**The Mechanism of General Providence in Levi ben Abraham’s Astronomical-Astrological Book of *Livyat Ḥen***

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Toward the end of the thirteenth-century, the Provençal Jewish scholar Levi ben Abraham ben Ḥayyim (ca. 1235–ca. 1305) composed a voluminous treatise entitled *Livyat ḥen*.[[1]](#footnote-1) The composition was intended to provide its readers with a presentation of scientific, philosophical, and theological knowledge. *Livyat ḥen* was divided by its author into two distinct sections called *ʿammudim* (pillars). The first section treats general philosophy and sciences, and it consists of the following five books: logic; arithmetic and geometry; astronomy and astrology (in 40 chapters); natural science; and metaphysics. Of these five, only the astronomical-astrological book (hereafter, *Livyat ḥen*III) exists in full, and it is extant only in manuscript form.[[2]](#footnote-2) *Livyat ḥen*’s second *ʿammud* is dedicated to Judaism and theology, and thanks to Howard Kreisel's outstanding work, we now have an edition of the entire section.[[3]](#footnote-3)

As one might expect, Levi’s detailed discussion on providence is found in the theological section of *Livyat ḥen*.[[4]](#footnote-4) However, Levi also refers to providence in the first section of his treatise. In the twelfth chapter of *Livyat ḥen* III (hereafter, *Livyat ḥen* III:12), Levi identifies God’s general providence, or at least one aspect of it, with a natural mechanism that provides optimal thermal conditions for the existence of human life. According to Levi, this mechanism constantly offsets the impact of two distinct heat-generating processes, and by doing so it secures the persistence\ perdurability of the inhabited world. The mechanism, whose *modus operandi* will be described here in detail, is based on three scientific assumptions: (a) The Sun’s orbital circle is eccentric; (b) The heat generated by the Sun is the result of two distinct processes: the motion of the Sun and its sphere, and the reflection of Sun’s rays; (c) The inhabited part of the Earth is located solely in its northern hemisphere. While the mechanism itself is by no means Levi’s original notion, as it is borrowed from Averroes’ Epitome of the *Meteorology* known to Levi through Moses Ibn Tibbon’s Hebrew translation (ca. 1252), the identification of the mechanism with general providence is, as far as I know, indeed original.[[5]](#footnote-5) In what follows, I present a comprehensive study of this mechanism as it is described in *Livyat ḥen* III:12.

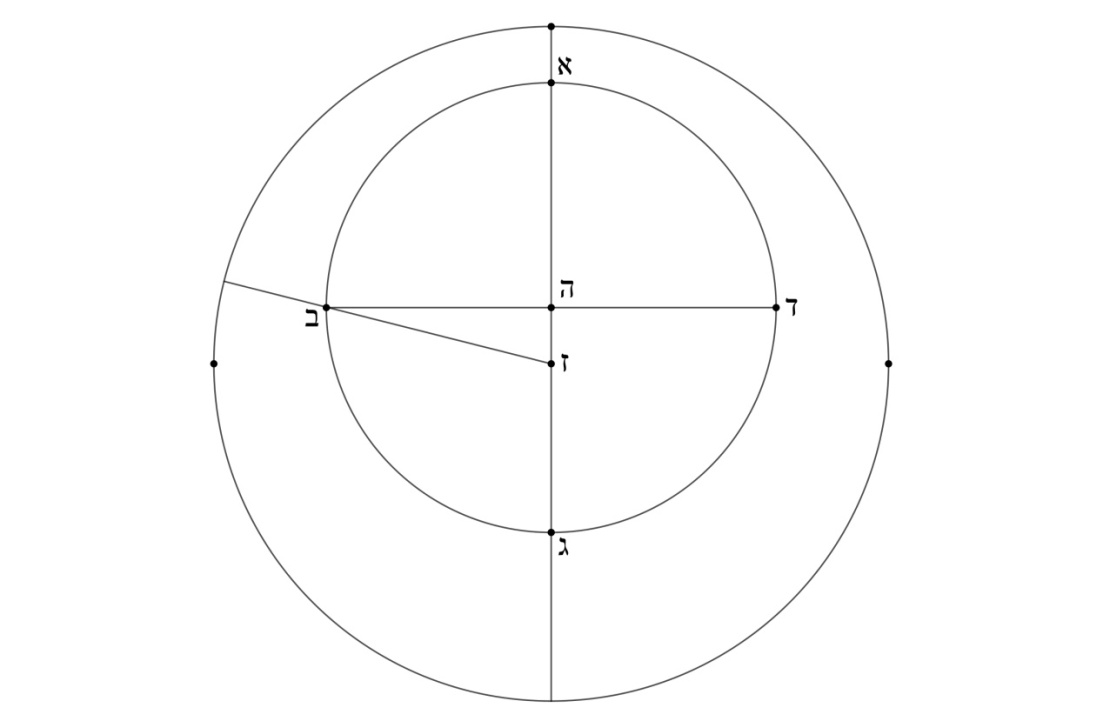
Before delving into Levi’s description of the mechanism, it seems necessary to present a short introduction to his treatment of the three assumptions (parts I-III). I will use this introduction to shed light on some of the contents and sources of *Livyat ḥen* III. Then, I will turn to present a close study of Levi’s mechanism, which is the main focus of this paper, and I will discuss whether or not, in Levi’s view, the heavenly bodies exist only for the sake of the sublunar ones (part IV). Thereafter, I will show that the mechanism was also known to Gersonides, and I will discuss his approach to it (part V). This part also offers a brief comparison of Levi’s mechanism with Gersonides’ notion of ‘stellar preservation’. Finally, on the basis of this research, I will suggest some insights into the character of *Livyat ḥen* III.

