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ABRAHAM IBN EZRA'S SCIENTIFIC CORPUS BASIC CONSTITUENTS AND GENERAL CHARACTERIZATION*

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INTRODUCTION

Abraham ibn Ezra (*ca* 1089 – *ca* 1167) was a prolific writer on a great variety of subjects and one of the most original medieval thinkers. His fame was due principally to his outstanding biblical exegesis, but he also wrote religious and profane poetry and a series of religious-theological monographs.[1] However, Ibn Ezra's intellectual interests extended to the field of science as well and his main contribution to the history of science lies in the composition of a significant but poorly known scientific corpus. Its contents are typical of and faithfully reflect Ibn Ezra's times. On the one hand, Ibn Ezra's scientific contribution may

* I am indebted to Gad Freudenthal for his valuable comments and suggestions.

[1] For a discussion of Ibn Ezra's biblical exegesis, particularly focused on his commentary on *Psalms*, but also useful as a general evaluation of his exegetical contribution, see U. Simon, *Four Approaches to the Book of Psalms from Saadia Gaon to Abraham Ibn Ezra* (Albany, 1991), pp. 145-205. For an assessment of Ibn Ezra's philosophical-religious thought, see the following main works: M. Friedlander, *Essays on the Writings of Abraham Ibn Ezra* (London, 1877); D. Rosin, "Die Religionsphilosophie Abraham Ibn Esra's", *Monatsschrift für Geschichte und Wissenschaft des Judentums*, 42 (1898): 17-33, 58-73, 108-15, 154-61, 200-14, 241-52, 305-15, 345-62, 394-407, 444-57, 481-505; 43 (1899): 22-31, 75-91, 125-33, 168-84, 231-40; H. Greive, *Studien zum jüdischen Neuplatonismus: Die Religionsphilosophie des Abraham Ibn Ezra* (Berlin, 1973). About Ibn Ezra's non-conformism and individualism viewed as part and parcel of his cultural contribution and wanderings see A. Graboïs, "Le non-conformisme intellectuel au XII^e siècle: Pierre Abélard et Abraham Ibn Ezra", in M. Yardeni (ed.), *Modernité et non-conformisme en France à travers les âges* (Leiden, 1983), pp. 3-13. For a study of Ibn Ezra's utilization of astrological concepts in his philosophy from the perspective of the history of Jewish thought see Y. T. Langerman, "Some astrological themes in the thought of Abraham Ibn Ezra", in I. Twersky and J. M. Harris (eds.), *Rabbi Abraham Ibn Ezra: Studies in the Writings of a Twelfth-Century Jewish Polymath* (Cambridge, Mass., 1993), pp. 28-85. For a study of the integration Ibn Ezra made of scientific contents into his biblical commentaries and theological monographs see S. Sela, *Astrology and Biblical Exegesis in the Thought of Abraham Ibn Ezra* (in Hebrew) (Ramat-Gan, 1999).

be understood as the very beginning of an historic cultural development which may be named *the scientific renaissance of medieval Hebrew*. This was a process in which Jewish scholars gradually abandoned the Arabic language and adopted the *holy tongue* as a vehicle not limited to strictly religious contents but open also to express secular and scientific ideas.[2] On the other hand, on a broader European stage, Ibn Ezra's scientific output may be understood as one of the multiple expressions of the *twelfth century scientific renaissance*. It was a cultural process in whose framework the Greek scientific world conception was transferred to scholars in Western Europe, after being adopted, refined and extended by Islamic culture and Arabic language. In this context, Ibn Ezra's scientific corpus represented an exceptional case: instead of the common Latin model embodied by the scholar coming from the Christian North and daring to penetrate the Iberian Peninsula to initiate a translation enterprise, we have in Ibn Ezra the contrary case of an intellectual imbued with the Arabic culture, who abandons al-Andalus, roams around the Christian countries and delivers in his wandering through Italy, France and England,

[2] I have adopted this special denomination – "*scientific renaissance of medieval Hebrew*" – because medieval Jewish intellectuals believed that their Hebrew ancestors were vigorously engaged in sciences and that Greek philosophy and sciences were in fact a product of the "theft" of the pristine Hebrew wisdom. Medieval Jewish intellectuals therefore assumed that by being engaged in sciences of Greek or Arabic origin they were in fact reawakening their brilliant scientific past. For a discussion of the development of these ideas, especially in Late Antiquity, see N. Roth, "The 'theft of philosophy' by the Greeks from the Jews", *Classical Folia*, 32 (1978): 53-67. For a discussion of this belief, focused mainly on the work of twelfth century Jewish intellectuals, see Sela, *Astrology and Biblical Exegesis*, pp. 47-54. For a general review and discussion of the movement of translations from Arabic into Hebrew which embraced the full range of philosophy and scientific learning performed between the 12th and the 15th centuries, see A.S. Halkin, "Translation and translators", *Encyclopaedia Judaica*, XV (Jerusalem, 1972), cols. 1318-1329; J.-P. Rothschild, "Motivations et méthodes des traductions en hébreu du XII^e^ à la fin du XV^e^ siècle", in G. Contamine (ed.), *Traduction et traducteurs au Moyen Âge* (Colloque International du CNRS, IRHT, 26-28 mai 1986) (Paris, 1989), pp. 279-302. For a study of the role that sciences played in Jewish medieval society, chiefly focused in Provence, see G. Freudenthal, "Les sciences dans les communautés juives médiévales de Provence: leur appropration, leur rôle", *Revue des études juives*, CLII (1993): 29-136, esp. 32-41. On the process of creation of the corpus of medieval Jewish texts on gynaecology and obstetrics, see R. Barkai, *A History of Jewish Gynaecological Literature in the Middle Ages* (Leiden, 1998), pp. 6-20. For the contribution of Abraham bar Ḥiyya, another Jewish scientist contemporary with Ibn Ezra, see Ḥ. Rabin, "R. Abraham bar Ḥiyya uteḥiyyat leshonenu bimei habeinayim", in R. Rawidowicz (ed.), *Meṣuda* (London, 1945), pp. 158-70.

the scientific and cultural cargo that he amassed during his youth in al-Andalus.[3]

Researchers in the past have explored some components of Ibn Ezra's scientific corpus. A brilliant start was carried out in the closing years of the last century by the bibliographic contribution of Moritz Steinschneider[4] and by Moritz Silberberg who translated and prepared a critical edition of Ibn Ezra's *Sefer haMispar*.[5] In our century, José Maria Millás Vallicrosa focused his attention on Ibn Ezra's astronomical works, editing two important Latin treatises ascribed by him to Ibn Ezra.[6] Also B. R. Goldstein, in connection with his research on *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī*, an important lost astronomical Arabic source that is extant in Latin and Hebrew translations, edited, translated and commented upon the Hebrew translations, including the version carried out by Ibn Ezra.[7] But these important works represent quantitatively only a small part of Ibn Ezra's scientific corpus. The overwhelming majority of the works composing Ibn Ezra's scientific corpus were, as we will soon see, original treatises written in Hebrew, and this is the most neglected part of his scientific output. As a matter of fact, some of the Hebrew treatises of Ibn Ezra were printed, but mainly in order to achieve important goals which were quite tangential to the scientific contents of the corpus. For instance, Raphael Levy

[3] For a general evaluation of Ibn Ezra's scientific contribution, see J. M. Millás Vallicrosa, "El magisterio astronómico de Abraham Ibn 'Ezra en la Europa latina", in *Estudios sobre historia de la ciencia española* (Barcelona, 1949), pp. 289-347; S. Baron, *A Social and Religious History of the Jews*, VIII (New York, 1958), pp. 138-220; M. Levey, "Abraham ibn Ezra", *Dictionary of Scientific Biography*, vol. IV (1971), pp. 502-3; B. R. Goldstein, "Astronomy and astrology in the works of Abraham Ibn Ezra", *Arabic Sciences and Philosophy*, 6 (1996): 9-21.

[4] See, especially, M. Steinschneider, "Abraham Ibn Esra (Abraham Judaeus, Avenare)", *Supplement zur Zeitschrift für Mathematik und Physik*, XXV (1880): 59-128; *id.*, "Abraham Judaeus – Savasorda und Ibn Esra", *Supplement zur Zeitschrift für Mathematik und Physik*, XXII (1867): 1-44, rprt in M. Steinschneider, *Gesammelte Schriften* [eds. H. Malter and A. Marx (Berlin, 1925)], pp. 407-98; 327-87.

[5] *Sefer haMispar, Das Buch der Zahl,* ein hebräisch-arithmetisches Werk des R. Abraham Ibn Esra, Zum ersten Male herausgegeben ins Deutsche übersetzt und erläutert von Dr. Moritz Silberberg (Frankfurt a. M., 1895), pp. 27, 79.

[6] José M. Millás Vallicrosa, *El Libro de los Fundamentos de las Tablas Astronómicas de R. Abraham Ibn Ezra* (Madrid-Barcelona, 1947); J. M. Millás Vallicrosa, "Un nuevo tratado de astrolabio de R. Abraham ibn Ezra", *Al-Andalus,* V (1940): 9-29.

[7] B. R. Goldstein, *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī* (New Haven-London, 1967).

edited the Hebrew text of Ibn Ezra's book *Reshit Ḥokhma* (The Beginning of Wisdom), together with its medieval French translation, not so much because he was interested in this important Hebrew astrological treatise, the most famous of Ibn Ezra's scientific corpus, as by virtue of the fact that the medieval French translation of *Reshit Ḥokhma* was an excellent source in his research of the process of crystallization of the incipient French language.[8] Similarly, J. L. Fleischer, a scholar interested in Ibn Ezra's biography and literary work, published some of his Hebrew astrological works, but confessed openly that he undertook the task not so much by reason of being attracted by its inner contents as because he estimated that in the subject-matter of these texts he would be able to find important biographical data in order to learn about Ibn Ezra's biography and biblical commentaries.[9]

My main purpose in this article is to provide a picture of Ibn Ezra's scientific corpus as comprehensive and detailed as possible given the present state of research, by continuing and updating the work of those who in the past were interested in his output. I will add new significant data that I was able to discover as a result of my exploration of Ibn Ezra's work, the published books as well as the works that are extant in manuscripts only. The paper will fall into two main parts: (a) Ibn Ezra's scientific work will be broken up into three main genres: (1) Mathematics, Astronomy, Scientific Instruments and Tools; (2) The astrological encyclopaedia; (3) Translations from Arabic into Hebrew. Within these genres, the treatises composing the scientific corpus, including the various versions of a same treatise, will be treated separately and follow a chronological order, to establish fundamental bibliographical facts, such as date and place of composition. At the same time, the scientific contents

[8] See R. Levy, *The Astrological Works of Abraham Ibn Ezra* (Baltimore, 1927), p. 65: "It is not primarily as a study of the literary significance of these treatises, however, that the present work was undertaken. Its chief object is to investigate the language of the French translation from the point of view of French lexicography". See also Raphael Levy and Francisco Cantera, *The Beginning of Wisdom, An Astrological Treatise by Abraham Ibn Ezra* (Baltimore, 1939), p. 15.

[9] See what J. L. Fleischer wrote with remarkable frankness in the introduction to his edition of Ibn Ezra's first version of *Sefer haṬe'amim* (Jerusalem, 1951), pp. 8-9: "I was not interested at all by the astrological-professional aspect of this book. Instead, I prepared photographs of the manuscripts of Ibn Ezra's astrological works because I meant to find in them new data to explore Ibn Ezra's biography, the chronology of his works and new insights into his intellectual character."

of these works will be briefly shown and its sources indicated sporadically. I will pay special attention to the questions of Ibn Ezra's problematic authorship of some works; (b) In the second part, Ibn Ezra's scientific corpus will be reassembled as a whole in order to provide a global characterization, trying to point out its general organization and shape, and to indicate its main aims and special traits revealing Ibn Ezra personal contribution.

PART I: BASIC CONSTITUENTS OF THE SCIENTIFIC CORPUS

1. *Mathematics, Astronomy, Scientific Instruments and Tools*

We begin our review with the works of Ibn Ezra dealing mainly with mathematics and astronomy. As we will soon see, it is not principally with the purpose of providing pure theoretical knowledge in mathematics or astronomy that these works were written. They were mainly oriented to solve technical astronomical problems arising from the astrological praxis. Of paramount importance in this context was to explain and teach the use of scientific tools and instruments, such as the astrolabe and the astronomical tables. Another important aim was to explain the foundations of the Hebrew calendar implementing the tools provided by Greek and Arabic astronomy.

• ***Sefer haMispar*** (Book of the Number): This treatise was written in Italy, possibly in the city of Lucca, approximately in 1146 or before, and therefore has to be considered as Ibn Ezra's first scientific work. This assertion follows from the following two facts. First, *Sefer haMispar* was surely written before or in 1146, since Ibn Ezra alludes to *Sefer haMispar* as an already accomplished work in his *Sefer ha'Ibbur* (Book of Intercalation), which was definitely written in the city of Verona in 1146 (see below p. 113). Secondly, in his *Sefer haMispar* Ibn Ezra refers on two different occasions to the first Hebrew version of *Sefer Ṭa'amei haLuḥot* (Book of the Reasons behind Astronomical Tables), using the future tense and so alluding to it as a still unaccomplished work.[10] Since the first Hebrew version of the *Sefer Ṭa'amei haLuḥot* was written in Lucca approximately in 1146 (see below p. 97), it follows that *Sefer haMispar* was written in 1146 or before, in the city of Lucca or in Rome, which was

[10] Silberberg, *Sefer haMispar*, pp. 27, 79.

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Ibn Ezra's previous station in Italy. This treatise was published in a critical edition already in 1895, with a commentary and a German translation.[11]

Sefer haMispar was intended to be an arithmetic textbook, and as such it was divided into seven chapters, dealing with the following basic operations: multiplication, division, addition, subtraction, fractions, proportions and square roots. At the same time, *Sefer haMispar* presents and explains in its introductory chapter the decimal positional system, which assumes, besides separate symbols for 1 to 9, also an additional "void" symbol for 0 as a placeholder, and Ibn Ezra refers explicitly to it metaphorically as a "wheel, *like straw before the wind*, designed to keep the values in their degrees and in foreign language (Arabic) is called *sifrah*".[12] Before turning to explain the decimal positional system, Ibn Ezra claims in *Sefer haMispar* that this system was an invention of the Hindu sages.[13] Also, in the introduction to his translation of *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī*, Ibn Ezra informs us that Kanka, a Hindu scholar, "taught the Arabs the basis of numbers, i.e., the nine numerals", and that subsequently "all later Arabic scholars multiply, divide and extract square roots as is written in Muḥammad b. Mūsā al-Khwārizmī's book on Hindu reckoning".[14] Hence, *Sefer haMispar* was, very probably, based on al-Khwārizmī's *Treatise on Calculation with the Hindu Numerals* or the *Book of Addition and Subtraction by the Method of Calculation of the Hindus*, which may have expounded for the first time in Arabic the use of the Hindu numerals 1 to 9, and 0, and the place-value system, besides the four basic operations of addition, subtraction, multiplication and division as well as the extraction of the square root.[15] In this

[11] See note 5 above. For a discussion of some arithmetic and terminological topics related to this book, see G. Ben-Ami Sarfatti, *Mathematical Terminology in Hebrew Scientific Literature of the Middle Ages* (in Hebrew) (Jerusalem, 1968), pp. 131-9.

[12] Silberberg, *Sefer haMispar*, p. 3. The word *sifrah*, appears with the same meaning in *Liber de rationibus tabularum*, the Latin version of Ibn Ezra's *Sefer Ṭa'amei haLuḥot* as *cifre*, which is a transliteration of an Arabic word meaning void or zero. See Millás, *Tablas*, pp. 102, 114.

[13] Silberberg, *Sefer haMispar*, p. 2.

[14] Goldstein, *Muth.*, pp. 148, 301-2.

[15] For a discussion of these two al-Khwārizmī's arithmetic treatises, see G. Toomer, "Al-Khwārizmī", *Dictionary of Scientific Biography*, VII (1973), p. 360. For a discussion of al-Khwārizmī's role in the beginnings of algebra, see R. Rashed, *Entre arithmétique et algèbre. Recherches sur l'histoire des mathématiques arabes* (Paris, 1984), pp. 17-29.

context, it is worth pointing out that the Hebrew *Sefer haMispar* is one of the first to introduce the arithmetic of al-Khwārizmī into Latin Europe, let alone the presentation of the decimal positional system, together and in parallel to a Latin contemporary version named *algorismus*, a name that clearly betrays al-Khwārizmī's influence.[16]

• ***Sefer Ṭa'amei haLuḥot*** (Book of the Reasons behind Astronomical Tables): Abraham ibn Ezra presumably wrote this treatise in four different versions, two in Hebrew and the other two in Latin.[17] The Hebrew versions are lost but a Latin text, the *Liber de rationibus tabularum*, was ascribed to Ibn Ezra and edited in 1947 by José Maria Millás Vallicrosa.[18] We have sound evidence about Ibn Ezra's authorship over both Hebrew versions: according to the highly reliable testimony of Joseph Bonfils in his work *Ṣafnat Pa'aneaḥ* – a supercommentary written on Ibn Ezra's commentary on the *Pentateuch* at the end of the fourteenth century – Ibn Ezra wrote two different Hebrew versions of the astronomical tables, the first in Lucca and the second in Narbonne. As far as the first Hebrew version is concerned, besides being composed in Lucca as Joseph Bonfils

[16] The name of the Latin treatise is *Liber ysagogarum Alchorismi* and one of the eight extant manuscripts attributes it to *Magister A*. Names such as Adelard of Bath, Abraham bar Ḥiyya and Petrus Alphonsi were presented as plausible candidates, but taking into account that Ibn Ezra wrote *Sefer haMispar*, which clearly reveals al-Khwārizmī's influence, and given that the Latin treatise covers also *Jewish* topics, such as the Jewish calendar, the Hebrew names of the planets, etc. it is not impossible that *Magister A.* was Abraham ibn Ezra. For a discussion of this Latin arithmetic treatise introduced in Latin Europe in the middle of the twelfth century, See especially A. Allard, "The Arabic origins and development of Latin algorisms in the twelfth century", *Arabic Sciences and Philosophy*, 1 (1991): 233-83. See also L. Cochrane, *Adelard of Bath, The First English Scientist* (London, 1994), pp. 80-1, 83-4 (n. 31, 32); M. S. Mahoney, "Mathematics", in D. Lindberg (ed.), *Science in the Middle Ages* (Chicago, 1978), pp. 150-1.

[17] For a discussion of the different versions of this treatise, and especially regarding the presumed authorship of Ibn Ezra, see the following works: Steinschneider, "Abraham Ibn Esra", pp. 494, 469; José M. Millás Vallicrosa, "Avodato ṣel R. Abraham Ibn Ezra beḥokhmat hatekhuna", *Tarbiz*, IX (1938): 306-22; *id.*, *Tablas*, pp. 11-21; *id.*, "El magisterio astronómico de Abraham Ibn 'Ezra", pp. 289-347; I dealt with this subject in two articles, and here I will confine myself to point out the main arguments: S. Sela, "Contactos científicos entre judíos y cristianos en el siglo XII: El caso del *Libro de las Tablas astronómicas* de Abraham Ibn Ezra en su versión latina y hebrea", *Miscelanea de Estudios Arabes y Hebraicos,* 45 (1996): 185-222; *id.*, "Puntos de contacto entre contenidos del *Libro de las Tablas astronómicas* en su versión latina y las obras literarias hebreas de Abraham Ibn Ezra", *Miscelanea de Estudios Arabes y Hebraicos*, 46 (1997): 37-56.

