Medieval Jews displayed a great\vivid interest in the study of astronomy. They contributed to the field in various languages and played an active role in the transmission of astronomical knowledge to Latin Europe. Their ~~astronomical~~ work covers diverse astronomical topics: the structure of the heavens and Earth, planetary motion, lunar and solar eclipses, star catalogues, calendric problems, instructions for using observational instruments, the length of the solar year, and so on. The following entry sketches the (main) contours of the astronomical literature written by Jews in the Middle-Ages, focusing mainly on Hebrew astronomical treatises and their book history.

While some discussions of astronomy can be found in Hebrew treatises that were written before the rise of Islam or in its very beginning (see Sarfatti 1968:52–57), early astronomical works that are more representatives of Jewish culture are those that\which were composed under\in (the) Islamic region\rule. Already in the early period of Islam, and especially after the Abbasid revolution, Jews who lived in the Islamic lands managed to successfully integrate into their cultural environment, and to participate in\(and contribute to) the cultural and scientific efflorescence of the Islamic world. This was possible, among other things, thanks to the willingness of Muslims to cooperate in scientific matters with their non-Muslim counterparts. Scientists from different religions worked together in astronomical matters, (usually) under the sponsorship of the Caliphate. This\That was the case of Sanad ibn ʿAlī, a converted Jew who was a member of al-Maʾmūn’s group of astronomers (reigned 813–833). Sanad drew-up a now-lost set of astronomical tables and constructed a number of observational instruments for the Abbasid caliph and his fellow astronomers (Goldstein 2001:24–26). In the following century, Dunash ibn Tamīm, who served the Fatimid Caliph al-Manṣūr in North Africa, wrote a number of works devoted to astronomy. These works are now lost, with the exception of a treatise on the armillary sphere, which is preserved in a single manuscript.

The Jewish integration into the Islamic society reached its peak in Al-Andalus between the 10th and the 12th centuries. Perhaps the quintessential representatives of this phenomenon are the physician Ḥisdai ibn Shaprut (d. c. 970) and the (famous) Hebrew poet Samuel Ibn Nagrela (ha-Nagid, d. 1056). The former was a diplomat at the court of Abd al-Raḥman III, while the latter became the vizier of Granada and commanded a Muslim army. Jewish astronomers, too, were well assimilated in the general Andalusian elite. Ṣāʿid al-Andalusī’s group of astronomers included not only the outstanding Muslim astronomer al-Zarqallū, but also Jews, which, unfortunately, we are not familiar with their names. Jews continued to be involved in astronomical projects under different sponsorships even after most of Spain had come under Christian control. Isaac ben Sid and Judah ben Moses ha-Kohen prepared the Castilian Alfonsine Tables (c. 1272) under the patronage of Alfonso X, and Jacob Corsuno drew-up the Tables of Barcelona (c.1381) at the behest of Pedro IV.

In the 12th century, a profound\striking cultural shift (began to?) occurred in the Jewish communities of Latin Europe. Until then, Jews who lived\resided in Christian lands were almost exclusively engaged with the canonical Jewish texts, notably the Torah and the Talmud, and had no access to the sciences. Now, due to new historical and social circumstances (enumerating them will be beyond the scope of this entry), Jewish scholars knowledgeable in Arabic began to transmit (the) Greco-Arabic knowledge to their brethren who lived in Christian lands, and made it accessible for these Jews for the very first time.

The pioneer of the\this new ‘medieval Hebrew science’ was Abraham Bar Ḥiyya (c. 1065–c. 1136). He wrote several works summarizing the sciences, apparently at the request of Jews from the Midi. Two of his works are of our special interest. The first, *Ṣurat ha-*ʾ*areṣ*, is a non-technical textbook, which provides its readers with the basics of Ptolemaic astronomy in a lucid manner. From a book history perspective, it seems that it became particularly popular in the Middle-Ages. The treatise is preserved in more than 65 manuscripts, and a summarized version of the work is extant in at least ten. A few printed editions were made\published, the earliest in 1546. Gersonides (1288–1344), the eminent philosopher-scientist, possessed a copy of the treatise in his private library (Weil 1991:46); and according to the book-list prepared at the end of 1595 at the request of (the?) Bishop Francesco Gonzaga, the Jews of Mantua had\held\possessed seven manuscripts\copies of the work (Baruchson 1993:166).