**I. The Solar Eccentric Model in *Livyat ḥen***

Chapter 18 of the third book of *Livyat ḥen* is dedicated to Levi’s solar theory, as well as to instructions for the use of an astrolabe for examining different aspects related to the Sun.[[6]](#footnote-6) In a manner similar to other scientific treatises rooted in the Ptolemaic tradition, Levi reports\indicates\notes that there are two optional models that can explain the motion of the Sun and the inequality in the lengths of the seasons – the eccentric model; and the concentric-deferent-plus-epicycle model – and exactly like Ptolemy and his successors, he justifies his preference for the eccentric model on the grounds of its greater simplicity.[[7]](#footnote-7)

According to the Ptolemaic solar theory, the center of the Sun’s orb is further north than the Earth, and therefore its apogee (the point where the Sun is at its greatest distance from the Earth) is further north as well. Levi makes an explicit reference to the position of the center of the Sun’s orb (“the Sun’s center is turned a little bit to the north”), as well as to the position of the Sun’s apogee (“the position of the Sun’s apogee is close to Cancer”).[[8]](#footnote-8) According to this model, the Sun travels at a constant speed; however, due to its varying distance from the Earth, it appears to travel at a constantly changing speed: the Sun reaches its highest speed at perigee and its lowest speed at apogee. Since the Sun’s apogee is in the northern part of its orbit, ~~we can conclude that~~ the Sun appears to be traveling more slowly in the northern part of its orbit, and more rapidly in its southern part.Levi attempts to explain this phenomenon by describing the Sun’s motion as it travels on its eccentric orb from the apogee to the end of the orb’s first quarter, and addressing the Sun’s position on the eccentric orb with respect to its appearance against the background of the fixed stars.[[9]](#footnote-9)

Levi probably assumed that this notion may be hard to understand without visualization. He then describes a geometrical diagram, which illustrates the solar eccentric model and the position of the Sun on its eccentric orb with respect to the position in which it appears to be.[[10]](#footnote-10) Levi’s description is probably based on a parallel description with a similar purpose found in Abraham Bar Ḥiyya’s *Ṣurat ha-ʾareṣ* (The Form of the Earth), one of the sources used by Levi for the composition of the third book of *Livyat ḥen*.[[11]](#footnote-11) Although we have Levi’s description, the geometrical diagram itself is absent from all surviving manuscripts of *Livyat ḥen* III. In one manuscript the scribe left an empty space for the illustration.[[12]](#footnote-12) Following Levi’s description, I have sketched the diagram (see figure A). Circle אבגד represents the Sun’s eccentric orb; the larger circle represents the “orb of the zodiac”; point ה is the center of the eccentric; point ז represents the center of the cosmos, i.e., the Earth; and points א and ג are the solar apogee and perigee, respectively. Levi explains that when the Sun travels from point א to point ב, it has indeed completed one quarter of its orb; however, for the observer, who stands on point ז and observes the Sun against the background of the orb of the zodiac, it seems like the Sun has not yet completed one quarter of its path.