[18] See above note 6. This treatise, as we will soon see, is the second Latin version of *Liber de rationibus tabularum*.

claimed, it is possible to establish with a reasonable certainty that it was written in 1146, after Ibn Ezra wrote his *Sefer haMispar* and briefly before he moved to Verona.[19] Regarding the second Hebrew version of *Sefer Ṭa'amei haLuḥot*, we know for certain that it was composed in Narbonne, as Joseph Bonfils claimed, and it may thus be safely stated that it was composed after Ibn Ezra left Italy and arrived in Provence in 1148 but before 1154.[20]

As said above, the two Hebrew versions are lost, but we can catch a glimpse of their contents by exploring other sources. In *Ṣafnat Pa'aneaḥ* of Joseph Bonfils it is possible to trace four interesting references pointing directly to four passages of Ibn Ezra's *Sefer Ṭa'amei haLuḥot* – two dealing with the motions of the moon, one with the longitude of Jerusalem, and one furnishing a very high opinion of Claudius Ptolemy. An analysis of these passages shows that its contents are either similar but not identical to parallel passages found in the Latin version or non-existent in it altogether.[21] Similarly, a comparison between, on the one hand, numerous references to *Sefer Ṭa'amei haLuḥot* found in the Hebrew scientific corpus of Ibn Ezra[22] along with the already-mentioned four references to it found in *Ṣafnat Pa'aneaḥ*, and, on the other hand, the contents of the Latin extant version, allows us to conclude that the Hebrew and Latin versions were similar in some details but quite different in other significant parts.

We now turn to the Latin version. Several manuscripts survive of this version which, as said above, was edited by José

[19] The last assertion follows from the following two points: first, as said above (see p. 95), in his *Sefer haMispar* Ibn Ezra refers on two different opportunities to some *Sefer Ṭa'amei haLuḥot*, that is, the *Book of the Reasons Behind Astronomical Tables*, using the future tense and so alluding to it as a still unfinished work. Secondly, later in 1146 Ibn Ezra left Lucca and moved to Verona where he also wrote in 1146 the first version of his *Sefer ha'Ibbur*, a fact that was registered by Ibn Ezra himself in this book (see below p. 113).

[20] The second Hebrew version was quite certainly composed before 1154, when Ibn Ezra wrote the second version of his *Sefer haMoladot*, in whose Latin extant translation we found a reference to the *Liber de rationibus tabularum* as an accomplished work (see below p. 125).

[21] The four references may be found in Joseph Bonfils, *Sophnat Pane'ach*, Ein Beitrag sur Pentateuchexegeses des Mittelalters von D. Herzog (Heidelberg, 1911-1930), I, pp. 14-15, 17-18, 84, 142. I have analyzed these four references in Sela, "Contactos científicos", pp. 200-7.

[22] For a review and analysis of these references see: Millás, *Tablas*, pp. 11-19; Sela, "Contactos científicos", pp. 190-200.

Maria Millás Vallicrosa in 1947, who, following some hesitant claims of M. Steinschneider,[23] also ascribed this work to Abraham ibn Ezra.[24] Notwithstanding Millás Vallicrosa's important contribution in the edition of this work, some important obstacles still remain and need to be removed before Ibn Ezra's authorship can safely be assumed. I will refer to these difficulties while furnishing bibliographical information about the Latin versions.

In the Latin text there appears in several places the name of *Abraham* or *Abraham Iudaeus* as a reference to its writer,[25] which remark surely implies that the writer was a Jew whose name was Abraham. This, however, does not imply that *Abraham* or *Abraham Iudaeus* is the author of the Latin version, for the text may originally have been written in Hebrew and subsequently translated into Latin. Nor is it certain that *Abraham* or *Abraham Iudaeus* can be identified with Ibn Ezra. Still, in my opinion, the evidence suggests the following three points: (i) Ibn Ezra was the ultimate author of the contents found in the Latin text; (ii) the Latin text was not a mere translation from a Hebrew source; (iii) Ibn Ezra had some knowledge of the Latin language, a fact that works in favor of the possibility that he was in some way involved in the composition of the Latin version. These points may be defended with the following arguments.

(i) Abraham ibn Ezra's authorship is grounded primarily on correspondences between the Latin text and Ibn Ezra's other known work. In this context, Millás Vallicrosa's main argument was to provide a series of references in Ibn Ezra's Hebrew scientific corpus pointing to a *Sefer Ṭa'amei haLuḥot* or *Sefer haLuḥot* (Book of the Astronomical Tables).[26] But, besides the fact that this list may be further enlarged and that the references do not always point to topics which may be actually found in the Latin text, my main objection to this argument is as follows: Based on passages extracted from Ibn Ezra's Hebrew scientific corpus, these references point naturally to the lost *Hebrew versions* of Ibn Ezra's *Sefer Ṭa'amei haLuḥot* or *Sefer haLuḥot* and so they cannot be presented as a proof of Ibn

[23] Steinschneider, "Abraham Ibn Esra", pp. 494, 469.

[24] Millás, *Tablas*, pp. 11-19.

[25] The Latin text begins with the words "Dixit Abraham Iudaeus", and the name Abraham appears on several occasions, especially in the trigonometric chapter. See Millás, *Tablas*, pp. 73, 137, 148, 154, 159.

[26] Millás, *Tablas*, pp. 11-19.

Ezra's authorship over a Latin counterpart. In my opinion, a proper demonstration-methodology should employ the opposite approach, that is, considering the Latin text as the point of departure, lines of contact should be traced to link the Latin text with Ibn Ezra's Hebrew work. In this context, Millás Vallicrosa and especially B. R. Goldstein already made important contributions, showing that there is a close and direct correspondence of the contents between some parts of the Latin text and Ibn Ezra's translation of *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī*.[27] What is more, additional evidence may be presented showing striking resemblance between some passages of the Latin text and parallel passages of Ibn Ezra's whole Hebrew literary work, that is, the scientific corpus as well as his biblical exegesis and theological monographs.[28]

(ii) As said above, a comparison of the references in Ibn Ezra's Hebrew scientific corpus to *Sefer Ṭa'amei haLuḥot* or *Sefer haLuḥot* with the corresponding passages in *Liber de rationibus tabularum*, shows that the Hebrew and Latin versions were

[27] Millás, *Tablas*, pp. 51-4, 73, 137, 148, 154, 159; Goldstein, *Muth.*, pp. 11, 200-8, 218, 231, 234.

[28] I dealt with this problem in Sela, "Puntos de contacto", pp. 37-56. In this article I presented several links between the Latin text and Ibn Ezra's oeuvre, but I limited myself to two main topics: a scientific subject such as the relation between the perimeter and the radius of the circle as well as a loaded religious topic such as a comparison between the Hebrew and the Christian calendars. Yet additional striking instances may be supplied, and I will limit myself here to a single one. This is a passage found in the Latin text as well as in the first version of *Sefer ha'Olam*, discussing in Latin and in Hebrew the various amounts ascribed to the sun declination with a similar approach and with almost identical wording: Millás, *Tablas*, p. 77: "Nam indi dicunt 24 graduum integrorum declinationem solis esse, sed Abrachix et Ptholomeus dixerunt 23 graduum 51 minutorum, secundum horum sententiam arcus declinationis sic se habebit ad totum circulum ut 11 ad 83. Omnes vero alii magistri probationum dixerunt declinationem esse 23 graduum et 35 minutorum, exceptis Abnebimezor et Azarchel qui dixerunt eam esse 23 graduum et 33 minutorum"; *Sefer ha'Olam* (first version), Paris, Bibliothèque Nationale de France (hereafter Paris, BNF), MS Héb. 1056, fols. 81^{r}-81^{v}:

"כי חכמי הודו אמרו שהיא כ"ד מעלות שלמות, ובטלמיוס אמר שהוא יותר מכ"ג מעלות ויותר מן מ"ה חלקים ופחות מן נ"א חלקים והנה בטלמיוס לא יכול לדעת האמת. ואברכז אמר שהוא י"א חלקים משמנים ושלש בכל הגלגל והנה הוא כ"ג נ"א. וחכמי ישמעאל דקדקו יותר מכולם והסכימה דעתם כי קשת הנטיה היא כ"ג ל"ה, חוץ מן יחייא בן אבן מנצור ואברהם אל זרקל שדקדקו יותר מכולם ואמרו כי הוא כ"ג ל"ג."

See another example, referring to two different versions of *trepidatio*, in Millás, *Tablas*, p. 77: Cf. Hebrew counterpart in *Sefer ha'Ibbur*, ed. by S. Z. H. Halberstam (Lyck, 1874), p. 10 (a).

similar in some details but quite different in other significant parts. Some of these differences – a reference to Jerusalem and a comparative and didactic approach to explain the points of contact between the Jewish and the Christian calendars – imply that the Hebrew and Latin versions were addressed respectively to Jewish and Christian audiences.[29] These similarities and differences work in favor of the possibility that both texts were different versions and militate against the possibility that the Latin version was a mere translation of the Hebrew version.

(iii) Regarding the question of Ibn Ezra's ability to write directly in Latin or of being involved in the composition of a Latin scientific treatise, an exploration of his biblical exegesis reveals some remarkable examples that show clearly that Ibn Ezra knew the Latin language well enough to refer critically to some parts of the Latin Vulgate, or to argue, with the help of words translated into Latin, against fellow Jewish commentators.[30] Consequently, we can assume that he was able, either by himself or more likely with the help of a disciple, to write a scientific technical treatise in Latin. Indeed, there is another instance of a scientific treatise which, as we shall explain (see below p. 107), Ibn Ezra wrote in Latin with the help of a Christian disciple: a *Book on the Astrolabe*, a parallel version to his Hebrew *Keli haNeḥoshet*.

There is a further central feature of the Latin text – the place of composition – which also must be reconciled with the known

[29] In this context, it should be noted that in Joseph Bonfils, *Sophnat Pane'ach* I, p. 142, a reference is made to Ibn Ezra's *Sefer haLuḥot* giving the exact longitude of Jerusalem, a reference which does not appear in the Latin parallel text. Given the fact that the geographic parameters of Jerusalem are commonly endowed by Ibn Ezra with Jewish ritual and religious significance, that may explain why the Latin parallel version, which was presumably directed to a Christian audience, does not contain the same Jerusalem reference. Also, some passages may be found in the Latin text setting out, with a clearly comparative and didactic approach, the fundamentals of the Jewish intercalation alongside some traits of the Christian calendar. See Millás, *Tablas*, pp. 98-100. These passages may be construed as an effort of the author, *Abraham Iudaeus*, to convey to a Christian audience the fundamentals of the Jewish calendar, stressing particularly the points of contact which link it with the Christian calendar.

[30] In his short commentary on *Genesis* 37:35 and on *Isaiah* 38:10, Ibn Ezra sharply criticizes Jerome because of his wrong translation of the Hebrew word *She'ol* with the Latin term *infernus*. Also, in a commentary on *Genesis* 49:10, reported by Joseph Jacob of Modeville (See M. Friedlander, *Essays on the Writings of Abraham Ibn Ezra* [London, 1877], pp. 67-8) Ibn Ezra finds fault with Jerome because in his translation he distorted such a geographical term as *Shilo* and saw in it an allusion heralding the rise of Christianity. Conversely, in the short commentary on *Exodus* 30:23, Ibn Ezra employs the term *myrrha*, which is the Latin translation of the Hebrew word *mor*, to argue against his fellow commentator Saadia Gaon.

biography of Ibn Ezra in order to ascribe the book to him. The contents of the *Liber de rationibus tabularum* show clearly that the text was written in the year 1154 in some unspecified location in France.[31] In fact, the Latin text records that "he tabule composite sunt secundum meridiem Pisanorum quorum remotio est ab occidentis termino 33 gradus",[32] a remark implying that a previous and first Latin version had been composed in Pisa. Therefore, when attempting to identify the author of the Latin text, it is crucial to determine whether Ibn Ezra dwelt or resided in the city of Pisa. We have plenty of information about Ibn Ezra's stay in the neighboring city of Lucca, where he developed a very rich literary production,[33] where he wrote, as was said above, the parallel Hebrew version of *Liber de rationibus tabularum*. Nevertheless, previous research has not traced any reference to Ibn Ezra's residence in Pisa. Fortunately though, a fragment of the second Hebrew version of Ibn Ezra's *Sefer ha'Olam* (Book of the World) – implying that Ibn Ezra performed astronomical observations oriented to clearly astrological uses in both Pisa and Lucca – allows us to establish quite safely that Ibn Ezra resided some time in Pisa.[34]

A general overview of the Latin text indicates that Ibn Ezra wrote this treatise in order to provide astronomical and astrological theoretical knowledge to whoever may be interested in using the astronomical tables[35] and expound and explain the main traits

[31] This is highly reminiscent of the fact that the second version of Ibn Ezra's *Sefer haMoladot*, which is extant only in a Latin translation, was also written approximately in the same year. Compare the two following references: a) Millás, *Tablas*, p. 78: "anno 1154 ab incarnacione Domini, quo hanc edicionem fecimus", see also p. 99; b) *Liber Abraham Iude de nativitatibus* (Venetia, 1484), p. c 3^{v}: "Hoc 1154 ab incarnatione domini est adunatio eorum in triplicitate terrae".

[32] Millás, *Tablas*, p. 87.

[33] J. L. Fleischer, "Abraham Ibn Ezra's literary output in the city of Lucca in Italy" (in Hebrew), *Hasoker*, 2 (1934): 77-84; 4 (1936-7): 186-94.

[34] In *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fol. 89^{v} we read that Ibn Ezra registered a list of 22 cities, including Lucca and Pisa, accompanied by their respective *city zodiacal sign* (Hebrew = *mazzal medinah*) and its ecliptic parameters. Yet while in the case of the great majority of the cities Ibn Ezra limited himself to the routine annotation of the zodiacal sign and its exact ecliptic parameters, regarding precisely the two cities of Lucca and Pisa he adopted a completely different way of reporting; thus, he wrote that "Pisa: some say that its sign is Piscis, but, *according to my own observations,* its sign is 3 degrees in Aquarium; Lucca: *according to my own observations on two occasions*, its sign is Cancer in the limit of Jupiter".

[35] Millás, *Tablas*, p. 83: "Nunc autem antequam ratiocinemus de compositione tabularum quas fecimus secundum probationem predictorum virorum sibi consentientium, *quedam convenienter ad totam astronomiam premittemus*". That the expression *tota*

and uses of these astronomical tables.[36] The treatise begins by illustrating the astronomical and astrological features of each one of the seven planets, and deals particularly at length with the sun and the moon; continues with a trigonometric chapter and ends with specific astronomical problems, such as establishing the moon's latitude, the latitude of cities, the seasonal hours, the twelve astrological houses or the first visibility of the lunar crescent. The author of the treatise refers explicitly to Greek and Hermetic sources such as Hipparchus, Ptolemy, Doronius and Hermes;[37] Hindu astronomical tables are mentioned in general as *tabulas indorum* and in particular as zīj al-Sindhind;[38] Arabic astronomers and astrologers are referred to in general as *magistri probationum* and in particular by mentioning the names of notable scientists such as al-Khwārizmī, al-Battānī, al-Ṣūfī, Ibn Sīnā, Thābit b. Qurra, al-Nayrīzī, Ibn Yūnus, Banū Sākir, Māshā'allāh, Abū Ma'shar;[39] Andalusian scientists such as Ibn al-Muthannā, Maslama, Ibn al-Ṣaffār, Azarchiel are also mentioned.[40]

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astronomia implies elements of astronomy as well as of astrology can be affirmed after an inspection of the following lines. See, for example, the contents of the next note.

[36] Millás, *Tablas*, pp. 84-5: "He tabule quas composuimus utiles sunt ad declinationem solis sciendum et altitudinem meridianam et ad inveniendum oriens per altitudinem solis et per umbram et ad cognoscendas horas temporales diei et noctis coequationem domorum orientis et ascensionis terrarum et ad apparitiones planetarum matutinas et nocturnas et remotiones fixarum a recto circulo et ad cognoscendum cum quo gradu fixa sit in medio celi et cum quo sit in oriente et cum quo occidat, et ad arcum diurnum et nocturnum fixe ad sciendum quantitatem mutacionis visus secundum longitudinem et latitudinem et adunacionem solis et lune et oposicionem, et quando prima erit secundum visum et ad eclipsum lune et quantitatem eius et in qua parte, utrum scilicet dextra an sinistra, et suum colorem et ad cognoscendum sua tempora eclipsis et eclipsim solis, partesque omnes eius et omnes ductus qui sunt secundum latitudinem terre, et signa mobilia et fixa et bicorpa et recta signa et obliqua et longa et curta et omne opus astrolabii".

[37] See the following references in Millás, *Tablas*: Claudius Ptholomeus: pp. 74-82, 89, 93, 130-1, 143, 155, 160; Hipparchus (Abracaz or Abracax): pp. 75, 77, 80, 91, 105; Hermes: pp. 77, 160; Doronius: p. 160; Hermes: pp. 77, 160.

[38] For the zīj al-Sindhind (Scindehind, Acintdeindi) see *ibid*., pp. 75, 88. See references to the *tabulas indorum*, pp. 81, 82, 89, 101, 120, 130.

[39] See the following references. Al-Khwārizmī (Elcaurezmus): pp. 74, 75, 105, 109, 110, 126, 127, 144, 155, 160, 164, 166, 167; al-Battānī (Albateni): pp. 78, 80, 83, 86; al-Ṣūfī (Azofi): pp. 78, 86, 87, 98; Ibn Sīnā (Abencine): pp. 76, 77, 79, 81, 82, 95; Thābit b. Qurra (Tebith ben Core): pp. 76, 79, 81, 82, 83; al-Nayrīzī (Anarizi): p. 76; Ibn Yūnus (Abeniunuz): pp. 83, 86; Banū Sākir (fratres Beni Saquir): pp. 81, 83; Māshā'allāh (Mescella): pp. 75, 160; Abū Ma'shar (Albumasar): pp. 75, 160.

[40] See the following references. Ibn al-Muthannā (Abenmucenne): pp. 110, 130, 147, 153, 154, 155, 158, 160, 161, 163, 166; Maslama (Mezlame): p. 75; Ibn al-Ṣaffār (Abnezafar): p. 75; Azarchiel (Acerchel, Azarchiel Hispanus): pp. 76, 77, 79, 80, 83, 86, 87, 93, 95.

• ***Keli haNeḥoshet*** (The Instrument of Brass – The Book on the Astrolabe). As far as I was able to find out, Abraham ibn Ezra composed this treatise, designed to describe the physical configuration of the astrolabe and teach its astronomical and astrological uses, in three different Hebrew versions. What is more, Ibn Ezra wrote, with the aid of a disciple, a Latin version of the *Astrolabe Book* as well.