The second work, *Ḥešbon mahalak̲ot ha-kok̲avim*, is the canons of Bar Ḥiyya’s astronomical tables, also\commonly known as *Luḥot ha-naśi*ʾ. Although there is not a single manuscript containing\including both, it was recently argued that the two were (originally?) supposed to be distributed together as a (one?) single composition (Garshtein 2016:75). *Ḥešbon* is extant in at least 19 manuscripts, and was published by José María Millás Vallicrosa in 1959. Vallicrosa’s edition, though, lacks of\omits Bar Ḥiyya’s star catalogue, which was recently edited, translated, and studied. (Sela 2016–2017. See also Goldstein 1985b). *Ḥešbon* is mentioned\brought in a few medieval book-lists, and it also appears in the curricular program embedded in Joseph ibn Kaspi’s ethical will (Abrahams 1926:144). *Luḥot ha-naśi*ʾ are the first astronomical tables written in Hebrew, and are largely drawn from the tables of al-Battānī. In addition to the tables drew-up by Bar Ḥiyya, within\in much of its 14 extant manuscripts we find tables and texts that were originally composed by other scholars between the 12th and the 15th centuries. It is noteworthy that some manuscripts of both, *Ḥešbon* and *Luḥot*, contain\include notes and additional tables which are attributed to Abraham ibn Ezra (Langermann 1999:16). Some of these notes and tables were recently published and examined in-depth (Garshtein, forthcoming A).

Abraham ibn Ezra (c. 1089–c. 1161) was a prolific intellectual who almost exclusively wrote in Hebrew. He has made a significant contribution to the field of astrology and is considered to be an important transmitter of Greco-Arabic knowledge to Latin Europe. Unsurprisingly, his intellectual interests extended to astronomy as well. He carried out astronomical observations in Pisa and Lucca (Sela 2010:166), and composed three Hebrew ~~versions~~ and one Latin version(s) of *Sefer* *Keli ha-neḥošet*, in which he describes the physical configuration of the Astrolabe and explains its varied uses (Sela 2003:28–36). In addition, Ibn Ezra composed three versions of his astronomical tables, and four versions of their canons. Unfortunately, with the exception of one Latin version of the canons (published by Vallicrosa in 1947), Ibn Ezra’s astronomical tables and their canons are now lost. In his latter\later years, Ibn Ezra translated into Hebrew Ibn al-Muthannā’s commentary on the astronomical tables of al-Khwārizmī (Goldstein 1967).

During the following century, a**stronomical treatises of much of the best authorities were translated into Hebrew**. One eminent\prominent figure in this matter is Jacob Anatoli (c. 1194–1256), who enjoyed the patronage of Frederick II and held an intellectual relationship with his court-fellow Michael Scot. At the first half of the 1230s, Anatoli translated Ptolemy’s *Almagest*, Al-Farghānī’s *Elements*, and Averroes’s *Compendium of Ptolemy*’*s Almagest*. Anatoli’s Hebrew translation of Al-Farghānī’s *Elements* became particularly popular in\among medieval Jewish circles. The text, which is extant in at least 39 distinct manuscripts, was summarized and commented during the Middle-Ages. It is also mentioned in medieval book-lists and curricular programs, and was frequently quoted by later\latter Jewish scholars such as Levi ben Abraham and Gershom ben Solomon. Another Jewish intellectual who resided at the court of Frederick II and contributed to the transmission of astronomical knowledge to the Hebrew-reader was Judah ben Solomon ha-Kohen. In 1247, he translated his encyclopedic composition *Midraš ha-ḥok̲mah*, which includes, among other things, close paraphrases of Ptolemy’s *Almagest* and Al-Biṭrûjî’s *Principles of Astronomy*. Al-Biṭrûjî’s work was later translated by Moses ibn Tibbon (1259) (Goldstein 1971). Ibn Tibbon also translated Geminus’s *Introduction to the Phenomena* (1246), Averroes’s Epitome of Aristotle’s *De caelo et mundo* (c. 1248), and Jābir ibn Aflaḥ’s *Correction of Ptolemy*’*s Almagest* (1274). The latter work was also translated by Jacob ben Mak̲ir, and then revised by Samuel ben Judah of Marseilles in 1335. More\other astronomical works were translated during the 13th century: Pseudo-Avicenna’s *De caelo et mundo*; Averroes’s Middle commentary on Aristotle’s *De caelo*; and al-Haytham’s *On the Configuration of the World*. Translations of astronomical texts, such as Ptolemy’s *Planetary Hypotheses*, continued to appear in the 14th century as well.