**Figure A**

**II. Two Processes that Allow the Heating by the Sun in *Livyat ḥen***

According to the Aristotelian world-picture, the physical world is divided into two distinct realms: the sublunary, constituted of the four elements; and the supralunary, constituted of the so-called ‘fifth element’. The four qualities – heat, cold, dryness, and moistness – are attributed only to the terrestrial elements. For this reason, in Aristotelian perspective, it is impossible for the Sun to be hot. On the other hand, Aristotle and his successors agreed that some of the sublunar processes and phenomena are influenced by celestial bodies, and in particular\**notably** (prominent\manifest phenomenon?) the phenomenon of heat and its obvious empirical connection to the Sun. This raises a crucial problem: how can the Sun, which has no terrestrial qualities, heat the Earth?[[13]](#footnote-13) Aristotle was well aware of the problem, and suggested two distinct solutions [**to it?**] (which by itself testifies to\emphasizes his difficulty in explaining the phenomenon).[[14]](#footnote-14) However, it seems that his explanations were unsatisfactory to his successors. Medieval scholars returned to this question time and time again, to provide it with a better solution.[[15]](#footnote-15) At the beginning of *Livyat ḥen* III:12, Levi discusses this problem, offering two different processes that allow the heating by the Sun:

חום הכוכבים ובפרט השמש, אעפ"י שאינם בעלי איכויות כמו שאמרנו, ואינם חמים ולא קרים, סבת חממם הוא התנועה או האורה. וזה כי התנועה תוליד חום ותעיר אותו כדרך שנראה בדברים רבים, כמו שיראה בחץ המורה שיותך העופרת. וכן מסגולת האור לחמם בהתהפכות הניצוץ. [...] וזו הסבה יותר חזקה ומיוחדת. ולזה יחממו השמש והכוכבים יותר משאר חלקי הגלגל. [[16]](#footnote-16)

The heat of the stars, and particularly the Sun: although they [= the stars and the Sun] have no [inherent] qualities, as we have said [above], and are neither hot nor cold, the causes for their generation of heat are [their] motion and [their] light. And that is because motion generates heat and stimulates it, as is evident in many cases, for instance it is apparent in a launched arrow in which the lead [arrowhead] melts. And also it is the special quality of light to generate heat when its rays are reflected. […] And this [second] cause is stronger and more special [than the first]. And this is why the Sun and the stars generate more heat than [any] other part of the sphere.

This paragraph, and what follows it, is based on Averroes’ Epitome of *On the Heavens*, known to Levi through Moses Ibn Tibbon’s Hebrew translation (ca. 1248).[[17]](#footnote-17) Here Levi abridges the Epitome’s **words**, and interestingly omits Averroes’ notion that the warming effect of the stars’ light is produced by virtue of a “divine power”.[[18]](#footnote-18) However, he adopts Averroes’ notion that not only the Sun but all stars are responsible for the generation of heat.

Two processes, then, allow the heavenly bodies to generate heat: (a) their motion; and (b) the reflection of their rays of light. However, Levi does not provide us with a lot of details on the first process: What is the cause of the heating effect of motion? Is motion the *per se* cause of heat or an accidental cause?[[19]](#footnote-19)What are the factors, according to Levi, for the generation of heat by motion? Does the distance between the moving celestial object and the Earth play any role in the amount of heat caused by the motion of the heavenly bodies? Is the heat caused by motion affected by the speed of the moving object? Is there any difference between the amount of heat generated by the Sun’s sphere and the amount of heat generated by the Sun itself? Although Levi does not provide explicit answers, over the course of chapter 12 it becomes clearer that both, the speed of the celestial body and its distance from the Earth, are crucial factors of the first process;[[20]](#footnote-20) and that exactly like in Averroes’ Epitome of *On the Heavens*, although both the Sun’s sphere and the Sun itself generate heat by their motions, the Sun’s motion has a much greater impact.[[21]](#footnote-21) Levi assumes that at **a~~\any~~** given time, this process has the exact same impact on all different geographical locations. His assumption is based on the notion that the Earth is like a point in relation to the Sun’s orb, and therefore at any given time the distance between the Sun and each part of the Earth is exactly the same.[[22]](#footnote-22)

As for the second process, the heat is generated only by the illuminating celestial bodies, i.e., stars and planets. Levi identifies the second process as the dominant one, and explains that due to its dominance, the illuminating bodies have a greater heating effect than any other part of the sphere (in the Epitome of *On the Heavens*, Averroes argues that the heavenly bodies’ greater heating effect is due to their solidity). Levi continues to follow Averroes by explaining that the effect of the second process depends on the angle at which the Sun’s rays strike the earth. The closer the rays get to a right angle, the more effect of warmth will be generated by the reflection of their light.[[23]](#footnote-23) Therefore, at any given time, this process has a different impact on different geographical locations. According to Levi’s understanding, the warming effect of the Sun’s reflected light is generated when the Sun’s rays strike the ground, and not when they cross the upper parts of the sublunary realm.[[24]](#footnote-24)