The first Hebrew version of *Keli haNeḥoshet* was composed, as Ibn Ezra himself annotated at the beginning of the Rete's list of stars,[41] in 4906 A.M. (anno mundi) that is, in 1146. The first version was composed in Northern Italy, possibly in Lucca, before Ibn Ezra wrote his *Sefer ha'Ibbur* (Book of Intercalation) and after he had completed the first Hebrew version of *Sefer Ṭa'amei haLuḥot*. We may conclude that from a fragment of the first version of *Sefer ha'Ibbur* – written in 1146 in Verona (see below p. 113) – wherein the reader is referred to *Keli haNeḥoshet* as an already completed work.[42] Also, in the text of the first version of *Keli haNeḥoshet* the author points out that he had already written a book dealing with the differences of opinion confronting the sages of Greece, India and Persia about the astrological *aspects*.[43] This passage, even though it has stark astrological connotations, is closely related to astronomy, and therefore we estimate that it is a reference to the first Hebrew version of *Sefer Ṭa'amei haLuḥot*, written in Lucca in 1146 or earlier.[44]

The second version of *Keli haNeḥoshet*, whose existence has not hitherto been known to modern research and which is extant only in manuscript,[45] was also written in the year 1146

[41] *Keli haNeḥoshet* (first version), ed. H. Edelman (Koenisberg, 1845), p. 31. I also consulted the following manuscripts: Paris, BNF, MS Héb. 1053, fols. 1^{v}-36^{v}; Paris, BNF, MS Héb. 1061, fols. 148^{v}-164^{r}; St. Petersburg, MS 311, fols. 4^{v}-20^{v}; Moscow, MS Gunzburg 1080, fols. 53^{v}-67^{v}. For another printed edition of this text see, *Keli haNeḥoshet*, in Me'ir Yṣḥaq Bak'al (ed.), *Sefer Mishpeṭei haKokhavim* (Jerusalem, 1971), pp. 99-132.

[42] Halberstam, *Sefer ha'Ibbur*, p. 8 (a).

[43] Edelman, *Keli haNeḥoshet* (first version), p. 29.

[44] See a similar opinion in Millás, *Tablas*, p. 15, but Millás Vallicrosa regarded this passage as a reference to *Liber de rationibus tabularum*, the Latin version of *Sefer Ṭa'amei haLuḥot*.

[45] I made use of the following manuscripts: Mantova, Biblioteca di Mantova, Fondo Ebraico Mantovano, MS Ebr. 10 (hereafter MS Mant. 10), fols. 35-51; Warsaw, MS Pinsker 26, fols. 58-71, left col.; Paris, BNF, MS Héb. 1045, fols. 188^{r}-196^{v}; Paris, BNF, MS Héb. 1047, fols. 76^{r}-84^{v}; St. Petersburg, MS 349, fols. 1^{v}-14^{r}; New York, Jewish Theological Seminary MIC 2550/2, fols. 72-82.

(4906 A.M.), as the author himself annotated at the beginning of the corresponding Rete stars list.[46] It follows that the second version was written in the same year as the first one (in fact, as we shall see, a few months after it), no wonder therefore that the second version is in some parts very similar to the first one – in the date of composition, in the Rete's list of stars and in its general structure. However, the two versions have substantially different traits that make them distinct one from the other. I will now present these traits:

(i) The two versions differ sharply in the details and formulation of some of the astrolabe's operations, *inter alia*, in relation to the procedure to find "the latitude of cities or places",[47] to find "how many degrees each zodiacal sign will rise in the equator",[48] the procedure to locate one of the Rete's stars,[49] or the procedure to locate one of the planets.[50] Concerning the latter operation, we shall consider below a significant passage of the second version referring to Venus' visibility in very special conditions, a reference that makes the second version unique in the framework of the three Hebrew versions, but at the same time marks out a connection with an extremely similar reference that may be found in the Latin version of the *Astrolabe Book* (see below p. 111).

(ii) The two versions differ in their connection to *Sefer ha'Ibbur* (Book of Intercalation). In the second version of *Keli haNeḥoshet*, Ibn Ezra directs the reader to consult *Sefer ha'Ibbur* as an already accomplished work.[51] But, in *Sefer ha'Ibbur* itself he refers to *Keli haNeḥoshet* also as an already accomplished work.[52] The explanation of these apparently incompatible cross-references is that *Sefer ha'Ibbur* was written some time in the year 1146 between the redaction of the two different versions of *Keli haNeḥoshet*. The first version of *Keli haNeḥoshet* was written sometime early in 1146, and this is the version referred to in

[46] *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 39^{v}.

[47] *Keli haNeḥoshet* (second version), MS Mant. 10, fols. 42^{v}-42^{r}. Cf. Edelman, *Keli haNeḥoshet* (first version), pp. 22-3.

[48] *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 41^{v}. Cf. Edelman, *Keli haNeḥoshet* (first version), p. 20.

[49] *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 44^{v}; Edelman, *Keli haNeḥoshet* (first version), p. 35.

[50] *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 44^{v}; Edelman, *Keli haNeḥoshet* (first version), pp. 23-4.

[51] *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 46^{v}.

[52] Halberstam, *Sefer ha'Ibbur*, p. 8 (a).

Sefer ha'Ibbur. The second version was written late in 1146, after Ibn Ezra finished *Sefer ha'Ibbur*, and in this second version of *Keli haNeḥoshet* Ibn Ezra refers to *Sefer ha'Ibbur* as an already finished work.

(iii) It is possible to locate in both versions of *Keli haNeḥoshet* a series of distinctive references that draw a clear dividing line between the first and second versions of *Keli haNeḥoshet*.[53] In clear contrast with the first version, Ibn Ezra mentions in the second version several times *Sefer haLuḥot* as a not yet written work.[54] Hence, we can conjecture that after moving from Lucca to Verona or Mantova, Ibn Ezra was required to compose a new version of the *Sefer haLuḥot*, a task that he eventually accomplished after he arrived in Provence. Similarly, references to *Sefer haMishpaṭim* (Book of Astrological Judgments), that appear several times in the first version of *Keli haNeḥoshet*,[55] disappear completely from its second version.

The third version of *Keli haNeḥoshet*, which also is extant in manuscript,[56] was written almost two years later (4908 A.M.), early in 1148, as the author recorded in the corresponding Rete's list of fixed stars.[57] The details, wording and composition of the third version are substantially different from those of the previous two versions. What is more, in the Rete's list of fixed stars we find 36 stars, while the two previous versions included only 23 stars.[58] As in the second version, the third version con-

[53] But we also find in both versions of *Keli haNeḥoshet* some similar references to other works by Ibn Ezra. Thus, in both versions of *Keli haNeḥoshet* Ibn Ezra refers to an already written book dealing with the differences of opinion of the sages of Greece, India and Persia concerning the astrological aspects. See *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 47^{v}; cf. Edelman, *Keli haNeḥoshet* (first version), p. 29. As said above, I believe that both references point to the first Hebrew version of *Sefer Ṭa'amei haLuḥot*, written in Lucca in 1146 or before. Likewise, as in the first version, we continue to find in the second version references to *Sefer haMoladot* (Book of Nativities), a reiteration that is clearly accounted for by the fact that *Sefer haMoladot* remained until 1148 an unaccomplished project. See *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 36^{v}. Cf. Edelman, *Keli haNeḥoshet* (first version), pp. 9, 14.

[54] *Keli haNeḥoshet* (second version), MS Mant. 10, fols. 37^{r}, 42^{r}.

[55] Edelman, *Keli haNeḥoshet* (first version), pp. 25, 29, 30, 31.

[56] I used the following manuscripts: Warsaw, MS Pinsker 26, fols. 58-71, right col.; Paris, BNF, MS Héb. 1054, fols. 4^{v}-10^{r}; Moscow, MS Gunzburg 179, fols. 111^{v}-116^{r}; Moscow, MS Gunzburg 937, fols. 2^{v}-14^{r}.

[57] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 67^{v}, right col.

[58] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 67^{v}, right col. Cf. Edelman, *Keli haNeḥoshet* (first version), p. 31; *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 39^{v}. The star lists of the first and third version of *Keli haNeḥoshet*

tinues to refer the reader to *Sefer haLuḥot* in the future tense.[59] But, in the third version, for the first time, we detect a reference in future tense to an astrological treatise named *Reshit Ḥokhma*, a book that Ibn Ezra was to complete in the next weeks or months.[60] From this evidence we may conclude that the third version of *Keli haNeḥoshet* was the first work that Ibn Ezra wrote in Provence, after he left Italy. The fact that Ibn Ezra composed yet another version of the same *Book on the Astrolabe*, just before he began the composition of his *astrological encyclopaedia* headed by the *Reshit Ḥokhma*, is an additional proof of the importance of the astrolabe in solving astronomical as well as astrological problems.

A Latin manual describing the astrolabe and teaching its uses is available in two manuscripts of the British Library – MS Cotton Vesp. fols. 40-37 and MS Arundel 377 fols. 63-68 – following copies of the Latin text of the *Liber de rationibus tabularum* ascribed to Abraham ibn Ezra. Moritz Steinschneider was the first to draw attention to this text and to connect it with the work of Jewish medieval scientists. To corroborate his assertion, Steinschneider adduced a passage of the Latin text that mentioned a personage named *Abraham*, undoubtedly a Jew, dictating the astrolabe manual to a disciple. This disciple could not conceal his deep admiration towards his teacher and wrote: "Ut ait philosophorum sibi contemporaneorum Abraham magister noster egregius quo dictante et hanc dispositionem astrolabii conscripsimus …".[61] But Steinschneider hesitated whether the author was Abraham ibn Ezra, Abraham bar Ḥiyya, or Abraham Zacuto.[62] The subsequent chain of events connected to the research on this text was very similar to that related to the *Liber de rationibus tabularum*. The Polish investigator A. Birkenmajer conjectured that Ibn Ezra was the

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were meticulously studied by B. R. Goldstein, in the context of his research on star lists in Hebrew. See B. R. Goldstein, "Star lists in Hebrew", *Centaurus*, 28 (1985): 185-208.

[59] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fols. 59^{v}, 60^{r}, 66^{r}, right col.

[60] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 65^{v}, right col.

[61] *Tractatus de Astrolabio conscriptus dictante authori quodsam egregio pilosopho Mro. Abraham*, London, British Library, MS Cotton Vesp. A II, fol. 40^{r} and MS Arundel 377, fol. 68^{r}.

[62] Steinschneider, "Abraham Ibn Esra", pp. 494-5; *id.*, *Die Hebraeischen Uebersetzungen des Mittelalters und die Juden als Dolmetscher*, 2nd ed. (Graz, 1956), p. 569.

author of this Latin text and communicated his idea to Jose Maria Millás Vallicrosa. This distinguished Spanish historian of the science, returning to his homeland after the Spanish Civil War, continued the research and in 1940 published an important article on this Latin text. The methodology of this article was similar to that adopted in relation to the *Liber de rationibus tabularum*. Millás Vallicrosa edited the Latin text of this astrolabe manual and cautiously suggested that Ibn Ezra was its author.[63] To corroborate his assertion Millás Vallicrosa brought forward mainly two passages, in addition to the passage mentioning *Abraham magister noster*. The first one goes on to explain that "locum lune in tabulis coequationis planetarum secundum artem quam dedimus de coequandis planetis ad quamuis horam sume", a somewhat vague statement which in Millás Vallicrosa's opinion referred to the astronomical tables that Ibn Ezra had written previously.[64] The second passage alludes to a singular astronomical phenomenon that allegedly could be observed in England – "si quis fuerit in Anglia cum sol fuerit a parte capricorni…" – a reference that in Millás' opinion indicated that the Latin text was composed by Ibn Ezra in England during his residence there approximately in 1160.[65] We will return later to this passage and offer a different interpretation to it. Although Millás Vallicrosa made a formidable contribution to the elucidation of the issue, he restricted his analysis to the contents of the Latin text. Millás Vallicrosa was aware only of the first Hebrew version of *Keli haNeḥoshet* but he did not compare even this text with the Latin one, excusing himself by writing that the World War was raging when he published his article.[66]

No doubt, given that Ibn Ezra wrote three versions of *Keli haNeḥoshet*, his authorship of a Latin counterpart should be grounded on a comparison of the Hebrew texts to the Latin text. After such an examination which I made, the weight of evidence

[63] Millás, "Tratado de astrolabio", pp. 9-29.

[64] London, British Library, MS Cotton Vesp. A II, fol. 39^{r} and MS Arundel 377, fol. 66^{r}. Cf. Millás, "Tratado de astrolabio", pp. 2, 19.

[65] London, British Library, MS Cotton Vesp. A II, fol. 39^{r} and MS Arundel 377, fol. 67^{v}. Cf. Millás, "Tratado de astrolabio", pp. 3-4, 22. Concerning Ibn Ezra's sojourn in England, see M. Friedlander, "Ibn Ezra in England", in *Transactions of the Jewish Historical Society* (London, 1894-5), pp. 47-60; J. L. Fleischer, "Abraham Ibn Ezra's literary work in England" (in Hebrew), *Etz haHaim*, VII (1931): 69-76, 107-11, 129-33, 160-8, 189-203.

[66] Millás, "Tratado de astrolabio", p. 5. note 3.

seems to favor Millás Vallicrosa's hypothesis about Ibn Ezra's authorship. The three Hebrew versions are very similar to the Latin text not only in the description of the astrolabe – as expected, since they describe one and the same instrument – but also in its sources, the composition of the treatises and the wording employed to explicate the uses of the astrolabe. The overwhelming majority of the scientific sources recorded in the Latin text – the *magistri probationum* as a distinct group of astrologers and astronomers, Ptolomeus, Enoc (Hermes), Mesella (Māshā'allāh), Albumassar (Abū Ma'shar), Doroneus (Dorotheus of Sidon), Andruzgar (Andruzgar b. Saadi Faruch), Anurizi (al-Faḍl b. Ḥātim al-Nayrīzī) – may be found in the scientific corpus of Ibn Ezra, inclusion made of the *Liber de rationibus tabularum*.[67] The Arabic transliteration of the names of the sources, as seen above, and also of the components of the astrolabe – terms such as *alhidada*, *alilac*, *assabata*, *acemuth*, *almucantarath*[68] – indicate clearly that the Latin text author did receive his scientific education in al-Andalus, as indeed did Ibn Ezra. Moreover, some technical expressions may be found which are strongly reminiscent of the Hebrew parallel terminology found in the different versions of the *Keli haNeḥoshet*, such as the expression *ductus planetae*, whose Hebrew counterpart is *nihug hakokhab*,[69] or the operation of *ponere in linea medii caeli*, whose Hebrew counterpart is *lasim beḥeṣi hashamaym*,[70] or the central and general term *iudicia*, reserved in the Latin text for the "astrology rules", whose Hebrew counterpart is *mishpaṭim*, a Hebrew word used for the first time with a clear astrological connotation by Ibn Ezra.[71]

[67] London, British Library, MS Cotton Vesp. A II, fols. 39^{r}-40^{v}; MS Arundel 377, fol. 67^{r}. For some of these names mentioned in *Liber de rationibus tabularum*, the Latin version of *Sefer Ṭa'amei haLuḥot*, see above notes 37, 39. The only one personage that appears in the Latin text and that I was incapable to locate in the other works of Ibn Ezra is Avennouausth Christianus.

[68] London, British Library, MS Cotton Vesp. A II, fol. 38^{v}; MS Arundel 377, fols. 63^{r}-64^{v}; Millás, "Tratado de astrolabio", pp. 9-11.

[69] London, British Library, MS Cotton Vesp. A II, fol. 40^{r}. Cf. *Reshit Ḥokhma*, ch. X, p. lxxv. Regarding this procedure, see below note 72.

[70] London, British Library, MS Cotton Vesp. A II, fol. 40^{r}. Cf. Edelman, *Keli haNeḥoshet* (first version), p. 19; *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 41^{v}; *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 60^{r}, right col. This procedure implies positioning some point of the Rete over the midheaven line of the astrolabe, that is the projection of the observer's meridian.

[71] London, British Library, MS Cotton Vesp. A II, fol. 40^{r}. The Hebrew counterpart, *mishpaṭim*, was used profusely by Ibn Ezra in his Hebrew literary output, let alone

A common characteristic of paramount importance is that, although the astrolabe is known as an instrument mainly dedicated to astronomical uses, an important portion of the texts of the four versions, the three Hebrew and the Latin version as well, was devoted to typically astrological procedures. Since the astrolabe allows the determination of the pattern of the heavens at any (past, present or future) time (birth, coronation, foundation of a city, etc.), it was extremely useful to compute the fundamental components of the horoscope, particularly those parts entailing calculations related to spherical-trigonometry, avoiding tedious calculations which would otherwise have been necessary. In this context, the four versions are very similar and refer to all three horoscope-related procedures: (a) arranging the twelve astrological houses; (b) establishing the astrological *aspects*; (c) performing the procedure of *ducere gradus*.[72] Furthermore, those astrological topics are treated in a very similar way in the four versions. We will see later (see below p. 145) that a main characteristic that distinguishes Ibn Ezra as a writer is that he is very fond of treating the technical aspects of some issue by recording the disputes that aroused between different schools of thought to solve this problem. Now, this is precisely a trait that may be easily detected in all four versions, Hebrew as well as Latin, of the *Astrolabe Book*.[73]

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in his biblical exegesis. As I showed in my article, S. Sela, "El papel de Abraham Ibn Ezra en la divulgación de los "juicios" de la astrología en la lengua hebrea y latina", *Sefarad*, 59 (1999): 159-93, Ibn Ezra coined this new Hebrew word, or furnished the new astrological meaning to the old biblical word *mishpaṭim*, that is, *judgments*. After his death, the new Hebrew word was widely used with the new astrological meaning and with the explicit or implicit reminder that the word *mishpaṭim* originated in Ibn Ezra's literary work.

[72] In this procedure, some planet (called *apheta* in Greek, *indicator* in Latin, or *paqid* in Hebrew) is *directed* from one of the five *places of life* to one of the five *places of death*. This means computing the angular distance between two sky places, being the resulting number of degrees converted subsequently in a number of years, which are interpreted as the life expectancy of the newborn. Regarding this procedure, see Ptolemy, *Tetrabiblos*, edited and translated by F. E. Robbins, Loeb Classical Library (London, 1980), Book III, ch. 10, pp. 271-307. A. Bouché-Leclercq, *L'astrologie grecque* (Paris, 1899), pp. 411-19.

[73] Compare the following places: Edelman, *Keli haNeḥoshet* (first version), pp. 29-31; *Keli haNeḥoshet* (second version), MS Mant. 10, fols. 46^{v}-49^{r}; *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fols. 64^{r}-66^{r}, right col.; Millás, "Tratado de astrolabio", pp. 22-9. See a similar approach and treatment of the topics dealt with in the *Astrolabe Book* also in other works of Ibn Ezra: Millás, *Tablas*, pp. 84-5; 93-4; 97-8; *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 44^{r}; *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fols. 71^{v}-71^{r}.

But, what about the place and time of composition of the Latin version of the *Astrolabe Book*? In this context, it is worthwhile to reexamine the passage that Millás Vallicrosa brought forward to assert that the Latin text was written in England approximately in the year 1160. The referred to passage is part of a chapter entitled *De loco planete cognoscendo*, which describes several techniques intended for establishing the location of a planet, and especially finding out whether the planet is retrograde or stationary. After dealing with Jupiter and Mars, the author proceeds to treat the special case of the inferior planets, Mercury and Venus. The underlying point here is that Mercury and Venus never get very far from the sun, so that it is almost impossible to employ the same techniques that were previously implemented in connection with Jupiter and Mars. Nevertheless, the author of the Latin version goes on to explain: "Simili modo operandum est de uenere, *si quis fuerit in Anglia* cum fuerit a parte capricorni et uenus *a sole remotissima* quod est 47 gradibus, alibi autem non."[74] This interesting passage of the Latin text is closely connected to a very similar passage that may be found in the second Hebrew version of *Keli haNeḥoshet*: "You will be able to know the position of Venus or Mercury when they rise or set, but at *midheaven* it is impossible to see them… However, if you happen to be *in the seventh climate*, namely the climate called *Little Brittania* by Ptolemy[75] and which is located after *Inglaterra* in the western side, then you will be able to see Venus at *midheaven* when the sun is in the sign of Scorpio and Venus is at the end of the sign of Cancer. But in all the other places it is impossible (to see Venus at midheaven)."[76] It follows, then, that England is mentioned in these

[74] London, British Library, MS Cotton Vesp. A II, fol. 40^{v} and MS Arundel 377, fol. 67^{v}: Translation: "As far as Venus is concerned, this procedure may be operated in a similar way (as for Jupiter and Mars) if someone happens to be in England when the sun is in the sign of Capricorn, and Venus is located 47 degrees far away from the sun. But in other places it is impossible to operate in this way."

