Astronomy in the Iberian Peninsula: Abraham Zacut and the Transition from Manuscript to Print by José Chabás and Bernard R. Goldstein

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The present book is a highly technical study in which the authors describe and analyze the astronomical texts of Abraham Zacut (1452–1515), an outstanding intellectual figure in the Spanish Jewish community who lived, as the title indicates, in a very interesting period: the transition from manuscript to print. Zacut benefited from contact with Christian astronomers in Salamanca who had access to a vast corpus produced by astronomers from all over northern Europe. He also took advantage of the Jewish tradition in astronomy that developed mainly in southern France and Spain during the late Middle Ages. When the Jews were expelled from Spain in 1492, he moved to Portugal where he remained until 1496. Later, in Tunis, he made an adaptation of one of his works, the *Ḥibbur*, for the year 1501 and prepared, around 1513, a new set of tables for Jerusalem using the Jewish calendar.

The authors have already written several studies on the topic. For instance, Goldstein [1981] has published new materials related both to Zacut's biography and to his works; and together Goldstein and Chabás [1999] have published new information on Zacut, his sources, and the general development of astronomy in the Iberian Peninsula in the second half of the 15th century. In these works they display their profound knowledge of all related aspects, and conclude that significant contributions to astronomy need not involve alterations in fundamental theories or new observations. In the present work they apply this insight to their analysis of Zacut's astronomy, his sources, and his influence.

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The authors have focused on the book by Zacut that was generally known as the *Almanach Perpetuum* and published in Leiria, Portugal, in 1496. They also devote a chapter to another of his compositions, the *ha-Ḥibbur ha-gadol (The Great Composition)* which he wrote in Hebrew in 1478. One of the findings of their research is that the *Almanach Perpetuum* should no longer be considered a translation of Zacut's *ha-Ḥibbur*. For this study they have consulted medieval texts not only in Latin and Hebrew, but also in Castilian, Catalan, Portuguese, and Arabic.

In the introduction to this study we find a complete summary of the contents in which the authors state, for instance, that Zacut was pre-eminent among astronomers in Spain at the time. They begin by giving what they call 'Supplementary Notes for a Biography'. The most complete biography of Abraham Zacut was written by Francisco Cantera Burgos in two separate works published in 1931 and 1935. Our authors offer a critical reading of some of the materials previously published concerning Zacut. In fact they modify some of Cantera's statements by referring to the sources. They fix the dates of composition of certain works from internal evidence; for instance, they do not agree with Cantera's claim that he played a significant role in educating Portuguese navigators, since Zacut produced a book on astronomy, not on navigation. Besides, before his arrival in Portugal he had never lived near the sea and in his extant works he never discusses astronomical instruments or problems of astronomical navigation. Since Cantera studied the documents containing the different versions of the canons of the *Ḥibbur*, Chabás and Goldstein have focused on the tables and their mathematical structure rather than on the canons.

The following section, called 'Setting the Scene', introduces us to the knowledge of astronomy of the time: it is an analysis of Zacut's sources, which are basically materials related to Salamanca. First of all they describe the almanac tradition in the Iberian peninsula beginning with the almanac of Azarquiel, the earliest of its kind compiled in Muslim Spain. The advantage of an almanac is that it is 'user-friendly' in that it requires only linear interpolation between adjacent entries. Azarquiel was followed by several astronomers such as R. Abraham Ibn Ezra (*ca* 1089–1167) and Ibn al-Bannā' al-Marrākushī (1256–1321). Other almanacs were compiled outside the Iberian Peninsula and its area of influence. For instance, at the end

of the 13th century and the beginning of the 14th century in Paris, John of Lignères and John of Saxony compiled tables in almanac form. As well as analyzing Zacut's tables, our authors trace the pre-existing tradition of almanacs in the Iberian Peninsula and show that this tradition culminates with Zacut.