Levi does not seem to offer a full discussion about whether or not heatcan **also be** generated by the reflection of the light of terrestrial bodies; however, he does accept that terrestrial fire heats **by means of** its rays: in order to exemplify the notion that the heating effect of the Sun’s rays depends on the angle at which they impinges the earth, he **equates** the Sun **with** fire, arguing that the fire’s rays have a greater heating effect on objects that are **(situated?)** in straight line with respect to it (i.e., above it; because terrestrial fire has a rectilinear upward motion) than objects that are **(situated\placed)** around it.[[25]](#footnote-25)

Levi’s treatment of the question ‘how does the Sun heat the Earth?’ illustrates *Livyat ḥen*’s eclectic approach: in addition to the Averroean two-process solution, Levi mentions two other hypotheses that account for the heating effect caused by the Sun: (i) Parts of the fiery sphere are often scattered by the Sun’s rays and driven downwards, thus heating the Earth. Levi ascribes this hypothesis to Avicenna (this hypothesis is described in chapter 12 of the Pseudo-Avicenna’s *De caelo et mundo*);[[26]](#footnote-26) (ii) The “power” of the zodiacal sign **(that?)** the Sun is **in\placed\located in(?)**; the Sun’s position with relation to other planets (conjunctions and aspects), and earthly conditions, all affect the amount of heat on the Earth.[[27]](#footnote-27) Levi neither informs his readers that the two are **incoherent\in conflict** with the Averroean two-process solution, nor does he mention that the latter is based on a distinct body of knowledge, namely astrology. **In this regard**, it is hard to determine from these passages whether Levi was fully aware **to the tension between Aristotelian-Averroean natural philosophy and astrology**.[[28]](#footnote-28) As we shall now see, Levi’s eclecticism is even more prominent in his discussion on the inhabited part of the Earth.

**III. The Inhabited Part of the Earth in *Livyat ḥen***

As Resianne Fontaine has pointed out, two main models were used by medieval Jewish scholars for describing the Earth’s habitability and the boundaries of the inhabited world: the seven-clime theory and the five-zone theory.[[29]](#footnote-29) Levi was familiar with both theories, and was well aware of the fact that the two are in conflict. This is well evident from his discussion on the disagreement between Aristotle and Ptolemy about whether or not the thermal conditions around the equator permit the existence of human life (Levi could have been **aware to\familiar with** this disagreement through the Hebrew translation of Averroes’ Epitome of the *Meteorology*).[[30]](#footnote-30) Nevertheless, Levi does not seem to determine between the two. His treatment of the issue is, above all, a report **of\on** the opinions he finds in his various (contradicting) sources. This is another example of Levi’s eclectic approach, which in this case led him to (a?) scientific inconsistency.

Quantitatively speaking, Levi refers much more to the seven-clime theory. Following Jacob Anatoli’s Hebrew translation (ca. 1231-1235) of Al-Farghānī’s *Elements*, he confines the seven climes to an area that stretches from 12°45’ north to 66°25’ north, and describes the boundaries of each clime (as well as the length of its longest day, its width, the length of its shadow at the days of the equinoxes, and some of its most important cities).[[31]](#footnote-31) Levi reports that according to “most sages”, the inhabited part of the Earth exists only in its northern hemisphere, and remarks that this is evident since at the days of equinoxes the shadow in every inhabited area always points to the north.[[32]](#footnote-32) He also mentions that the Earth’s northern hemisphere was designed for human habitation\residence: the presence of most of the fixed stars at the heavens’ northern hemisphere is responsible for the emergence of dry land in the Earth’s northern hemisphere (the stars produce dry land by raising and relocating the exhalations).[[33]](#footnote-33) Levi mentions different **variations** of this notion in the second section of *Livyat ḥen*.[[34]](#footnote-34)

On the other hand, Levi also refers to the five-zone theory and to additional models that assume the presence of humans in the Earth’s southern hemisphere. Paraphrasing Moses Ibn Tibbon’s Hebrew translation (1246) of Geminos’ *Introduction to the Phenomena*, Levi mentions four optional geographical relations between inhabitants on the surface of the Earth; two of these relations assume the existence of human life in the Earth’s southern hemisphere.[[35]](#footnote-35) Although Levi presents these four optional geographical relations, he does not reveal his opinion about them. Later, he raises the possibility of the presence of humans around the South Pole, though immediately afterwards he expresses some doubts (*ʾaval ʾefšar še-yimana*ʿ) about the possibility of any human presence “in part of or in the entire” southern hemisphere, because of great mountains or an ocean that might prevent any human access to it.[[36]](#footnote-36) A few lines later, Levi asserts\states decisively that “the southern hemisphere is covered by [an?] ocean”, and even describes its boundaries.[[37]](#footnote-37)

Thus, we can conclude that Levi was familiar with two contradicting\incompatible models that\which refer to the boundaries of the inhabited world. Although he was aware that the two models are in conflict, he neither offers an organized systematic presentation of the two nor determines between them. Even though he does not explicitly reveal his opinions, he tends to be more hesitant when he discusses the possibility of human habitation in the Earth’s southern hemisphere. This leaves the reader with the impression that Levi ultimately tends to hold the opinion that the inhabited region of the Earth is located solely in its northern hemisphere. As we shall now see, this **notion** serves as one of the assumptions of Levi’s mechanism of general providence.