[75] See *Ptolemy's Almagest*, translated and Annotated by G.J. Toomer (London, 1984), p. 88.

[76] *Keli haNeḥoshet* (second version), MS Mant. 10, fol. 44^{v}:

"ותוכל לדעת מקום נגה גם כוכב חמה בזרחם גם בשקעם, רק בדרך קו חצי השמים לא יתכן לדעתם ... אך אם היית בגבול השביעי, שיקראנו תלמי ברטיינא הקטנה והוא אחר אינגלאטירה בפאת מערבי והשמש במזל גדי ונוגה בעקרב בסוף היתר יתכן להיות גם נוגה בחצי השמים ובשאר המקומות לא יתכן."

Cf. *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 66^{v}, right col.

two parallel passages only in order to corroborate that Venus, normally observed not far from the sun and appearing as an evening star or a morning star, may be seen exceptionally *a sole remotissima* or at *midheaven*.[77] The crucial point to be stressed here is that Ibn Ezra thought fit *when dwelling in Northern Italy* to refer, using some unknown source,[78] to a singular astronomical phenomenon that may be observed in England, since the second version of *Keli haNeḥoshet*, where this passage may be found, was written in 1146 in Mantova or Verona. Thus, the link adduced by Millás Vallicrosa between the report of this singular phenomenon and Ibn Ezra's allegedly dwelling in England is severed. What is more, this interest in England (as an especial geographic parameter or a suitable scenario to perform astronomical observations) may be also detected in Ibn Ezra's first version of *Sefer ha'Ibbur*, which was undoubtedly written in Verona, Italy, in 1146.[79]

We thus reach the conclusion that the mention of England in the context of the report of astronomical observations does not indicate that the Latin version of the *Astrolabe Book* was written in England. Taking in account the very similar report of the second version of *Keli haNeḥoshet*, written in Northern Italy, we consider quite surely that the Latin version of the *Astrolabe Book* belongs to the Italian phase of Ibn Ezra's career, so that probably the Latin version of the *Astrolabe Book* was written in Verona or Mantova, at the same time approximately as the second version of *Keli haNeḥoshet*. To strengthen this assertion, the interesting hypothesis of Enea Datei may be brought forward, according to which Ibn Ezra gave astronomical advice to the city of Mantova to build four towers called *Torri del Sole*. The relative position of these four towers, which were built some time close to the middle of the twelfth century, was exactly chosen and designed, as Enea Datei has shown, to reflect the four main stations of the sun's path, namely the two

[77] It is worth to stress that this passage from the second Hebrew version of the *Keli haNeḥoshet* makes this version unique in the whole context of the three Hebrew versions, and especially makes the second version clearly distinct from the first version of *Keli haNeḥoshet*.

[78] I was incapable of finding this source, but it might have been some discussion about Venus visibility based on *Almagest* XIII, 7-10. A similar passage found in *Mishpeṭei haMazzalot* which we shall refer to below was analyzed in K. Fischer, P. Kunitzsch and Y.T. Langerman, "The Hebrew astronomical codex Ms. Sasson 823", *The Jewish Quarterly Review*, LXXVIII (1988): 257-8.

[79] Halberstam, *Sefer ha'Ibbur*, pp. 8-9.

equinoxes and the two solstices.[80] Thus, the possibility arises that Abraham ibn Ezra, who wrote in Mantova a treatise dealing with Hebrew grammar called *Sefer Ṣaḥut* and possibly the second Hebrew version of *Keli haNeḥoshet* as well, also composed in the same city a Latin parallel version of the *Astrolabe Book*, being motivated by the need to provide advice to the council of the city of Mantova in the endeavor of locating the above-mentioned *Torri del Sole*.

• ***Sefer ha'Ibbur*** (Book of Intercalation). Abraham ibn Ezra wrote this treatise, designed to establish the Jewish Calendar and explain its fundamentals, in two different versions, as Joseph Bonfils reports in his supercommentary *Ṣophnat Pa'aneaḥ*.[81] The first version of *Sefer ha'Ibbur*[82] was written in Verona in 1146 (4906) – as Ibn Ezra says himself in the text of the book[83] – in between the composition of the first and the second version of *Keli haNeḥoshet* (see above p. 105). The second version of *Sefer ha'Ibbur*, which is at present lost, was written in Narbonne – as Joseph Bonfils reported in *Sophnat Pa'aneah* – and we assume that it was composed later than 1148, after Ibn Ezra moved from Italy to Provence.

The first version of *Sefer ha'Ibbur* was originally designed in three different chapters, but the manuscripts and the printed edition include only two of them. The first chapter deals with four different ways for calculating the *molad* (the "birth" of the moon), that is, establishing the beginning of the lunar month, a fundamental feature in the solar-lunar Jewish calendar. The second chapter, which is more than twice as large as the first, was designed to discuss the theoretical fundamentals of the Jewish calendar and carried out the task by applying important elements of Greek and Arabic astronomy, particularly relevant traits which furnish a scientific explanation to cyclic time and provide the rationale behind the Jewish calendar. As said above, the third chapter is absent in the manuscripts of the first version of *Sefer ha'Ibbur* as well as in the printed edition. But

[80] Enea Datei, "Mantova, le torri del sole", *Civiltà Mantovana*, XXVIII (1993): 57-65.

[81] Joseph Bonfils, *Sophnat Pane'ach*, I, p. 142.

[82] This first version is available in manuscripts and has been already published in 1874: *Sefer ha'Ibbur*, ed. by S. Z. H. Halberstam (Lyck, 1874). We used this edition. See also *Sefer ha'Ibbur*, in Me'ir Yṣḥaq Bak'al (ed.), *Sefer Mishpeṭei haKokhavim* (Jerusalem, 1971), pp. 57-94.

[83] Halberstam, *Sefer ha'Ibbur*, pp. 8 (b), 9 (a) (b).

curiously enough, Ibn Ezra refers several times, in the extant first two chapters, to the topics and contents of the lost, or perhaps never written, third chapter. From these references we can conclude that the third chapter included (or was intended to include) strictly astronomical subjects, such as the first visibility of the moon,[84] irregularities in the lunar cycle,[85] or the length of the solar year;[86] either highly technical topics which Ibn Ezra allegedly put aside, leaving them as an unaccomplished project, or heavy and obscure astronomical contents which later copyists presumably did not regard as relevant enough and excluded from their manuscripts.

• ***Sefer ha'Eḥad*** (Book on the Unit): Ibn Ezra wrote this short mathematical treatise concerned with the attributes of numbers at an unspecified place and date. The book is divided into 9 short chapters, each of them dealing with the characteristics of each of the nine numerals which are explained employing varied elements belonging to arithmetic, geometry, combinatorial analysis as well as astrology and theology. *Sefer ha'Eḥad* is regarded as a less important mathematical book than *Sefer haMispar*,[87] but yet it may be considered an outstanding mathematical treatise precisely because of its concern with pure mathematics, without any pretension of serving, as in the case of *Sefer haMispar*, as an auxiliary or practical tool in related subjects such as solving astronomical-astrological problems or establishing the Hebrew calendar.[88] *Sefer ha'Eḥad* was already edited and commented upon in 1921 and has also earned a modern edition.[89]

[84] Halberstam, *Sefer ha'Ibbur*, pp. 4 (a)-(b), 8 (a), 11 (a).
[85] Halberstam, *Sefer ha'Ibbur*, pp. 3 (b), 11 (a).
[86] Halberstam, *Sefer ha'Ibbur*, p. 3 (b).
[87] See Sarfatti, *Mathematical Terminology*, pp. 139-40.
[88] A close examination shows that some elements of *Sefer ha'Eḥad* were transferred by Ibn Ezra into his biblical exegesis, especially in a theological context. Compare, for example, the treatment furnished to the number one and the Long Commentary on Exodus 3:15.
[89] Abraham Jbn Ezra, *Buch der Einheit*, aus dem Hebräischen übersetzt nebst Parallelstellen und Erläuterungen zur Mathematik Jbn Esras, von Ernst Müller (Berlin, 1921). For a modern edition see *Abraham Ibn Ezra Reader* (in Hebrew), Annotated texts with Introductions and Commentaries by Israel Levin (New York-Tel Aviv, 1985), pp. 399-414.

2. *The Astrological Encyclopaedia*

The central part of Ibn Ezra's scientific writings is composed of a series of astrological writings which may be well called an *astrological encyclopedia*.[90] This denomination may be justified, as we shall see later in detail, on two main grounds. On the one hand, not all the astrological works of Ibn Ezra but the majority of them, that is, at least one version of these astrological treatises, may be regarded collectively as a product of a steady and concentrated effort carried out in one single year, 1148 (4908 A.M.), and in one and the same place, the city of Béziers in Provence. On the other hand, from a thematic point of view, these treatises may be considered as chapters of a single major work, since part of them are designed as general textbooks, while others deal separately with the four main systems of Arabic astrology: nativities, elections, interrogations and universal astrology.

• ***Mishpeṭei haMazzalot*** (Book of the Judgments of the Zodiacal Signs). This treatise, an astrological textbook teaching the most general tenets and topics of this art, is embedded in some of the manuscripts that make up the collection of Ibn Ezra's astrological works.[91] Nevertheless, *Mishpeṭei haMazzalot* remains the most poorly known and less researched part of Ibn Ezra's astrological works. Even his authorship over this book has not yet been fully demonstrated, one of the main reasons being the fact that, even though Ibn Ezra was accustomed to profusely employing cross-references in his treatises, in the case of *Mishpeṭei haMazzalot* such references are *almost* non-existent. However, we shall try to show here, on the one hand,

[90] José Maria Millás Vallicrosa employed the term *encyclopaedic* to describe one of the main characteristics of the scientific output of Abraham bar Ḥiyya and Abraham ibn Ezra as well. See J. M. Millás Vallicrosa, "La obra enciclopédica de R. Abraham bar Ḥiyya", in *Estudios sobre historia de la ciencia española* (Barcelona, 1949), vol. I, pp. 219-62 (a new facsimile edition (Madrid, 1987); *id.*, "Avodato ṣel R. Abraham Ibn Ezra beḥokhmat haTekhuna", pp 306-22. But, as far as Abraham ibn Ezra is concerned, Millás Vallicrosa did not add any comment or explanation to corroborate his statement. For a study of the encyclopaedic characteristics of Ibn Ezra's astrological treatises and literary work see S. Sela, "Encyclopedic aspects of Abraham Ibn Ezra's scientific corpus", in Steven Harvey (ed.), *The Medieval Hebrew Encyclopedias of Science and Philosophy* (Amsterdam, 2000), pp. 154-70.

[91] See, *inter alia*, the following manuscripts: Cambridge, Classmark ADD 1517, fols. 40-44; Rome, Vatican MS Ebr. 477, fols. 68-86; Paris, BNF, MS Héb. 1058, fols. 13-26.

that Ibn Ezra's authorship over this treatise may be safely demonstrated and, on the other hand, we shall also try to supply arguments to prove that this astrological treatise may be considered his first astrological treatise, written in Northern Italy, before moving to France.

An examination of the technical terminology used in *Mishpeṭei haMazzalot* demonstrates that this treatise is undoubtedly the work of Abraham ibn Ezra. As we shall see later, (see below p. 132) a clue that clearly identifies Ibn Ezra is his especial translation strategy, which was based on the exploration of the biblical text in order to find out "original" Hebrew words endowed with scientific meaning, and avoided the creation of new Hebrew words based on cognate Arabic words or on loan translations of Arabic words. Thus, in the lexical texture of *Mishpeṭei haMazzalot* we may find the special word *gevul* taken by Ibn Ezra from *Psalms* 74:17, a word meaning literally *limit* or *frontier* but which in his opinion was designed originally to express the technical concept of the *seven climates,* known in the ancient world and the Middle Ages.[92] Also, in the text of *Mishpeṭei haMazzalot* we may detect the very peculiar Hebrew word *muṣaq*, taken by Ibn Ezra from *Job* 36:16, 37:10 and 38:38, meaning literally *solid*, *stable* or *strong*, but intended by him to designate the concept of *center*.[93]

Moritz Schteinschneider, still in the last century, noticed the existence of *Mishpeṭei haMazzalot*, assigned it to Ibn Ezra and conjectured that the second version of *Sefer haṬe'amim* (see below p. 121) was designed as a commentary on *Mishpeṭei haMazzalot*.[94] Since the first version of *Sefer haṬe'amim* was composed expressly as a commentary on *Reshit Ḥokhma* (see below p. 120) the logical corollary to it is that *Mishpeṭei haMazzalot* should be regarded as a second and later version of

[92] See, for instance: *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fol. 68^{v}: "ואז תחל השמש לנטותה לצד צפון להיותה קרובה אל היישוב שהם שבעה גבולים כי אין ישוב בפאה הדרומית בעבור חם השמש."

[93] See, for example: *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fols. 75^{v}-76^{r}: "וזה השנוי יבא מפאת גלגלו המוצק שמוצקו רחוק ממוצק הארץ". See also fols. 74^{r}, 74^{v}, 76^{v}, 78^{r}, 78^{v}.

[94] M. Steinschneider, "Zur Geschichte der Uebersetzungen aus dem Indischen ins Arabische und ihres Einflusses auf die arabische Literatur", *Zeitschrift der deutschen Morgenländischen Geselschaft* [*ZDMG*], 24 (1870): 341-2. See similar arguments in the introduction of J. L. Fleischer to his edition of Ibn Ezra's *Sefer haṬe'amim* (Jerusalem, 1951), pp. 19-22.

Reshit Ḥokhma.[95] Also, if we accept this conjecture, and if we take also into account that the second version of *Sefer haṬe'amim* was certainly written in France after 1148, it will follow that *Mishpeṭei haMazzalot* should also have been written in France after the year 1148 (the year in which we detect Ibn Ezra in France for the first time). However, our findings lead us to reject this hypothesis and to favor the assertion that *Mishpeṭei haMazzalot* was composed in Italy, presumably in Lucca or Verona approximately in 1146, so that *Mishpeṭei haMazzalot* should be regarded as the first astrological treatise written by Ibn Ezra. This assertion is based on the following five points:

(a) In the first version of *Keli haNeḥoshet*, written early in 1146 in Lucca or Verona, Ibn Ezra promised to explain some astrological subjects – namely the astrological aspects and houses – and referred the reader on five different occasions, using the future tense, to a non yet written treatise that he entitled *Sefer haMishpaṭim* (Book of the Judgments).[96] Can we identify this treatise? One possibility is to recognize *Sefer haMishpaṭim* as being the *Sefer Mishpeṭei ha'Olam* (Book of World Judgments), which is an alternative title given in some manuscripts to Ibn Ezra's *Sefer ha'Olam* (Book of the World. See below p. 129). However, this possibility may be discarded since the references to *Sefer haMishpaṭim* are concerned with topics related to genethlialogical astrology whereas *Sefer ha'Olam* deals essentially with universal astrology. On the other hand, we found in *Mishpeṭei haMazzalot* some passages dealing with the very same topics mentioned in *Keli haNeḥoshet* as referring to *Sefer haMishpaṭim*.[97] We favor, thus, the possibility that *Sefer haMishpaṭim* (Book of the Judgments) should be regarded in fact as identical with *Mishpeṭei haMazzalot* (Book of the Judgments of the Zodiacal Signs).

(b) As we said above, all the above-mentioned references to *Sefer haMishpaṭim* (Book of the Judgments) may be found in the first version of *Keli haNeḥoshet*, that was written early in 1146 in Lucca or Verona. But an examination of the second version of *Keli haNeḥoshet*, written later in 1146, reveals the

[95] See additional arguments in the introduction of J. L. Fleischer to his edition of Ibn Ezra's *Sefer ha'Olam* in *Otzar Ḥaim*, 13 (1937), p. 19.

[96] Edelman, *Keli haNeḥoshet* (first version), pp. 25, 29, 30, 31.

[97] *Mishpeṭei haMazzalot,* Rome, Vatican MS Ebr. 477, fols. 71^{r}-71^{v}, 76^{v}-77^{r}.

striking fact that these references to *Sefer haMishpaṭim* disappear there completely (an additional feature that makes the second version of *Keli haNeḥoshet* distinct from the first version). This interesting feature leads us also to the conclusion that *Mishpeṭei haMazzalot* was written in between the time of composition of the first and the second version of *Keli haNeḥoshet*, namely sometime in the middle of 1146. Moreover, just as we considered the disappearance of references to *Sefer haMishpaṭim* a clear singular trait that distinguishes the second version of *Keli haNeḥoshet*, so from the same cross-references we may assume that *Mishpeṭei haMazzalot* was written in the same place – Lucca or Verona – and for the same audience for which Ibn Ezra wrote the first version of *Keli haNeḥoshet*.

(c) As may be clearly seen in its introductory phrase, the second version of *Sefer haṬe'amim* was designed (like the first version) as a commentary on *Reshit Ḥokhma*.[98] Thus, the possibility should be discounted that the second version of *Sefer haṬe'amim* was written as a commentary on *Mishpeṭei haMazzalot*, so that *Mishpeṭei haMazzalot* is not a second and later version of *Reshit Ḥokhma* but rather the opposite is presumably the true. Since *Mishpeṭei haMazzalot* was composed in 1146 and *Reshit Ḥokhma* was written in 1148, and taking also in consideration that both treatises are very similar in their contents and composition, *Reshit Ḥokhma* should be considered a second and improved version of *Mishpeṭei haMazzalot*.

(d) Also in *Mishpeṭei haMazzalot*, analogously with the first and second version of *Keli haNeḥoshet* that were written in 1146, Ibn Ezra promises to explain some astrological concepts and refers the reader, using the future tense, to *Sefer haMoladot*, a treatise that in fact was eventually written in 1148.[99] It follows clearly from this reference that *Mishpeṭei haMazzalot* was written before 1148, which is an additional corroboration of what was said in point (c).

(e) Likewise, Ibn Ezra goes on to say in *Mishpeṭei haMazzalot* that "you should establish the astrological houses by the way of the rising times, such as I explained it to you in the *Book of the (Astronomical) Tables*".[100] With these words he refers to the

[98] *Sefer haṬe'amim* (second version), ed. Naphtali Ben Menachem (Jerusalem, 1941), p. 1.

[99] *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fols. 84^{v}, 85^{r}.

[100] *Ibid.,* fol. 71^{v}.

first Hebrew version of his *Sefer haLuḥot*, a treatise that was composed in Lucca in 1146. From this and the previous remarks, we conclude that *Mishpeṭei haMazzalot* was written in Lucca between the years 1146 and 1148, an assertion that is completely congruous with our previous assumption that it was written in 1146.