As a result of the reinforcement\enhancement of\in the translational activity, Hebrew-reading scholars finally had access to most of the (major) Greco-Arabic astronomical texts, and in turn composed new astronomical treatises. The astronomical sections of the encyclopedic compositions written by Levi ben Abraham and Gershom ben Solomon (*Livyat ḥen* and *Šaʿar ha-šamayim*, respectively), are almost exclusively based on the outputs of the Hebrew translation movement. Other\~~another~~ encyclopedic composition, *Sefer ha-Kolel* (1256), contains numerous quotations of Abraham Bar Ḥiyya’s and Abraham ibn Ezra’s works (Sela 2014).

Jews who resided in Christian Europe also wrote original and innovative treatises on astronomy. The most conspicuous\prominent\eminent character\figure in this matter is Gersonides, perhaps the most talented and original Jewish astronomer in the Middle-Ages. For him, an astronomical theory that helps one determine the position of the planets at any given time was insufficient. He was a realist who sought\aimed to understand true nature and to establish an astronomical theory that is compatible with natural science (principles?) and, at the same time, fits empirical evidence. Therefore, he believed that astronomical investigation “can only be undertaken in its perfection by one who is both a mathematician and a natural philosopher.” (Goldstein 1985:23). He did not hesitate to criticize great authorities, including Ptolemy. One example in this matter is Gersonides’s arguments against the existence of epicycles, which are based on natural science principles, observations, and geometry (Mancha and Freudenthal 2005). Accurate astronomical observations were significantly important to Gersonides. He carried out no less than 82 observations of his own, tested and used observational instruments, and even designed new ones, such as Jacob Staff and Ḥug šamayim (an armillary sphere of his own design. Sela 2017:324–332).

The astronomer, then, must take physical and philosophical principles into consideration. Therefore, one should not be surprised to find that Gersonides’s main astronomical work – also\commonly known as (the?) *Astronomy* – is not an independent one, but forms an integral part of his great philosophical work *Milḥamot ha-šem* (book 5, part 1). Nevertheless, his *Astronomy* is now preserved in manuscripts apart from the rest of Gersonides’s *magnum opus*. It is also excluded\omitted from all printed editions of *Milḥamot ha-šem*, and, in fact, only some of its 136 chapters have been published. Although Gersonides considered his *Astronomy* as incomplete, he collaborated with Petrus de Alexandria in translating it into Latin. In 1342, Gersonides dedicated a revised version of chapters 4 to 11 of the Latin translation of his *Astronomy* to (the) Pope Clement VI.

Two 14th century treatises that survived in a relatively large number of manuscripts are *Yesod* ʿ*olam* of Isaac Israeli and *Luḥot* *ha-po*ʿe*l* of Jacob ben David Bonjorn. The first\former deals with the Jewish calendar; but provide much more astronomical details than other treatises in the genre. Noteworthy is Israeli’s reference to Al-Biṭrûjî’s astronomy (book 2, chapter 9). Except (for) its large number of extant manuscripts, the work was printed twice (Berlin 1777, Berlin 1846–1848). *Luḥot* *ha-po*ʿe*l* are Bonjorn’s tables for syzygies and eclipses. The work survived in at least 40 Hebrew manuscripts and is also extant in Latin, Catalan, and Greek versions (Chabás 1992:151–166).

Two eminent Jewish astronomers who were active in the 15th century are Judah ben Verga and Abraham Zacut. Judah wrote a number of astronomical works, in some of which he recorded astronomical observations he made in Lisbon in 1456–1457. His treatise *ha-Kli ha-*ʾ*ofqi* describes an astronomical instrument of his own invention (Langermann 1999:19–21). He also composed a work belonging to the genre of *hay*ʾ*a* entitled *Sefer Toledot ha-šamayim ve-ha-*ʾ*areṣ*; and drew-up a set of astronomical tables which are now preserved in two manuscripts (their canons are extant in a single manuscript) (Goldstein 2001b, 2004). A commentary on Al-Farghānī’s *Elements* is also associated with his name (Langermann 1999:23–25). Abraham Zacut (1452–1515) was born in Salamanca, but after the expulsion of the Jews in 1492 he roamed through Portugal, North Africa, and ultimately Jerusalem. In 1478 he composed *ha-Ḥibbur ha-gadol*, a Hebrew treatise consisting of astronomical tables and their canons. Three years later the work was translated into Castilian by Juan de Salaya in collaboration with Zacut himself. The influential work *Almanach Perpetuum* (first published in Leiria in 1496) is based on\contains Zacut’s tables; however its canons are different from those in the *Ḥibbur*. Two Arabic and one Ladino versions of the *Almanach Perpetuum* are also extant\exist. Zacut continued to compose sets of astronomical tables when he resided in North Africa and Jerusalem.