Another aspect studied is the knowledge of the Alfonsine Tables among astronomers working in Salamanca. The authors discuss the first evidence for the use of the Alfonsine Tables in Spain, the availability of the Alfonsine Tables in Hebrew, and Zacut's relationship to the traditions surrounding these tables. In this context it is surprising that, although the Alfonsine Tables were produced in Castile in the 13th century at the court of Alfonso X, the earliest evidence for their use in Spain comes from *ca* 1460 in Salamanca, with the arrival of Nicholaus Polonius. From this time on there was a lively tradition in astronomy at Salamanca and the authors believe that Zacut was acquainted with it. Zacut was also heir to a long and distinguished astronomical tradition in Hebrew and he acknowledges the works of some of his predecessors.

The third part contains a detailed description and analysis of the tables in one of Zacut's works, the *Ḥibbur*. The 65 tables contained in it are studied individually in great detail and some of them are compared with the ones found in the *Almanach Perpetuum*.

Zacut's *Almanach Perpetuum* is analyzed in the following section, beginning with the dedication, and then the canons and the tables. The *Almanach Perpetuum* consists of a set of relatively short canons followed by a large number of astronomical tables for diverse purposes. The canons are different from those in the *Ḥibbur*, but the tables were largely taken from it. Most of the tables are in the form of an almanac, that is, they give a set of positions for a given planet (including the Sun and the Moon), arranged at intervals of a day or a few days over the period of the planet's motion (ranging up to 125 years in the case of Mercury). Using modern calculators, the authors have verified that Zacut accurately computed the entries in these tables from the Alfonsine Tables. Doing so by hand required an enormous effort, a high level of skill, and careful attention to detail. It was indeed a task for a man of exceptional ability.

The edition of the *Almanach Perpetuum* of 1496, on which Zacut's fame rests, has many interesting features. The first is the fact

that the canons are in Latin in some copies and in Castilian in others. The work was edited by a printer, d'Ortas, whose other publications were exclusively Hebrew texts. Associated with d'Ortas is Joseph Vizinus, mentioned in the colophon to the Castilian version as having translated the text from Hebrew into Latin and then from Latin into Castilian. Vizinus seems to have played a major role in the history of astronomy and navigation, based on his skill in astronomy demonstrated in this edition of Zacut's tables.

The first part of this chapter is the dedication, included in the Latin version of the Almanach and absent in the Castilian version, to an unnamed dignitary of the Church of Salamanca. From the analysis of this dedication the authors conclude that it had nothing to do with either the bishop of Salamanca or with Zacut, and that it was added by Vizinus or by the printer d'Ortas as a tribute to Regiomontanus who had included a similar dedication to an Archbishop in Hungary in his work *Tabulae Directionem* composed in 1467.

The authors describe the two versions of the canons in Castilian and Latin and point to the striking differences between them and the canons in the *Ḥibbur*, concluding that the *Ḥibbur* and the *Almanach* are distinct works. This is followed by a very detailed analysis of the tables and also of the figure of Joseph Vizinus who, according to the colophon, was responsible for the preparation of the 1496 edition.

The last section of the book traces the influence of Zacut's astronomical works among his disciples *via* later editions of the *Almanach Perpetuum*, his influence on the Jewish community and on Christian scholars, and also the presence of the *Almanach Perpetuum* in the Muslim world. There was an immediate impact in Salamanca where we find texts in Latin and Castilian that are based on the *Ḥibbur* (independently of the *Almanach Perpetuum*). The publication of several editions of the *Almanach Perpetuum* in Latin in the 16th century attests to its popularity, and there were at least two translations into Arabic. Zacut's influence on Jewish scholars was most notable in the Eastern Islamic world, based to a great extent on the work he did in Jerusalem shortly before his death.

The book ends with an appendix in which Zacut's *Judgments of the Astrologer* is described. We also find indices of manuscripts cited, of parameters, and of names and subjects.

To sum up, this is an excellent work which is sure to be very useful for all those interested in the history of astronomy in the Middle Ages in the Iberian peninsula.

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