Mishpeṭei haMazzalot was organized as a sequence of references to various and multiple subjects covering the main elements of astrology. Following are its main topics, in the order in which they appear in the treatise itself: (a) the zodiacal constellations and their astrological characteristics; (b) the astrological houses and the differences of opinion confronting the astrologers about their correct arrangement; (c) the planets and their astrological characteristics; (d) the astrological aspects; (e) the astrological lots (f) the procedure of *nihug hakokhab* (see above note 72). In this clearly astrological milieu, we may also observe naturally embedded interesting astronomical observations, related mainly to the elongation of the planets in relation to the sun. *Inter alia*, we find an interesting remark concerning the visibility of Venus, a passage noticed and analyzed by Y.T. Langerman in a description of the contents of the Hebrew astronomical Codex Ms. Sasson 823.[101] In this passage Ibn Ezra states: "When the sun and Venus are in conjunction in the sign of Pisces, and Venus has its maximum northerly latitude, *Venus can be seen* – this is impossible for any other planet".[102] Even if this remark is not exactly identical to the two similar passages which we found in the second Hebrew version of *Keli haNeḥoshet* and in the Latin version of Ibn Ezra's *Astrolabe Book*, passages dealing as well with Venus visibility in exceptional circumstances (see above p. 111), these three references reveal a common interest and a similar treatment to the problem of Venus visibility, and thereby an additional argument is supplied to strengthen our assumption that *Mishpeṭei haMazzalot*, as well as the second version of *Keli haNeḥoshet* and its Latin version, were composed in Northern Italy in the year 1146.

All the effort invested above to establish Ibn Ezra's authorship and to determine the date of composition of *Mishpeṭei haMazzalot* was due mainly to the basic fact that this treatise

[101] See: Fischer, Kunitzsch and Langerman, "Ms. Sasson 823", pp. 257-8.
[102] *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fol. 76^{r}.

has remained a marginal work in the frame of his scientific corpus. The chief and fundamental reason for that is that Ibn Ezra, who was most used to link his works in a net of cross-references, subsequently completely ignored *Mishpeṭei haMazzalot*, except for the above-mentioned references, using the future tense, to *Sefer haMishpaṭim* from the second version of *Keli haNeḥoshet*. How should this striking fact be explained? We suggest that the main reason for the ensuing neglect of *Mishpeṭei haMazzalot* lies in the prominence attained by the second and improved version entitled by Ibn Ezra as *Reshit Ḥokhma*. This treatise, as we will immediately see, was composed by Ibn Ezra as soon as he arrived in France and was regarded, even by Ibn Ezra himself, as the most important component of his astrological corpus. So it turned out that *Reshit Ḥokhma* completely overshadowed its forerunner, *Mishpeṭei haMazzalot.*

• ***Reshit Ḥokhma*** (Beginning of Wisdom): Abraham ibn Ezra completed this book in *Tamuz* 4908 A.M., that is, approximately June 1148.[103] This treatise was the first link in a continuous and concentrated effort whose output was made up of seven treatises, covering the various branches of astrology, and was written in one single year, 1148, and in one and the same place, the city of Béziers in Provence. However, *Reshit Ḥokhma* is neither the first astrological book that Ibn Ezra wrote nor the first work he wrote in France. As we have seen above, *Mishpeṭei haMazzalot*, a general astrological textbook, was already written in 1146. Also, Ibn Ezra wrote the third version of *Keli haNeḥoshet* early in 1148, and from within this book he referred the reader to *Reshit Ḥokhma*, as a not yet completed work.[104] Ibn Ezra divided *Reshit Ḥokhma* into 10 chapters, dealing with three main subjects: (a) a general description of the fixed stars, the zodiac constellations and their astrological characteristics [chapters i, ii, iii]; (b) a general description of the planets and their astrological characteristics [chapters iv, v, vi, vii]; (c) a general discussion of miscellaneous astrological concepts, such as the lots, aspects and some elements of universal astrology [chapters viii, ix, x].

Thus, *Reshit Ḥokhma* is a textbook that explains the most basic tenets of the various branches of astrology, and may be considered a second and improved version of the previous

[103] Levy and Cantera, *The Beginning of Wisdom*, ch. X, p. lxxvi.
[104] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 65^{r}, right col.

Mishpeṭei haMazzalot, composed about two years earlier in Italy. *Reshit Ḥokhma* was considered by Ibn Ezra as his chief astrological work, which assertion lies in the multiple references to *Reshit Ḥokhma* annotated by Ibn Ezra from within his other astrological treatises, in order to elucidate diverse astrological concepts.[105] When writing *Reshit Ḥokhma*, considered the first and most important component of Ibn Ezra's *astrological encyclopedia*, Ibn Ezra already planned its other constituents. Therefore, from within *Reshit Ḥokhma* he referred his readers using the future tense to *Sefer haṬe'amim* (Book of Reasons), the second component of his *astrological encyclopedia*, and also to *Sefer haMoladot* (Book of Nativities), the third component.[106]

Reshit Ḥokhma was translated after Ibn Ezra's death to various European languages. Among these, the rendering to medieval French excels. This translation, undertaken by a Jew called Hagin under the guidance of Henry Bate in 1273, was extremely useful in learning about the process of crystallization of the incipient French language.[107] The French translation, alongside an English translation and the Hebrew text, were edited by Raphael Levy in 1939.[108]

• ***Sefer haṬe'amim*** (Book of Reasons). Ibn Ezra regarded the first element of his *astrological encyclopedia*, that is his *Reshit Ḥokhma*, as a non self-sufficient work, since the treatise presented raw astrological concepts without introducing their *reasons*, that is, their rational explanations. Consequently, still in the introduction to *Reshit Ḥokhma*, Ibn Ezra wrote that "when this book is finished, I shall compile a treatise explaining *the astrological reasons*".[109] He accomplished this task in 1148 (4908 A.M.),[110] and the outcome was his *Sefer haṬe'amim*, a treatise which Ibn Ezra considered it necessary to rewrite in an

[105] See, *inter alia*, the ensuing references to *Reshit Ḥokhma*, annotated in the following Ibn Ezra's astrological treatises: *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 48^{v}, 59^{r}, 60^{r}, 61^{v}; *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fols. 67^{v}, 68^{r}, 62^{v}; *Sefer haMibḥarim* (first version), ed. J. L. Fleischer (Jerusalem, 1969), p. 11; *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 86^{r}; *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fol. 90^{r}.

[106] Levy and Cantera, *The Beginning of Wisdom*, ch. VI, pp. xliv, lvii.

[107] Levy, *The Astrological Works*, pp. 19-32.

[108] See note 103.

[109] Levy and Cantera, *The Beginning of Wisdom*, p. v.

[110] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 34^{r}, 37^{r}.

additional version, considerably different in its contents from the first one.[111]

The first version of *Sefer haṬe'amim* was written when the imprint of *Reshit Ḥokhma* was still fresh in Ibn Ezra's memory. The two works are so tightly connected that it makes sense to think that they were composed almost simultaneously. *Sefer haṬe'amim* follows closely the inner structure and organization of *Reshit Ḥokhma*, that is, it keeps strictly the division into 10 chapters adopted in *Reshit Ḥokhma* and explains the *reasons* for astrological concepts in precisely the order in which the same concepts appear in *Reshit Ḥokhma*. The two works are so closely linked that in *Sefer haMoladot* (Book of Nativities), the next astrological treatise of the *astrological encyclopedia*, Ibn Ezra refers to *Sefer haṬe'amim* as *Sefer Teamei Reshit Ḥokhma*, namely "Book of Reasons of *Reshit Ḥokhma*".[112] Yet, even when writing the first version of *Sefer haṬe'amim*, Ibn Ezra carefully thought about the continuation of his *astrological encyclopedia*. Therefore, he promised to explain some topics more thoroughly in *Sefer haMoladot* and *Sefer ha'Olam* (Book of the World) or *Sefer haMaḥbarot* (Book of Conjunctions), both of them still non-existent works, and at the same time he also referred the reader to *Keli haNeḥoshet*, that is, to the third Hebrew version of the *Astrolabe Book*, already written before *Reshit Ḥokhma* early in the same year 1148.[113]

The second version of *Sefer haṬe'amim*, as well as the first version, was designed as a commentary on *Reshit Ḥokhma*, and Ibn Ezra asserts that expressly in the opening words of its introduction.[114] Why should this version be regarded precisely as the *second* version of *Sefer haṬe'amim*? The key that makes possible the chronological arrangement of the two versions of

[111] For a discussion of the two versions of *Sefer haṬe'amim*, see the introduction to the editions of both versions: N. Ben Menachem, *Sefer haṬe'amim* (second version), pp. v-xix; *Sefer haṬe'amim* (first version), edited by J. L. Fleischer (Jerusalem, 1951), pp. 5-24. J. Halbronn, "Le diptyque astrologique d'Abraham Ibn Ezra et les cycles planétaires du Liber Rationum", *Revue des Études Juives*, CLV (1996): 171-84.

[112] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 48^{v}.

[113] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 35^{r}, 36^{v}, 43^{v}, 44^{r}, 45^{v}.

[114] N. Ben Menachem, *Sefer haṬe'amim* (second version), p. 1: "I mean, thereupon, to lay the foundations of *Reshit Ḥokhma* …". Concerning the opinion that this version of *Sefer haṬe'amim* is rather a commentary on *Mishpeṭei haMazzalot*, see the introduction written by J. L. Fleischer to *Sefer haṬe'amim* (Jerusalem, 1951), pp. 19-22. See also Steinschneider, "Zur Geschichte der Uebersetzungen", *ZDMG*, 24 (1870), pp. 342-1.

Sefer haṬe'amim may be found in two different references to *Sefer ha'Olam*: While in one version of *Sefer haṬe'amim* Ibn Ezra writes, using the future tense, that "*I will explain* the Lunary Stations in *Sefer ha'Olam*",[115] in the other version of *Sefer haṬe'amim* Ibn Ezra goes on to say, using the past tense, that "the two luminaries command life and the place of conjunction or its opposition command every renewed thing, *as is written* in *Sefer ha'Olam*".[116] From this we clearly learn that the referred-to *Sefer ha'Olam* was written in between two different versions of *Sefer haṬe'amim*. Since the first version of *Sefer ha'Olam* was composed by 1148, we conclude that the second version of *Sefer haṬe'amim* was written after that date. What was precisely the period of time separating the two versions we cannot say, but it may be clearly noticed that not a short time elapsed since Ibn Ezra finished his *Reshit Ḥokhma*: even when we may observe that Ibn Ezra deals with concepts and topics that may be found in *Reshit Ḥokhma*, the division in 10 chapters as well as the ordering of the topics as adopted in *Reshit Ḥokhma* disappears completely in the second version of *Sefer haṬe'amim*. Also, from within the second version of *Sefer haṬe'amim*, Ibn Ezra refers the reader, using the past tense, to different parts of his "astronomical tables",[117] and we assume that with these words he is alluding to the second Hebrew version of his *Sefer haLuḥot* and to the *Sefer Ṭa'amei haLuḥot* written in Narbonne (see above p. 97). Besides, Ibn Ezra mentions *Sefer haMoladot* as a completed treatise,[118] and *Sefer haMe'orot* (Book of Luminaries) as a not yet completed work.[119]

• ***Sefer haMoladot*** (Book of Nativities): As said above, Ibn Ezra planned the composition of *Sefer haMoladot* from as early as 1146, as may be learned from references to it from within

[115] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 43^{v}.

[116] N. Ben Menachem, *Sefer haṬe'amim* (second version), p. 33.

[117] When explaining the concept of long and short zodiacal signs, Ibn Ezra refers to *Sefer haluḥot haḥeleq hagadol*, that is to the 'main chapter' of the Book of Astronomical Tables – see N. Ben Menachem, *Sefer haṬe'amim* (second version), p. 5 – and when dealing with two technical astrological topics, such as establishing the astrological "aspects" and the calculations related to the procedure of "ducere gradus planetae" (see above notes 43, 72) Ibn Ezra refers the reader on two occasions to *Sefer Ma'ase haLuḥot,* that is the Book to Proceed with Astronomical Tables – see N. Ben Menachem, *Sefer haṬe'amim* (second version), p. 41.

[118] N. Ben Menachem, *Sefer haṬe'amim* (second version), p. 36.

[119] *Ibid.,* p. 34.

the first version of *Keli haNeḥoshet* and from *Mishpeṭei haMazzalot*,[120] both of them composed in 1146. After completing the first version of *Sefer haṬe'amim*, Ibn Ezra continued in the same year of 1148 with the composition of *Sefer haMoladot,*[121] a treatise concerned with genethlialogical astrology, whose fundamental principle is that the destiny of the new-born is determined by the configuration of the celestial sphere at the instant of birth. *Sefer haMoladot* was considered by Ibn Ezra as one of his most central astrological works, as may be learned from the many references to it from within the other parts of Ibn Ezra's scientific corpus.[122] Ibn Ezra deals in *Sefer haMoladot* first with the fundamental problem of determining the criteria to choose an ascendant for the nativity, according to which the astrological houses may be calculated. The central and major part of the treatise is divided in twelve chapters, each of them dealing with each of the twelve astrological houses and the techniques to interpret their astrological characteristics. Ibn Ezra concluded the treatise with a discussion on the so-called *Tequfat hashanim* (*revolutiones annorum* in Latin or *taḥāwil al-sinīn* in Arabic), that is the calculation of the years, or fraction of years, which have expired since the birth of an individual.

The Hebrew text of *Sefer haMoladot* is available today only in manuscripts,[123] whereas a Latin translation was already published in Venice 1484, under the title *Liber Abraham Iude de nativitatibus*. This translation was performed by Henry Bate, together with other translations of Ibn Ezra's works into Latin and French, about one hundred years after Ibn Ezra's death.[124] A superficial examination of the Latin text suggests that the Latin translation follows the Hebrew text, in its general organization and division into twelve chapters, and also in its topics,

[120] Edelman, *Keli haNeḥoshet* (first version), p. 14; *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fol. 84^{r}.

[121] In the first version of *Sefer haṬe'amim*, Ibn Ezra refers several times to *Sefer haMoladot*, a sign that its composition was imminent. See *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 35^{r}, 44^{r}, 45^{v}.

[122] N. Ben Menachem, *Sefer haṬe'amim* (second version), p. 36; Fleischer, *Sefer haMibḥarim*, pp. 9, 10; *Sefer haShe'elot*, Paris, BNF, MS Héb. 1056, fols. 63^{r}, 63^{v}; *Sefer ha'Olam*, Rome, Vatican MS Ebr. 477, fol. 90^{r}.

[123] See, *inter alia*, *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 46^{v}-61^{v}.

[124] *Liber Abraham Iude de nativitatibus* (Venetia, 1484). Ibn Ezra's treatise was printed in Venice by Erhals Ratdolt together with the *Magistralis Composition Astrolabii*, written in 1274 by Henry Bate. Concerning Henry Bate's translations, see Levy, *The Astrological Works*, pp. 28-9.

wording and sources.[125] However, a more attentive perusal and a collation of the Hebrew and Latin texts reserves a surprise: whereas the Hebrew text of *Sefer haMoladot* commences with a remarkable introduction, wherein Ibn Ezra presents eight astrological universal principles that override the private fate of the newly born,[126] the Latin text begins with an encomium of the astrolabe and proceeds to present some astrolabe models;[127] also, the Hebrew text concludes, as we noted above, with a discussion of the *Tequfat hashanim*, a chapter which is completely non-existent in the Latin translation. An examination of dozens of manuscripts of the Hebrew version of *Sefer haMoladot* indicates clearly that, despite some minor and ordinary deviations between them, all of these Hebrew manuscripts stem from a single text, which is significantly different from the Latin translation in both aspects noted above. This assertion is corroborated also by the fact that *Sefer haMoladot* and *Liber Abraham Iude de nativitatibus* appear to be substantially different in their date of composition. As we noted above, the Hebrew *Sefer haMoladot* was written in 1148. But in the Latin text the author refers to a conjunction of Saturn and Jupiter and goes on to explain that "hoc 1154 ab incarnatione Domini est adunatio eorum in triplicitate terrae".[128] Most interestingly, this chronological remark regarding the year 1154 links the *Liber Abraham Iude de nativitatibus* with the second Latin version of *Liber de rationibus tabularum*, where we read, *inter alia*, "anno 1154 ab incarnacione Domini, quo hanc edicionem fecimus".[129] What is more, in the *Liber Abraham Iude de nativitatibus*, the author

[125] To corroborate that, the following two passages referring to Hermes, may be collated. *Liber Abraham*, fol. 2 (a): "Dixit Hermes quod locus lune in hora infusionis spermatis in matrice erit gradus oriens in nativitate, gradus oriens in conceptione est lune locus in nativitate; quod verum esse probatione cognitus est nisi nativitas vel septimo vel undecimo fuerit"; *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 47[r]:

"אמר חנוך לעולם במולד אדם מקום הלבנה ברגע המולד היא המעלה הצומחת ברגע רדת הטיפה ברחם, והמעלה הצומחת ברגע המולד שם היתה הלבנה ברגע הטיפה ע"כ אם ידענו רגע הטיפה נוכל לדעת רגע המולד ואם ידענו רגע המולד נוכל לדעת מתי היה רגע הטיפה... וכל זה שאמרנו הוא אמת בנולדים בקרוב מט' חודשים והם רובי האדם רק יש לפרקים שיולד הנולד בחודש הז' גם בחודש הי"א."

[126] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 46[r]-47[v].

[127] *Liber Abraham*, fol. 2 (a) "Optimum instrumentorum ad inveniendum gradum orientem in nativitatibus est astrolabius quo quanto perfectus tanto melior…".

[128] *Liber Abraham*, fol. 3 (c)[v].

[129] Millás, *Tablas*, p. 99. See also p. 109.

refers to his own *Liber de rationibus tabularum*,[130] in a passage that is non-existent in the corresponding Hebrew text. Since this mention is a reference to an already completed work, we assume that it is an allusion to the second Hebrew version of *Sefer Ṭa'amei haLuḥot*, which presumably was written in parallel with its Latin counterpart. We therefore conclude that *Liber Abraham Iude de nativitatibus* is the Latin translation of a second version of *Sefer haMoladot* whose existence was hitherto unknown. The Hebrew original of this second version is at present lost.

• ***Sefer haMibḥarim*** (Book of Elections) and ***Sefer ha-She'elot*** (Book of Interrogations). Next to the composition of the first version of *Sefer haMoladot*, Ibn Ezra wrote two new treatises, each of them concerned with two astrological systems. These systems were originally developed as part of Greek astrology, became part and parcel of Arabic astrology and subsequently were adopted by Hebrew and Latin astrologers. One of the books is *Sefer haMibḥarim*, concerned with an astrological system (called *katarkhai* in Greek, *ikhtiyārāt* in Arabic, *electiones* in Latin and *mibharim* in Hebrew) designed for choosing the most auspicious moment for accomplishing such and such act by the expedient of casting the horoscope and observing the place of the moon in the astrological houses. The second treatise is *Sefer haShe'elot*, concerned with an astrological system (called *eroteseis* in Greek, *masā'il* in Arabic, *quaestiones* in Latin and *she'elot* in Hebrew) designed to reply to questions referred to the astrologer and relating to common incidents of daily life, such as concerning someone who goes missing, discovering a thief or recovering a lost item. While both systems require interpretation by the astrologer of the horoscope cast at the moment at which the question was posed, the latter system is related to magic and presupposes, as Ibn Ezra wrote in his treatises, that the thoughts of the client, should be adequately read by the astrologer.[131]

[130] *Liber Abraham*, fol. 3 (a)^{r}: "In primis ergo secundum tabulas probationum, oriento invento, domos quoque secundum terrae latitudinem aequa, secundum terrae latitudinem aequa, secundum artem a nobis in astrolabio traditam, non secundum magistros astronomie quorum falsitate in *libro de rationibus tabularum ostendimus*". This passage was already noticed by J. Millás Vallicrosa, who thereby raised the conjecture that the Latin translation contained an additional version of *Sefer haMoladot*. See Millás, *Tablas*, p. 16.

