which may help explain what is, in our opinion, the corruption of the name al-Shīrāzī.

2) The title of the work: In his commentary to Maimonides, Aluḍel gives the full title of "the book of al-Shīrānī" as Niḥāyat al-Idrāk fī ilm al-Aflāk. (20b)
There is no such work ascribed to al-Fahhād. However, the book of al-Shīrāzī is called Nihāyat al-Idrāk ff Dirāyat al-Aflāk.

3) The theory. In the passage cited above, where Alu'el shows that al-Shirwānī is not the author of the Ṭabsīrah, we read: "Moreover, al-Shirwānī holds that the sun has an epicycle, but the author of the Ṭabsīrah is not of that opinion." In another comment (33b), Alu'el notes that al-Shirwānī assumes two epicycles in the theories of Venus and Mercury. Both of these details are appropriate to the "Marāgha school."

(Note: I do not have a copy of al-Shīrāzī's work. I sent a passage quoted by Alu'el from al-Shirwānī to Dr. George Saliba. Dr. Saliba could not find that exact passage in al-Shīrāzī, but neither he nor I regard this as conclusive).

3 Others

In the private collection of Mr. Yehudah Levi Nahum (Holon, Israel), which will surely prove to be of great value once the very numerous fragments have been identified and/or catalogued, are four pages belonging to the astronomical treatise of Qāsim bin Muṭarraf, composed 319 H. in Cordova. The identification is secured by the title of chapter 12 which is preserved in the fragment and matches that given by Sezgin, vol. 6, 158. The city of Cordova is mentioned as well, and the fragment breaks off in the year 300 of ... 

The Istanbul manuscript, from which Sezgin (by way of an article by F. Rostenhal) learned of the treatise, contains the unique copy of Qāsim's treatise. It is interesting that such an early Andalusian treatise reached Yemen.

The opening page of a treatise on twilight is found in one of the manuscripts in the collection of Rabbi Kafah. Unfortunately, the page is damaged, and it is impossible to make out either the name of the author or the title of the treatise. Reference is made to works on the same subject by Ibn Muāadh (published by B. R. Goldstein in Archive for History of Exact Sciences, 1977) and by another jurist, ʿAbd al-Raḥmān bin Ṭāhir.

A copy of the Zfj al-Jāmiʿ purports, according to a somewhat unclear note, to have been copied from Kushyār's autograph, which also contained autograph criticisms and corrections on the part of Bahrām ibn Bīnāyāmīn. However, this copy is missing part III of Kushyār's Zfj.

Several short quotations from Abū-l-ʿUqūl are found in a manuscript of Rabbi Kafah, but I do not know if these are taken from any of the works listed by King (pp.25ff.). They deal with the (1) size and distance of the sun and the moon, (2) lunar eclipses, (3) musical ratios of the orbs, and (4) circumference of the earth.

Also worth mentioning are (1) a short fragment from Ibn Yunus' Zfj al-Hākimī on the elevation of the pole of the ecliptic and (2) a table from the Zfj of Yaḥya ibn Abī Manṣūr.
DISCUSSION

S.M.R. Ansari: Did you find any work on Instruments in Yemen? If I understand correctly there is extent Zīj-i-Safiha of Al-Khazā'īni in Yemen.

Y. Tzvi Langerman: There is some mention of instruments but nothing special.

Sorry - I am referring to the Zīj with the title of al-Khazā'īnī by the astronomer Abū Bakr al-Farisī.