[131] Regarding both astrological techniques, see Bouché-Leclercq, *L'astrologie grecque*, pp. 458-86; S. Tester, *A History of Western Astrology* (Suffolk, 1987), pp. 88-92. Concerning the need of reading thoughts, see *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fol. 62^{v}.

Both treatises were composed by Abraham ibn Ezra in two different versions, the first in 1148, and the second at a later date that is very difficult to establish. Even though the inner contents of both versions of each of the treatises are similar, the four versions are clearly distinguishable by the remarkable introductions that Ibn Ezra attached to each of them. Thus, while in the first version of *Sefer haMibḥarim* Ibn Ezra endows the *superior soul* the power to prevail over the verdict dictated by the horoscope, in the second version of the same treatise, without changing the main message, Ibn Ezra sets the possibility of changing human fate into the context of Jewish tradition and religion.[132] An analogous change of mind appears in the two versions of *Sefer haShe'elot*. In the first version Ibn Ezra presents the main tenets of two opposing schools of astrologers, the first opposed to the validity of the astrological system of *quaestiones*, the second adhering to it by arguing that there is a direct link connecting stars, body and soul. The same two schools appear in the introduction to the second version, but both schools are there presented by Ibn Ezra as headed by two *kings*, the first named *Ptolemy the King* and the second named as *Doronius the King*,[133] an interesting remark which reveals how deeply immersed Ibn Ezra was in the context of the Arabic Andalusian cultural climate.[134]

Of these four treatises, only the first version of *Sefer haMibḥarim* has been edited,[135] while the other three treatises are available only in manuscripts.[136] Both *Sefer haMibḥarim*

[132] For the introduction to the first version of *Sefer haMibḥarim*, see Fleischer, *Sefer haMibḥarim* (first version), p. 9. For the introduction to the second version of *Sefer haMibḥarim*, see *Sefer haMibḥarim* (second version), Paris, BNF, MS Héb. 1058, fol. 9^{r}.

[133] For the introduction to the first version of *Sefer haShe'elot*, see *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fol. 62^{v}. For the introduction to the second version of *Sefer haShe'elot*, see *Sefer haShe'elot* (second version) Paris, BNF, MS Héb. 1058, fol. 1^{r}.

[134] In this introduction, as well as in other places, Ibn Ezra endorses a myth that converted astrologers and astronomers, such as Claudius Ptolemy and Doroteus from Sidon, into kings. For the myth of the savant-king in medieval Arabic culture, particularly regarding Claudius Ptolemy viewed as *Ptolemy the King*, see the following sources: Albumasar, *De magnis conjunctionibus, annorum revolutionibus ac eorum profectionibus*, Trans. Johannes Hispalensis (Augsburg, 1489), fol. c (7); D. Pingree, *The Thousands of Abū Ma'shar* (London, 1968), p. 131; Ṣā'id al-Andalusī, *Science in the Medieval World, "Book of the Categories of Nations"*, Translated and Edited by Sema'an I. Salem and Alok Kumar (Austin, 1991), p. 27.

[135] *Sefer haMibḥarim* (first version), edited by J. L. Fleischer (Jerusalem, 1969).

[136] *Sefer haMibḥarim* (second version), Paris, BNF, MS Héb. 1058, fols. 9-14; *Sefer*

and *Sefer haShe'elot* were referred to using the future tense from within *Sefer haMoladot*, an indication that their composition was imminent.[137] After Ibn Ezra completed the first version of *Sefer haMibḥarim* and *Sefer haShe'elot*, he referred retrospectively from within them to *Sefer haMoladot,*[138] to *Sefer haṬe'amim*[139] and to *Reshit Ḥokhma.*[140]

• ***Sefer haMe'orot*** (Book of Luminaries). This astrological treatise concerned mainly with medical astrology appears to have been written, as the other components of the *astrological encyclopedia*, in two versions. This assertion rests mainly on two references to *Sefer haMe'orot* dealing with medical astrology. On the one hand, Ibn Ezra refers to *Sefer haMe'orot* from within the first version of *Sefer haShe'elot* using the past tense;[141] on the other hand, Ibn Ezra refers also to *Sefer haMe'orot*, but using the future tense, from within the second version of *Sefer haṬe'amim*, which was written substantially later the first version of *Sefer haShe'elot*.[142] Thus, we reach the conclusion that the first version of *Sefer haMe'orot* was composed before Ibn Ezra wrote the first version of *Sefer haShe'elot*, that is, still in 1148. But, since Ibn Ezra refers to *Sefer haMe'orot* from within the second version of *Sefer haṬe'amim* in future tense, we come also to the conclusion that the second version of *Sefer haMe'orot* was composed at some time after 1149. The first version of *Sefer haMe'orot* was edited in 1933,[143] while the second version is at present lost.

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haShe'elot (first version), Paris, BNF, MS Héb. 1056, fols. 62-70; *Sefer haShe'elot* (second version), Paris, BNF, MS Héb. 1058, fols. 1-8.

[137] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 54^{r}, 65^{v}.

[138] Fleischer, *Sefer haMibḥarim* (first version), p. 10; *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fols. 63^{r}, 63^{v}.

[139] *Sefer haShe'elot*, first version, Paris, BNF, MS Héb. 1056, fols. 63^{r}, 63^{v}.

[140] Fleischer, *Sefer haMibḥarim* (first version), p. 11; *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fols. 62^{v}, 63^{r}, 70^{v}.

[141] *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fol. 66^{r}: "if someone is able to locate the place of the moon at the beginning of the illness, then it is possible to know if the patient will live or die, and also to know the turning point of the affliction, and *I have already explained* that in my *Sefer haMe'orot.*"

[142] See Ben Menachem, *Sefer haṬe'amim* (second version), p. 34, where Ibn Ezra goes on to explicate that the Moon "is the gist, and when the Moon arrives in a bad place the newly born will die, as *I will explain* in *Sefer haMe'orot*".

[143] J. L. Fleischer (ed.), *Sefer haMe'orot*, *Sinai,* Yearbook of the Ḥokhmat Israel Society in Rumania (1933), pp. xlii-li. See also *Sefer haMe'orot* in Me'ir Yṣḥaq Bak'al (ed.), *Sefer Mishpeṭei haKokhavim* (Jerusalem, 1971), pp. 7-19.

Sefer haMe'orot deals with medical astrology, and more precisely with the influence that the moon exerts on man's health. Ibn Ezra initiated it with an interesting cosmological introduction, in which a tripartite division is outlined, one that highlights the differences between the fixed stars, which keep their celestial relationships when moving, between the planets, which constantly change their position in relation to the zodiacal orb, and between the sub-lunar world, whose change in matter as well as in mind is a consequence of the planets' movements. A distinctive mark of this introduction is that Ibn Ezra, who in other places deals with the controversy related to the position of the sun's orb (below or above the orbs of Mercury and Venus) without making clear his position, chose this introduction to reveal his opinion, which is that the sun's orb is the second, after the moon's orb.[144]

• ***Sefer ha'Olam*** (Book of the World). This treatise is concerned with the branch of astrology dealing with the collective fate of mankind, by means of astrological forecasts as well as astrological analysis of past history. That Ibn Ezra regarded this treatise as a future project from as early as the beginning of 1148 can be confirmed on the basis of some references found in the first version of *Sefer haṬe'amim*, wherein he calls the book by two alternative titles: *Sefer ha'Olam* (Book of the World) or *Sefer haMaḥbarot* (Book of Conjunctions).[145] This second name, later abandoned by Ibn Ezra, nevertheless reveals two interrelated and important traits of *Sefer ha'Olam*. First, the title *Book of Conjunctions* points directly at the main source used by Ibn Ezra, namely Abū Ma'shar's *Kitāb al-qirānāt* (*De magnis conjunctionibus annorum revolutionibus ac eorum profectionibus*); secondly, the word *conjunctions* included in the title of the book hints at Ibn Ezra's main macro-astrological doctrine, namely the examination of Saturn-Jupiter conjunctions, a technique explained and implemented in Abū Ma'shar's book. Indeed, Joseph Bonfils, who knew Ibn Ezra's scientific work quite well, alluded also to this treatise using the name *Sefer Mishpeṭei ha'Olam* (Book of World Judgments),[146] a title that also appears in several manuscripts of *Sefer ha'Olam* (first version).[147]

[144] Fleischer, *Sefer haMe'orot*, p. xlii.

[145] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 36^{v}, 43^{v}.

[146] Joseph Bonfils, *Sophnat Pane'ach*, vol. I, pp. 75, 309, vol. II, p. 27. But in other passages the same book is named *Sefer ha'Olam*, see vol. I, p. 201 vol. II, p. 36.

[147] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 86^{v}.

This treatise, like the others mentioned above, was composed in two versions. One of them was published in a very poor edition in 1937,[148] the other version remains at present in manuscript.[149] For convenience, I call the published version the "first version", and the unpublished version the "second version". But, this nomenclature does not necessarily reflect their chronological order of composition, since on both versions appears the year 4908 A.M. (=1148) as the year of composition,[150] and in some manuscripts of the first version there also appears the date of composition as *Marḥeshvan* 4909 A.M. (=November 1148).[151] *Sefer ha'Olam* may be thought to be the final component of Ibn Ezra's *astrological encyclopedia* since in both versions we find only retrospective references referring to previous astrological works already composed during 1148. Thus, in the first version of *Sefer ha'Olam* Ibn Ezra refers the reader to *Reshit Ḥokhma* and *Sefer haMibḥarim*,[152] whereas in the second version he alludes to *Keli haNeḥoshet*, *Reshit Ḥokhma* and *Sefer haMoladot*.[153] As said before, both versions were composed in the same year and we assume that a gap of a few months separates them. Perhaps Ibn Ezra composed the second version fulfilling the request of a new student or audience, after he delivered the manuscript of the first version, or after he moved from Béziers to another city in Provence.

Both versions describe at the outset, following clearly Abū Ma'shar's *Kitāb al-qirānāt*, the periodical conjunctions of Saturn and Jupiter as divided in three main groups: big (960 years), medium (240 years) and short conjunctions (20 years).[154] Nevertheless, both versions differ plainly one from the other in other aspects. Ibn Ezra began the introduction to the first ver-

[148] *Sefer ha'Olam*, edited by J. L. Fleischer (using Rome, Vatican MS Ebr. 390) in *'Otzar Haim*, 13 (1937): 33-49. See also *Sefer ha'Olam* in Me'ir Yṣḥaq Bak'al (ed.), *Sefer Mishpeṭei haKokhavim* (Jerusalem, 1971), pp. 36-54. I used the following extant manuscripts: *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fols. 80^{v}-83^{v}; Cambridge, Classmark ADD 1517, fols. 50^{v}-53^{v}.

[149] *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fols. 86^{v}-95^{r}; Cambridge, Classmark Add 1186, fols. 74^{v}-83^{v}.

[150] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 82^{v}; *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fol. 91^{v}.

[151] Concerning this point, see the introduction to *Sefer ha'Olam* (1937), p. 34.

[152] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fols. 83^{v}, 86^{r}.

[153] *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fols. 90^{r}, 92^{r}, 93^{v}.

[154] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 80^{v}; *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fols. 86^{v}-87^{r}. Cf. Albumasar, *De magnis conjunctionibus*, fol. a (3).

sion with a harsh attack on Abū Ma'shar, who in his opinion was astronomically wrong in relying on the mean motion of the planets according to Hindu theory and Hindu astronomical tables.[155] Next Ibn Ezra developed a remarkable and detailed combinatorial analysis aimed to explain why the total number of the conjunctions of the seven planets is precisely one hundred and twenty, a piece of information that he extracted from the fiftieth article belonging to one of the most popular medieval treatises, the apocryphal *Centiloquium*, attributed to Claudius Ptolemy.[156] On the other hand, the second version is easily distinguishable from the first by a remarkable passage giving an astrological explanation of the history of the monotheistic religions, more precisely, endowing some special conjunctions of Saturn and Jupiter with the capacity of bringing about and exerting influence in the birth of powerful figures and prophets in history, such as Moses, Jesus and Mohammed, which subsequently created new religions.[157]

3. *Translations from Arabic into Hebrew*

Three translations of Arabic scientific treatises into Hebrew are ascribed to Ibn Ezra. However, only in one case may we assert safely that Ibn Ezra was actually the translator, while there are good reasons to cast serious doubts on Ibn Ezra's part in the two remaining cases. We will now discuss these two questionable translations – an astrological treatise of Māshā'allāh and a text dealing with astronomy of Ibn al-Muthannā – both of them particularly important since they are no longer extant in the original Arabic. The first of them is the *Book of Māshā'allāh on Eclipses of the Moon and the Conjunctions of the Planets, and the Tequfot of Years* (*revolutiones annorum*). Ibn Ezra's authorship

[155] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 80^{v}. Nevertheless, Abraham bar Ḥiyya endorsed the mean motion of the planets astronomical methodology. See *Sefer Megillat ha-Megalle von Abraham bar Chija*, published by A. Poznanski with introduction and notes by J. Guttman (Berlin, 1924), p. 117.

[156] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 80^{v}. Cf. Claude Ptolémée, *Les cent sentences astrologiques* (Paris, 1938), p. 25. For an Hebrew medieval translation see *Sefer haPri*, Paris, BNF, MS Héb. 1055, fols. 52^{r}-72^{r}. A similar though shortened combinatorial treatment of the 120 conjunctions motif, but theologically oriented, may be found in Ibn Ezra's Long Commentary to *Exodus* 33:21.

[157] *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fol. 88^{v}.

of this translations was first affirmed, with some reservations, by Moritz Steinschneider.[158] Later, B. R. Goldstein translated the work to English and added some commentaries on it, accepting Ibn Ezra as its translator.[159] The second debatable translation was also attributed to Ibn Ezra, again with some precautions, by Moritz Steinschneider. This is one of the two extant Hebrew translations, preserved in MS Oxford, Bodleian Library, Michael 400, fols. 45^{r}-74^{r} of *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī*.[160] The Hebrew text of the "Michael version" was edited and translated into English by B. R. Goldstein, who in this case negated Steinschneider's claim for Ibn Ezra's authorship.[161]

We will now see on what grounds Ibn Ezra's authorship in these two cases may be rejected. First of all, in neither of these translations does the translator identify himself, a trait not common for Ibn Ezra, whose presence is clearly and explicitly felt in all his works, and who normally presents himself in the introduction to his works as *Abraham the Spaniard*. An additional, noteworthy and in my opinion crucial argument that may be brought forward is related to Ibn Ezra's especial approach to overcoming the formidable task of filling the linguistic void of the Hebrew language, when coming to transfer Arabic sciences into a Hebrew mold. An exploration of the scientific terminology implemented by Ibn Ezra shows a remarkable characteristic, namely the consistent use of some *old* biblical Hebrew words, which in Ibn Ezra's opinion express central scientific concepts. This approach leads Ibn Ezra to adopt in some particular cases a very peculiar and conspicuous position as a translator, significantly different from that adopted by other Jewish contemporary writers and translators, who also wrote in Hebrew but adopted a translation strategy based mainly on the coinage of new Hebrew words, which were either cognates of Arabic words or loan translations of Arabic terms. In clear contrast with them, Ibn Ezra obstinately avoided the

[158] Steinschneider, *Hebraeischen Uebersetzungen*, par. 378-379; *id.*, "Abraham Ibn Esra", p. 497.

[159] B. R. Goldstein, "The Book on Eclipses of Masha'allah", *Physis*, V. 6 (1964): 205-13. Cf. *id.*, "Astronomy and astrology", pp. 14-15. For a printed edition of the Hebrew text, see *Sefer leMasha'allah bekadrut halebana vehashemesh*, in Me'ir Yṣḥaq Bak'al (ed.), *Sefer Mishpeṭei haKokhavim* (Jerusalem, 1971), pp. 1-15.

[160] Steinschneider, *Hebraeischen Uebersetzungen*, par. 356.

[161] Goldstein, *Muth.*, especially pp. 9-11, 15-144, 306-404.

use of cognate or loaned words stemming from the Arabic language, particularly in cases where in his opinion *original scientific Hebrew terms* were available in the biblical text.[162]

It is precisely the violation of these translation rules, obstinately observed by Ibn Ezra in all his work, that leads us to assert that the two above-mentioned translations were not done by Ibn Ezra. As far as *The Book of Māshā'allāh on Eclipses* is concerned, its translator used consistently, in at least 12 instances, the Hebrew word *aqlim*, which is the cognate translation of the Arabic term *iqlim*, a word that served to describe each of the *seven climates*.[163] But in his genuine works Ibn Ezra completely avoided using the word *aqlim*, and instead he consistently and frequently used in both his exegetical and scientific works the Hebrew biblical word *gevul*.[164] As far as the Michael version of *Ibn al-Muthannā's Commentary* is concerned, we note the disregard of the above-mentioned as well as other central Ibn Ezra's translation rules. On the one hand, it is possible to detect in the Michael version the use of the Hebrew word *aqklim*, and the absence of the word *gevul*.[165] On the other hand, in order to express the fundamental concept of *center*, we notice in the Michael version the use of the Hebrew word *merkaz*, a cognate word borrowed from the Arabic *markaz*. But the Hebrew word *merkaz* was completely avoided by Ibn Ezra, who employed instead in his works the biblical word *muṣaq*.[166]

[162] Regarding this especial feature of Ibn Ezra's scientific terminology see Sela, *Astrology and Biblical Exegesis*, Part II, ch. I, pp. 209-16. Cf. Sarfatti, *Mathematical Terminology*, pp. 145-6.

[163] *Sefer leMasha'allah bekadrut halebana vehashemesh*, pp. 1-15.

[164] The word *gvul* was taken by Ibn Ezra from *Psalms* 74:17 to express the concept of the *seven* climates. Actually the Hebrew word *gvul*, more precisely *gevulot areṣ*, appears in Psalms 74:17, a verse on which Ibn Ezra commented as follows: "and he mentioned that the seven climates stand forever and the inhabited part of the earth will not change, and the reason for writing 'summer and winter' is because the overwhelming majority of the inhabited part of the earth is in the north and only a slight part is in the south, and the reason for mentioning this together with the 'borders of the earth' (*gevulot areṣ*) is because when in one place it is summer in the other it is winter". See also above p. 116.

[165] Goldstein, *Muth.*, p. 357.

[166] Abraham ibn Ezra endowed the rather bizarre Hebrew word *muṣaq*, meaning literally *solid*, *stable* or *strong*, with a variety of correlated meanings: from the basic notion of *point*, the meaning of *muṣaq* shades into the concept of the *geometric center of the circle*, and thus is viewed as a synonym of the *earth*, located at the cosmic center of the spheres. Ibn Ezra believed that this extremely wide semantic field is part of the underlying meaning of the biblical text, particularly in the verses *Job* 36:16, 37:10 and 38:38. See Ibn Ezra's Commentary on these verses. The use of the word *merkaz*

Ibn Ezra's authorship of the second extant Hebrew translation of *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī*, the so-called "Parma version" (extant in Parma, Bib. Palatina, MS 2636, fols. 1-13^{v}) is indisputable. That can be safely affirmed on the basis of the fact that Ibn Ezra attached to it an outstanding introduction, where he not only plainly revealed his identity as *Abraham the Spaniard* and specified the year 1160 as the date of composition but also presented his own version of the transmission of Hindu and Greek astronomy to the Arabic sciences.[167] This translation was discovered by Moritz Steinschneider, who published its introduction for the first time.[168] Millás Vallicrosa, in an article published in 1938, was the first to establish that the author of this work was Aḥmad ibn al-Muthannā ibn 'Abd al-Karīm, who according to Ṣā'id al-Andalusī authored a work named *Ta'dīl Zīj al-Khwārizmī*.[169] The Parma version, alongside the Michael version, were edited and translated into English by B. R. Goldstein. J. Millás Vallicrosa as well as B. R. Goldstein showed that parts of *Ibn al-Muthannā's Commentary* were introduced into *Liber de rationibus tabularum*, the Latin version of *Sefer Ṭa'amei haLuḥot*, an additional ground for asserting that Ibn Ezra was engaged in its composition.[170]

Regarding the aforementioned characteristics of Ibn Ezra's scientific terminology, the Parma version is the antipode of the Michael version. The above-mentioned word *muṣaq*, completely absent in the Michael version, is most conspicuous in the Parma version, and is used precisely in the places where the word

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was adduced by B. R. Goldstein, in addition to stylistic traits which distinguish in his opinion the Michael version from the Parma version, in order to claim that the Michael version translation was actually not carried out by Ibn Ezra. See Goldstein, *Muth.*, pp. 9-11.

[167] See the introduction in Goldstein, *Muth.*, pp. 300-2.

[168] Steinschneider, "Zur Geschichte der Uebersetzungen", *ZDMG*, 24 (1870), pp. 325-92; 25 (1871), pp. 388-428; for the text of the introduction see *ZDMG*, 24 (1870), pp. 356-9; see also *id.*, *Die Hebraeischen Uebersetzungen des Mittelalters* (Berlin 1893; Graz 1956), par. 356. Later D. Smith and Y. Ginsburg translated Steinschneider's Hebrew text of the introduction into English and added a commentary. See D. Smith and Y. Ginsburg, "Rabbi ben Esra and the Hindu-Arabic problem", *The American Mathematical Monthly*, XXV (1918): 99-108.

[169] J. Ma. Millás Vallicrosa, "The work of Abraham Ibn Ezra in astronomy" (in Hebrew), *Tarbiz*, IX (1938): 306-22. Cf. Ṣā'id al-Andalusī, *Book of the Categories of Nations*, p. 53.

[170] Millás, *Tablas*, pp. 51-4; Goldstein, *Muth.*, pp. 11, 200-8, 218, 231, 234.

merkaz is employed in the Michael version.[171] Besides, Ibn Ezra made use in the Parma version of another outstanding biblical expression, namely *nahasḥ bariaḥ*, taken from *Job* 26:13 and *Isaias* 27:1. This expression means literally *the slant serpent*, but is used by Ibn Ezra to express the astronomical technical term of the nodes, that is, two points of intersection between two spheres: the sphere of the zodiac and the sphere of inclination. In this particular case Ibn Ezra adopts a peculiar way to introduce this expression in the translation. In a special chapter, in which is dealt the question "what is the node and what is the meaning of this word", Ibn al-Muthannā goes on to remind his readers that this astronomical term is called in Persian *kazohar*, and in Arabic *al-jawzahar*. When coming to translate the Arabic term, Ibn Ezra first uses the literal expression, product of a loan translation, *rosh hatanin uzenabo*, that is, the head and tail of the dragon – caput et cauda draconis. But it is completely clear that this translation was indeed unsatisfactory for Ibn Ezra. So, he abruptly interrupted the thread of the translation, burst into the text, and added his own gloss: *Abraham said: and this* (i.e. the head and tail of the dragon) *is called in the holy tongue naḥash bariaḥ.*[172]

PART II: GENERAL CHARACTERIZATION OF THE SCIENTIFIC CORPUS

Having dealt separately with each of Ibn Ezra's scientific works, we wish now to delineate the general features of this corpus. With this purpose, the following questions will be asked: How

[171] To corroborate this point, *inter alia*, the following two parallel passages may be collated:

a) Parma version, Goldstein, *Muth.*, p. 197:

"מהם גלגל הנמשל לגלגל המזלות והוא מתגלגל על אפודה והטעם על אמצעיותו ומוצקו הוא מוצק הארץ ויקרא גלגל המזלות וגלגל אחר יקרא גלגל הגבהות ומוצקו רחוק ממוצק הארץ."

b) Michael version, Goldstein, *Muth.*, p. 395:

"מהם הגלגל הדומה לגלגל המזלות יסבב על המרכז ומרכזו מרכז הארץ יקרא גלגל המזלות וגלגל אחר יקרא גלגל הרום ומרכז זה הגלגל יוצא ממרכז הארץ."

[172] Parma version, Goldstein, *Muth.*, p. 296; cf. English translation, p. 154. This is an additional and remarkable case in which Ibn Ezra found out an "original" Hebrew word endowed with scientific meaning. For a study of the special case of *naḥash bariaḥ* see Sela, *Astrology and Biblical Exegesis*, part II, ch. IV, pp. 270-3.

was Ibn Ezra's scientific corpus organized and shaped? What was its scope? How did Ibn Ezra envisage the scientific book as such? For what main purpose was it aimed? Are there any special features which reveal the unique contribution and special personality of the author?

1. *Organization and Scope*

At first sight, after having described, one by one, Ibn Ezra's scientific works, we may assume that this corpus was divided into many parts: a sum-up of all the above shows that Ibn Ezra's scientific corpus was composed of 26 different works, dealing with multiple and various subjects. Nevertheless, a more scrutinizing assessment reveals additional and essential characteristics.

(a) The large total number of books does not signify that the corpus is composed of completely distinct and independent treatises, since this number (26 works) is mainly the result of the sum of the multiple versions of Ibn Ezra's treatises. Two cases are particularly suggestive: Abraham ibn Ezra wrote presumably four different version of the *Book of the Reasons Behind Astronomical Tables* (see above p. 97) and of the *Book on the Astrolabe* (see above p. 104) as well. What is more, the absolute majority of Ibn Ezra's astrological treatises were composed in at least two different versions. This is a quality that characterizes the scientific corpus as well as the biblical commentaries of Ibn Ezra,[173] and in both cases the same motives are at work. On the one hand, the pen was Ibn Ezra's main means of subsistence; on the other hand, he was required to satisfy a demand that increased during his wandering in Latin Europe. Thus, probably when he arrived in a new town, he wrote a new version for a new audience.

(b) As a matter of fact, if we disregard the multiple versions, we get only 14 distinct treatises, including one translation from Arabic into Hebrew, which will be next presented, sorted

[173] Abraham ibn Ezra wrote commentaries on the majority of the biblical books, and in most of the cases he wrote two different commentaries on the same book, a short commentary as well as a long one. Ibn Ezra wrote two different versions to the following biblical books: *Genesis, Exodus, Psalms, Daniel, Song of Songs, Esther, Hosea, Joel, Amos, Ovadiah, Jonah, Micah, Nahum, Habakuk, Zephaniah, Haggai, Zechariah, Malachi*. On Ibn Ezra's exegetical work see U. Simon, "Spanish commentators", in *Jewish Biblical Exegesis* (in Hebrew), (Jerusalem, 1983), pp. 47-60.

chronologically by the date of the first version, but including also a short note about the different versions and their place and date of composition.

Hebrew Name	Translation of the Name	Versions
Sefer haMispar	Book of the Number	1. Hebrew, Lucca, *ca*. 1146
Sefer Ṭa'amei haLuḥot	Book of the Reasons behind Astronomical Tables *Liber de rationibus tabularum*	1. Hebrew, Lucca, *ca*. 1146 2. Latin, Pisa, *ca*. 1146 3. Hebrew, Narbonne, *ca*. 1148 4. Latin, France, 1154
Keli haNeḥoshet	Book on the Astrolabe	1. Hebrew, Lucca, 1146; 2. Hebrew, Mantova, 1146; 3. Latin, Mantova, 1146; 4. Hebrew, Beziers, 1148
Sefer ha'Ibbur	Book of Intercalation	1. Hebrew, Verona, 1146
Mishpeṭei haMazzalot	Book of the Judgments of the Zodiacal Signs	1. Hebrew, Lucca, 1146
Reshit Ḥokhma	Beginning of Wisdom	1. Hebrew, Beziers, 1148
Sefer haṬe'amim	Book of Reasons	1. Hebrew, Beziers, 1148 2. Hebrew, France, after 1148
Sefer haMoladot	Book of Nativities	1. Hebrew, Beziers, 1148 2. Hebrew, France, 1154
Sefer haMibḥarim	Book of Elections	1. Hebrew, Beziers, 1148 2. Hebrew, France, after 1148
Sefer haMe'orot	Book of Luminaries	1. Hebrew, Beziers, 1148 2. Hebrew, France, after 1148
Sefer haShe'elot	Book of Interrogations	1. Hebrew, Beziers, 1148 2. Hebrew, France, after 1148
Sefer ha'Olam	Book of the World	1. Hebrew, Beziers, 1148 2. Hebrew, France, 1148-1149
Sefer ha'Ehad	Book on the Unit	1. Hebrew, ?, ?
Ṭa'amei al-Muthannā	Translation of Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī	1. Hebrew, England, 1160

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(c) Yet the scope of the corpus may be limited further if the subject-matter of these treatises is taken into consideration. In this case, the corpus falls into two main sections. (i) The first section includes works designed to develop technical-theoretical skills related mainly to astronomy and mathematics, especially designed to teach the use of scientific tools and instruments, such as the astrolabe and the astronomical tables, or to explain the astronomical foundations and determine the Hebrew calendar. (ii) In contrast with that, the second section is composed exclusively of astrological treatises, which may be divided into two main groups: In the first group we find general reference books, designed to describe, teach and explain the fundamentals of astrology. In the second group we find a series of astrological works designed to deal with the various branches of astrology.

(d) Notwithstanding this double division and despite the multiple topics included in them, the scientific corpus may be well regarded in an overall view as a single body of texts, dealing with a rather homogenous body of knowledge. This assertion may be argued on the basis of several factors. First, we may consider the most common term with which Ibn Ezra himself referred to his own scientific praxis and to the scientific branches which make up his scientific corpus. For this, Ibn Ezra coined a new Hebrew expression: *ḥakhmei hamazzalot* – that is, the persons engaged in the "science of the zodiacal signs" (*ḥokhmat hamazzalot*). The range of meanings of this extremely conspicuous term is wide, and an analysis of the contexts in which it was used plainly reveals that Ibn Ezra referred collectively with one and the same expression to a broad variety of activities belonging to three main scientific branches: mathematics, astronomy and astrology. Thus, the *ḥakhmei hamazzalot* are described in *Sefer haMispar* as concerned with trigonometric problems.[174] Besides, on the one hand, the *ḥakhmei hamazzalot* are depicted as engaged in typically astronomical tasks such as, mapping the skies,[175] writing and using astronomical tables and the astrolabe,[176] establishing the relative order of the planets' spheres,[177] calculating time reckon-

[174] Silberberg, *Sefer haMispar*, p. 79.

[175] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 63^{r}, right col.; Short Commentary on *Exodus* 23:20.

[176] Halberstam, *Sefer ha'Ibbur*, p. 11 (a); Silberberg, *Sefer haMispar*, p. 27; Ben Menachem, *Sefer haṬe'amim* (second version), p. 22. *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 65^{r}, right col.

[177] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 35^{r}.

ing parameters, such as the tropical year length, the exact timing of the equinoxes and solstices,[178] calculating the planets' motions, especially of the sun and moon, and particularly the timing of conjunctions and eclipses.[179] On the other hand, the *ḥakhmei hamazzalot* are very frequently described as theoretical and practical astrologers engaged, *inter alia*, in writing books and dealing practically with genethlialogical astrology[180] or universal astrology,[181] and facing common astrological technical problems, such as the arrangement of the astrological houses,[182] or the technique called as *nihug hakokhab* (*ductus planetae*).[183]

(e) A similar picture emerges when exploring the subject-matter of Ibn Ezra's scientific treatises. Thus, a clearly astronomical book, such as the *Liber de rationibus tabularum*, begins precisely by describing the astrological attributes of the sun,[184] allots a similar treatment to the moon,[185] and includes a chapter dealing with the arrangement of the astrological houses and other technical problems related to casting the horoscope.[186]

[178] These parameters are calculated not only with the purpose of establishing and explaining the fundamentals of the Hebrew calendar but also with astrological aims, such as the determination of the *Tequfat hashanim* (see above p. 122). See: *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 37^{v}; *Sefer ha'Olam (*first version), Paris, BNF, MS Héb. 1056, fol. 81^{r}; *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 59^{r}-59^{v}; Halberstam, *Sefer ha'Ibbur*, p. 3 (a).

[179] Long Commentary on *Exodus* 12:2; Commentary on *Leviticus* 25:9.

[180] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 58^{r} Commentary on *Exodus* 23:25; Long Commentary on *Daniel* 2:2.

[181] *Sefer ha'Olam (*first version), Paris, BNF, MS Héb. 1056, fol. 84^{r}; Long Commentary on *Exodus* 32:1.

[182] *Sefer haTe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 36^{v}, 40^{v}.

[183] *Reshit Ḥokhma*, ch. X, p. lxxv. Regarding this procedure, see above note 72.

[184] Millás, *Tablas*, p. 73-4: "Dixit Abraham Iudeus: Cognitum est corpus solare habere magnitudinem et secundum eam omnia vincere corpora, eiusque effectus tam in simplicibus quam in compositis manifestos esse, eumque in mundo caloris naturalis in corde sedem habentis vicem optinere… Item omnia iudicia astronomica secundum proportionem aliarum planetarum ad solem fiunt, secundum quod sunt orientales vel occidentales et secundum respectus eoram ad ipsum vel secundum quod subiacent luci eius."

[185] Millás, *Tablas*, p. 97: "Nunc vero de luna, cuius potestas super noctem. Primum ergo de natura eius, quam astronomici asserunt humidam et frigidam, dicemus, et Phtolomeus dicit in libro 4 capitulorum quod ab adunatione solis et lune eius natura est calida et humida usque distiterit a sole per quadrantem integrum, et ab eo quadrante usque ad oppositum calida et sicca; ab opposito vero usque ad quadratum a sole frigida et sicca; a quadrato usque ad adunationem frigida et humida."

[186] Millás, *Tablas*, pp. 84-5: "He tabule quas composuimus utiles sunt ad… coequationem domorum… et omnes ductus qui sunt secundum latitudinem terre, et signa mobilia et fixa et bicorpa et recta signa et obliqua et longa et curta…". See also pp. 159-61.

Also, although the astrolabe is known as an instrument essentially oriented to astronomical uses, all three Hebrew versions of *Keli haNeḥoshet* as well as the Latin version of the *Book on the Astrolabe* include, as has been said above (see p. 110), central chapters dealing with typically astrological procedures, such as the arrangement of the astrological houses, the calculation of the astrological aspects and the *nihug hakokhab* (Latin *ductus planetae*) with the help of the astrolabe.[187] But, on the other hand, a stark astrological book such as *Reshit Ḥokhma*, the main component of Ibn Ezra's *astrological encyclopedia*, begins by mapping the skies into 48 constellations and by listing the number of stars in each of the constellations[188] – a list which follows closely and summarizes Ptolemy's star catalogue in *Almagest* VII,5 – and it must be borne in mind that the fixed stars have little incidence in astrology. Also, another clearly astrological book such as *Sefer haMoladot* contains an interesting chapter dealing with the exact length of the tropical year, reviewing and comparing the opinions of major Greek, Hindu, Persian and Arabic astronomers on this particular topic.[189]

(f) The scientific corpus may be also grasped as an homogenous body of texts because it is internally interconnected in a net of cross-references, in a way reminiscent of a modern hyperlinked electronic text. This is especially true as far as the *astrological encyclopaedia* is concerned; and we have already presented above, when dealing separately with each of the astrological treatises, many cases illustrating this point. But the same assertion may be corroborated by observing the interdisciplinary character of many cross-references that connect various treatises of Ibn Ezra's scientific corpus. Thus, for example, from within *Sefer haMispar*, a mathematical treatise, Ibn Ezra refers the reader on two occasions to the *Sefer Ṭa'amei haLuḥot*.[190] Also, from within the first version of *Keli haNeḥoshet*, that is

[187] There is nothing surprising in the fact that astrology took such a conspicuous part of the astrolabe book, the main reason for that being that the use of the astrolabe simplified the solution of astronomical problems closely related to the horoscope casting. This idea is concisely and plainly expressed by Ibn Ezra himself at the beginning of the chapter dealing with the arrangement of the astrological houses in *Liber de rationibus tabularum*. See Millás, *Tablas*, p. 160: "Nos vero in astrolabio docuimus *facile* distinguere domus."

[188] Levy and Cantera, *The Beginning of Wisdom*, ch. I, p. vi-viii. Cf. Toomer, *Ptolemy's Almagest*, VII, 5, pp. 341-99.

[189] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 59^{r}-59^{v}.

[190] Silberberg, *Sefer haMispar*, pp. 27, 79.

the *Astrolabe Book*, Ibn Ezra not only alludes implicitly to his *Sefer haLuḥot*,[191] but also explicitly directs the reader several times to consult two still non-existent astrological treatises: *Sefer haMishpaṭim,* that is the *Mishpeṭei haMazzalot*, and *Sefer haMoladot*.[192] Also, from within the third version of *Keli haNeḥoshet*, Ibn Ezra refers, on the one hand, to the *Sefer haLuḥot*, but on the other hand, refers also for the first time to the emblem of his *astrological encyclopaedia*, the *Reshit Ḥokhma*, at this stage still a non-existing treatise.[193] On the other hand, the *Keli haNeḥoshet* is referred to from within several of Ibn Ezra's astrological works, such as from the first version of *Sefer haṬe'amim* and the second version of *Sefer ha'Olam*.[194]

(g) The reconstruction of the scientific corpus produces an additional insight, which illustrates a remarkable feature of Ibn Ezra's works. It turns out that the above-mentioned two-part division of Ibn Ezra's scientific corpus is not only a matter of distinct subject areas but also a chronological partition. From the sorting of Ibn Ezra's scientific corpus by chronological order it emerges that all of the four first scientific works Ibn Ezra composed at the beginning of his career as writer of scientific treatises in Italy – *Sefer haMispar*, *Sefer Ṭa'amei haLuḥot*, *Keli haNeḥoshet, Sefer ha'Ibbur* – belong precisely to the first section, which was designed to develop mathematical and astronomical skills. Only afterwards, mainly in Provence though beginning in Northern Italy, Ibn Ezra turned his attention to the second section of his scientific corpus, which contained mainly seven treatises written in a concentrated effort as part of an *astrological encyclopaedia.*

(h) The same chronological feature described in the last paragraph is also highly suggestive, in a quite wider scenario, of some central traits in the process of reception of Greek-Arabic sciences in Western Europe. We may assume that the above-mentioned particular chronological ordering of the scientific corpus was not a product of Ibn Ezra's will, whose pen was his main means of subsistence and who wrote mainly to satisfy the

[191] Edelman, *Keli haNeḥoshet* (first version), p. 29.

[192] Edelman, *Keli haNeḥoshet* (first version), pp. 9, 14, 25, 29, 30, 31.

[193] *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fols. 59^{v}, 60^{r}, 65^{v}, 66^{r}, right col.

[194] *Sefer haṬe'amim* (first version) Paris, BNF, MS Héb. 1056, fol. 45^{v}; of *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fol. 93^{v}.

demand of his disciples. If this is true, the scope of Ibn Ezra's scientific corpus and its chronological ordering may be envisaged as reflecting not only the priorities of the local European learned audiences, Jewish and Christian as well, but also the way by which the Greek-Arabic sciences made their impact on a confused Europe. Latin and Jewish scholars, confused and perplexed after the initial impact of Greek-Arabic sciences, had in this initial stage poor tools and little knowledge to understand astronomical and mathematical theories. Therefore, they gave precedence to the understanding of problems involved in the mere practical handling of scientific tools and instruments: the astrolabe and the astronomical tables enabled simple and quick solutions to astronomical and astrological technical problems, in clear contrast with the difficulties and cumbersomeness involved in solving the same problems with sheer geometric and mathematical tools. Also, they were highly interested in the practical and immediate benefits arising from astrological forecasting, for whom the practical handling of astronomical tables and the astrolabe were crucially important. This assertion may be seen as corroborated by the scope and inner organization of Ibn Ezra scientific corpus, composed mainly of recurrent versions of treatises teaching the use of astronomical tables and the astrolabe, written in Hebrew as well as in Latin, and especially of an *astrological encyclopedia*.[195]

2. The scientific book of Ibn Ezra, its aims and peculiar traits

If a common factor is required, reflecting the most essential aim and most representative aspects of Ibn Ezra's scientific book, a close to true answer may be that Ibn Ezra's scientific book was designed mainly as a *textbook*, planned to provide his disciples with easy access and understanding of terms, concepts and general principles related to astrology, astronomy and mathematics, and particularly intended to teach the use of technical-theoretical tools and instruments. This assertion may be justified, *inter alia*, on the basis of Ibn Ezra's own explicit and

[195] For a discussion of the impact of Islamic astronomy on Latin scholars, and especially about the decisive influence exerted at this stage by the astrolabe and the astronomical tables, see O. Pedersen, "Astronomy", in D. Lindberg (ed.) *Science in the Middle Ages* (Chicago, 1978), pp. 308-14.

relevant remarks: He is accustomed to admit expressly that when shaping some conceptual or formal idea or trait of his books, he is guided by the need or wish *to make the study easy for the students*. Thus, for example, in the first version of *Sefer haṬe'amim*, as usual in astrological books, the planets' astrological qualities are described implementing physical attributes of sub-lunar bodies (such as saying that Sun is hot, or that Saturn is cold), infringing thereby basic principles of Aristotelian physics. But Ibn Ezra is aware of the fault. Therefore, he feels himself obliged to apologize for such an inexact expression, and so he goes on to explain that "you have to understand that all I said (about the planets) was meant to convey the idea that they (the planets) *generate* cold and heat, and if it was expressed in such a crude way, it was done only because of the need *to facilitate the understanding of the students*".[196]

Also in the shaping of the scientific book Ibn Ezra was led by didactic criteria. Thus, just before beginning the central part of *Sefer haMoladot*, which was dedicated to interpreting the characteristics of the astrological houses, Ibn Ezra saw fit to add a methodological remark, and so wrote that "*only in order to facilitate the learning of the students* I chose to follow the method of the astrologers, and therefore I decided to discuss the issue of the Nativities by dealing (separately) with the twelve houses".[197] A central feature that characterizes Ibn Ezra's scientific books and emphasizes its didactic nature is the inclusion of *solved exercises*, which illustrate and make easy to understand some theoretical doctrine. In this context, it is noteworthy that such *solved exercises* are numerous in Ibn Ezra scientific books. Moreover, Ibn Ezra provided these *solved exercises* with a special external sign that make them easy to detect: He used to begin them with the words "next I will present you an 'illustration' (Hebrew: *dimyon*)" and immediately after he goes on to present the solution of a problem which usually involves some calculations.[198]

[196] *Sefer haTe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 37^{r}.

[197] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 48^{r}. The same concern may be detected in *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fol. 63^{v}: "and I, Abraham say that… in order that the student will not be confused, I was obliged to divide this treatise into twelve chapters".

[198] See examples of solved exercises in the following places: Edelman, *Keli haNeḥoshet* (first version), pp. 40-1; *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fols. 63^{r}, 96^{r}-96^{v}; *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fols. 83^{v}-84^{r}; *Reshit Ḥokhma*, ch. III, p. xxxix; ch. VII, p. lviii; *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 53^{v}.

We come to the conclusion that Ibn Ezra's scientific books are mainly *textbooks* or *reference books*, aimed chiefly at conveying to the layman conventional scientific knowledge. Naturally, as such, Ibn Ezra's books are endowed with a clear didactic character and do not have any pretension of innovation. The bulk of the included scientific material is brought, explicitly or implicitly, as paraphrases or quotations of previous sources. In this context, Ibn Ezra's treatises are an excellent means of learning about scientific data and sources available in al-Andalus in the twelfth century or earlier, and especially of identifying the most prominent astronomers and astrologers.[199] Nevertheless, we have to do justice to the author. Although these works are mainly *textbooks*, we can still discern in them features that clearly reveal the unique contribution and personality of the author. We turn now to present these special features.

(a) Even in these scientific and technical textbooks it is possible to detect Ibn Ezra's inclination, we may rather say his obsession, to comment on and explain everything that falls into his hands, a trait that is highly reminiscent of the fact that he excelled chiefly as a biblical commentator. An unmistakable expression of this feature is that he wrote two different versions of *Sefer haṬe'amim*, a treatise openly aimed at explaining and commenting on the astrological terms and concepts included in *Reshit Ḥokhma* (see above p. 121), Ibn Ezra's chief astrological treatise. Another expression of the same trend is that Ibn Ezra does not content himself in some places with a merely rudimentary and basic presentation of some doctrine but goes on to add some rational explanation, beyond what his sources were ready to convey on the same topic. Thus, for example, in the first version of *Sefer haMoladot*, Ibn Ezra paraphrases Claudius Ptolemy, who in *Tetrabiblos* (iv, 10) dealt with the seven ages of man, each of them allotted to a planet, and wrote that the moon takes over the first four years of infancy. But Ibn Ezra was clearly not content with this rather simple observation; hence he added the following observation: "So wrote Ptolemy, but he did not provide any reason for this division. Here is the reason:

[199] See, for example, the list of scientists provided by Ibn Ezra at the end of the introduction he attached to his translation of *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī* [Goldstein, *Muth.*, p. 300], which includes the following prominent scientists: Ḥabash the Arab (al-Ḥāsib), Yaḥyā ibn Abī Manṣūr, al-Marwādhī, Ibn al-Muqaffa', al-Ṣūfī, Ya'qūb al-Kindī, Thābit ibn Qurra, Ibrāhīm al-Zarqāl, al-Battānī, Ibn al-'Istī, Ibn al-A'lam.

the moon takes over until the boy is weaned, so that four years will elapse over him, each year under the power of one zodiacal sign, until four zodiacal signs will be completed, each of them corresponding to each of the four natural elements".[200]

(b) Even although, as said above, the scientific material is brought in these textbooks as paraphrases or quotations of previous sources, Ibn Ezra avoids as much as possible a narrow and unilateral presentation of issues. Thus, in his *Sefer haMoladot*, before coming to deal with the central and technical issues of the treatise, Ibn Ezra added the following remark: "I will next mention all that the ancient sages have tested and examined (on this subject); but because countless books dealing with astrology (in Hebrew: *ḥokhmat hamazzalot*) are available, and since some of them include observations which are contradicted by common sense, and in view of the fact that the astrologers are divided by divergent opinions, I was obliged in this book to present everything that is clear and all that in which there is agreement in the opinions of the old sages, and with which I myself have experimented numerous times."[201] Ibn Ezra kept his promise and actually implemented in most of his scientific books the two methodological observations he mentioned in the last passage: first, to present the achievements of his predecessors; secondly, to add also his own ideas and the results of his own experimentation.

Consequently, Ibn Ezra is prone to convert the presentation of some specific subjects into an arena where scientists and scientific schools belonging to different times, nations and religions meet together and clash on some scientific issue. The most outstanding example is that related to establishing the length of the tropical year, a debate in which Ibn Ezra brings together the best of the scientists of India, Persia, Greece and Islam. It must

[200] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 52^{r}. See other examples of the same pattern in the following places: Fleischer, *Sefer haMibḥarim* (first version), p. 9. Ben Menachem, *Sefer haṬe'amim* (second version), p. 14; *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fol. 68^{v}; *Sefer ha'Olam* (second version), Rome, Vatican MS Ebr. 477, fols. 90^{r}-94^{r}; *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fols. 84^{v}-86^{v}; *Reshit Ḥokhma*, ch. X, p. lxxv.

[201] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 47^{r}. Cf. also what Ibn Ezra wrote at the end of the first chapter of *Reshit Ḥokhma*, ch. I, p. viii: "I shall mention in this book all that in which there is agreement in the opinion of the ancient Babylonians and the wise men of Persia, India, and Greece, whose chief is Ptolemy… until my book will be complete and there will be no need for any other book besides it in the introduction to this science."

be borne in mind that this is an issue involving not only astronomical parameters[202] but also very strong astrological[203] and religious overtones.[204] Other specific scientific subjects which are similarly treated as academic debates by Ibn Ezra are, *inter alia*, the different values of the solar declination,[205] the relation between the diameter and the perimeter of the circle,[206] the controversy related to the position of the spheres of the Sun, Venus and Mercury,[207] the question whether the sun apogee is static or is moving,[208] the different explanations of the fixed stars motion.[209] It is in the context of these disputations that Ibn Ezra sometimes fulfills the second of the above-mentioned promises,

[202] On this subject see, for example, Millás, *Tablas*, pp. 74-6: "Huius motus quantitas in 365 diebus et quarta parte diei perficitur, quam fraccionem diei philosophi egypci neglexerunt… Ptholomeus medium cursum solis composuit… Greci vero et omnes qui noticiam computacionis suorum annorum a diebus Alexandri vel Christi sumunt … Sapientes vero Indie secundum dies mundi, quos dies apellant dies de Scindehind… Sapientes vero persarum asserunt additamentum supra 4am diei esse 115m partem diei… Philosophi sarracenorum geometrie periti discipline secundum raciones Ptholomei et per instrumenta Ptholomei multa de celestibus probaverunt." Cf. similar reports in the following additional places: Millás, *Tablas*, pp. 82-83; *Keli haNeḥoshet* (third version), Warsaw, MS Pinsker 26, fol. 59^{r}, right col.

[203] The problem of finding the length of the tropical year is analogous and closely related to that of finding the exact time when the sun (in a geocentric cosmos) enters the sign of Aries, a crucial parameter in universal astrology. See the following places, where Ibn Ezra deals with this issue of the length of the year, regarded as a clearly astrological problem but involving an *international* debate: *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 59^{r}-59^{v}; *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fols. 81^{r}-81^{v}; *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 37^{v}-38^{r}; Ben Menachem, *Sefer haṬe'amim* (second version), pp. 34-5, 40, 41-2.

[204] The problem of finding the length of the tropical year is crucial in establishing the soli-lunar Hebrew calendar. Therefore, Ibn Ezra handles the problem not only in his *Sefer ha'Ibbur* but also in his exegetical commentaries and theological monographs, in a way reminiscent of that implemented in his scientific works. See Halberstam, *Sefer ha'Ibbur*, pp. 8 (a), 9 (b); cf. especially commentary on *Leviticus* 25:9; long commentary on *Exodus* 12:2, 34:21; M. Friedlander (ed.), *Igeret haShabbat* in *Transactions of the Jewish Historical Society of England*, 2 (1894/5), pp. 64-5.

[205] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fols. 81^{r}-81^{v}; Millás, *Tablas*, pp. 77, 92, 93.

[206] Silberberg, *Sefer haMispar*, p. 44; Millás, *Tablas*, pp. 79, 124; for a comparative examination and a discussion of this subject see Sela, "Puntos de contacto", pp. 39-47.

[207] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fols. 43^{r}-43^{v}; Ben Menachem, *Sefer haṬe'amim* (second version), p. 9; *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fol. 74^{v}; Fleischer, *Sefer haMe'orot*, p. 7; Millás, *Tablas*, pp. 120-2.

[208] Millás, *Tablas*, pp. 77-8; 91-2; Goldstein, *Muth.*, p. 300 (Ibn Ezra's introduction); *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 91^{v}.

[209] Millás, *Tablas*, pp. 78, 81-83, 94; *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 81^{v}; Halberstam, *Sefer ha'Ibbur*, p. 10 (a).

when he presents his own personal contribution in two main ways: on the one hand, Ibn Ezra allows himself to present his own view, as part of the *quasi academic* debate, generally in a compromising manner or giving precedence to one of the presented opinions,[210] but sometimes expressing disagreement and presenting an independent opinion as well;[211] on the other hand, Ibn Ezra makes express mention of empirical experiments that he carried out in order to corroborate or refute some of the arguments referred to in his scientific treatises.[212]

An additional quality that characterizes the scientific writings of Ibn Ezra is the extremely sharp criticism with which he sometimes attacks his predecessors, the most famous Greek and Arabic scientists. Thus, Ibn Ezra does not find a better way to begin the first version of *Sefer ha'Olam* than with a harsh attack on Abū Ma'shar's *Kitāb al-qirānāt*, his main source in universal astrology. These are the first words of this treatise: "If you have by chance found the book of Abū Ma'shar on the planets conjunctions, you would surely not like it and you should not observe its rules, since Abū Ma'shar relies on the mean motion of the planets and there is no other sage that agrees with him, for the correct motion of the planets refers to the zodiacal sphere".[213] Ibn Ezra also castigates Māshā'allāh – also one of his main astrological sources – in the first version of *Sefer haMibḥarim*, by applying arguments grounded on common sense and rational explanations.[214] Ibn Ezra criticizes also Ḥanoch (Hermes), who embodies several hermetic traditions, by asserting that he was accustomed to present his ideas without

[210] Ben Menachem, *Sefer haṬe'amim* (second version), p. 9; *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 49^{v}, 53^{v} 54^{v}; Millás, *Tablas*, pp. 77, 80, 81, 82, 93.

[211] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 39^{r}; Millás, *Tablas*, p. 92; *Reshit Ḥokhma*, ch. VII, p. lvii.

[212] Ibn Ezra uses not only general expressions, implying loosely that he carried out some empirical experiment, but also introduces explicit assertions, where he reports the use of the astrolabe in order to undermine some argument. See, for example *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fols. 47^{r}-47^{v}. See also: *Sefer haMoladot*, fol. 49^{v}; *Mishpeṭei haMazzalot*, Rome, Vatican MS Ebr. 477, fol. 73^{v}; *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 85^{v}; *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fol. 63^{r}; Fleischer, *Sefer haMibḥarim* (first version), pp. 12,14; Ben Menachem, *Sefer haṬe'amim* (second version), p. 36.

[213] *Sefer ha'Olam* (first version), Paris, BNF, MS Héb. 1056, fol. 80^{v}. See also fol. 85^{v}. Nevertheless, in other places Ibn Ezra regards positively the work of Abū Ma'shar. See, for example: *Sefer haShe'elot* (first version), Paris, BNF, MS Héb. 1056, fol. 62^{v}; *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 36^{r}.

[214] Fleischer, *Sefer haMibḥarim* (first version), p. 12.

reasons, that is without rational explanations.[215] Ibn Ezra's criticism of his colleagues sometimes turns to very sharp expressions, as for example when in *Sefer haMoladot* he wrote as follows: "the sage Al Abzidag brought in his book some tables, which were called *ovens* (תנורים) and were intended to find out the life expectancy of the newborn; but they deserve to be *burned* in the *fire ovens* (תנורי אש), since they the are completely wrong".[216]

Particularly remarkable is the way in which Ibn Ezra criticizes Claudius Ptolemy, his chief and most admired source, the sole source that Ibn Ezra dared to introduce explicitly in his biblical commentaries in order to strengthen some arguments.[217] In his criticism, Ibn Ezra opted for drawing a sharp distinction between Ptolemy's astronomical and astrological contribution. Thus, he wrote the following words in the first version of *Sefer haṬe'amim*: "I will now give you a rule: everything that you may find of Ptolemy that deals with the spheres is excellent and nothing is available that surpasses it, but his assertions related to the judgments of astrology do not befit his wisdom".[218] But even some parts of the non-astrological and sheer astronomical output of Claudius Ptolemy came as well under Ibn Ezra's criticism. Thus, in the *Liber de rationibus tabularum*, Claudius

[215] Fleischer, *Sefer haMibḥarim* (first version), p. 14.

[216] *Sefer haMoladot*, Paris, BNF, MS Héb. 1056, fol. 50^{r}.

[217] Claudius Ptolemy is explicitly mentioned and referred to on three outstanding occasions in Ibn Ezra's biblical exegesis. (a) In the Commentary on *Leviticus* 25:9, where Claudius Ptolemy stands by Moses, in order to provide astronomical data related to the length of the year as an argument against the Karaite Yehuda haParsi; (b) In the Commentary on *Amos* 5:8, where Ibn Ezra makes use of two of the main doctrines appearing in Ptolemy's *Almagest* – that there are two different motions in the heavens (*Almagest* I, 8), and that the sphere of the fixed stars has a very slow motion (*Almagest* III, 1) – in order to prove that the biblical stars *khsil* and *khima*, referred to in Amos 5:8, were each created in each of the equinoxes, but that they subsequently moved to other places in the skies; for a discussion of this commentary, see Sela, *Astrology and Biblical Exegesis*, pp. 308-14; U. Simon, *Abraham Ibn Ezra's Two Commentaries on the Minor Prophets* (in Hebrew), (Ramat Gan, 1989), pp. 209-215. (c) In the Long Commentary on *Exodus* 33:21, where Ibn Ezra identifies Claudius Ptolemy with *Ptolemy the King*, who in Ibn Ezra's opinion promoted the translation of the *Torah* into Greek in order to "steal" some astrological secrets immersed in the biblical text. For a discussion of this commentary and also of the myth converting Claudius Ptolemy into *Ptolemy the King*, see Sela, *Astrology and Biblical Exegesis*, pp. 37-62.

[218] *Sefer haṬe'amim* (first version), Paris, BNF, MS Héb. 1056, fol. 39^{r}. In another place in the same treatise, see *Sefer haṬe'amim,* fol. 35^{r}, Ibn Ezra dares to raise the assumption that Claudius Ptolemy was not the actual author of *Tetrabiblos*, asserting that this book includes arguments which completely contradict any rational explanation and are unsupported by empirical experimentation.

Ptolemy is not spared for having committed in his book *Algeraphie* (that is, the Arabic transliteration of *Geography*) some inaccuracies related to the geographic parameters of the city of Cordoba.[219] Besides, in the introduction to the translation of *Ibn al-Muthannā's Commentary on the Astronomical Tables of al-Khwārizmī*, Ibn Ezra wrote that Ptolemy's astronomical tables in the *Almagest* are "useless and contradicted by observation", even though he goes on to explain that the errors were due in fact to his predecessors.[220]

[219] Millás, *Tablas*, p. 79: "et invenimus in libro Ptholomei, qui est Algeraphie, quod longitudo Cordube est 9 graduum, latitudo vero 36 graduum, multis vero temporibus et diversis probata est eius longitudo, eclipsi solis et lune, 27 graduum, et latitudo, racione perfecta, 37 graduum et 30 minutorum, et in fine ostendam unde error contingit, nam longitudo et latitudo terre nec augescit nec decrescit."

[220] Goldstein, *Muth.*, pp. 300-1, 149-50: "The tables in the *Almagest* are useless and contradicted by observation, since the apogees are not fixed with respect to the constellations. Ptolemy himself did not commit these errors, which are due to his predecessors."