**IV. Levi’s Natural** **Mechanism of General Providence**

With all this in mind, we can now finally turn to Levi’s argument on the divine providence:

חכמה גדולה מבוארת בהניח האל גובה רום השמש בצפון, כי כמו שאמרנו סבות החום שתים. האחת סבה חזקה, והוא התהפכות הניצוץ; והשנית סבה רפה, והיא התנועה. ואלו שתיהן יחד ימצאו בדרום בהיות השמש שם, ויעדרו שתיהן יחד בדרום[[38]](#footnote-38) בהיות השמש אצל ההפוך הקיציי. ואלו התקבצו שתי הסבות יחד בצפון, היה שורף כל אנשי הארץ, והיה נכרת הישוב, כי הישוב בצפון. על כן היה הגובה בצפון, כדי שישתוה מיעוט החום אשר בתנועה עם גודל החום אשר יהיה מההתהפכות בקיץ, ושישתוה בסתו מיעוט החום אשר יהיה מהפוך הניצוץ עם החום אשר יהיה מקירוב התנועה. וגודל חום הקיץ ליתרון סבת ההתהפכות, וגברה על סבת התנועה. ולזה גבול החלק השני מן האויר קר, אע"פ שהוא יותר קרוב מתנועת הגלגל, לפי שלא יגיע שם התהפכות הניצוץ, ואין המקום ההוא עליון כל כך שיתנועע עם התנועה העליונה. וכן בקצה צפון ימצאו שתי סבות הקור: חולשת הפוך הניצוץ המכה שם בנטייה; וסבת התנועה משני פנים: האחד, כי אצל צפון גובה הרום; והשני כי כל ירחק מן האזור ויקרב אצל הקוטב, תתאחר יותר התנועה כמו שקדם, כי כבר התבאר בראיה, כמו שנבאר, יציאת המרכז לגלגל השמש. והיה זה מהשגחת השם על העולם השפל על הכונה השנית. [[39]](#footnote-39)

Great wisdom is evident in God’s placing the Sun’s apogee at the north, because, as we have said, the causes of heat are two: the first, a dominant cause, i.e., the reflection of rays [of light]; and the second, a minor cause, i.e., motion. And these two causes operate together in the southern [hemisphere] when the Sun is there; and [both causes] are absent [=inoperative] in the southern [hemisphere] when the Sun is at the summer solstice. And if both causes operated together in the northern [hemisphere], that would have burnt all human beings, and the inhabited part of the Earth would have been wiped out, because the inhabited part of the Earth is in the northern [hemisphere]. For this reason, the [Sun’s] apogee is at the north, to compensate at summer the smaller amount of heat caused by motion, by the greater amount of heat caused by reflection; and to compensate at autumn the smaller amount of heat caused by reflection, by the greater amount of heat caused by the proximity of motion. The greater amount of heat at summer is due to the excess of reflection qua cause and its being more powerful than motion qua cause. Therefore, the border of the second region of the air is cold, although it is closer to the sphere’s motion, namely because the reflection does not reach there, and [because] this place is not high enough to be moved with the uppermost motion. At the northernmost part [of the Earth] there are two causes of the cold: the weakness of the reflection, that strikes there with inclination; and the [weakness of the] cause of motion which has two aspects: the first, because the [Sun’s] apogee is at the north; and the second, the farther [the Sun travels] from the [southern part of the] zodiac,[[40]](#footnote-40) and the closer it gets to the [north] pole, the more the motion would be slowed down, as has been noted, because the eccentricity of the Sun’s orb has already been clarified with a proof, as we will clarify. And [all] this is by His providence over the sublunar world according to the second intention.[[41]](#footnote-41)

Before going into details, let me present Levi’s argument in a schematic structure:

1. ***Assumption A***: The orb of the Sun is to be eccentric; its center is further north than the center of the universe, i.e., the Earth. ***Therefore*:**
   1. When the Sun is in the northern part of its orbit, its distance from the Earth is greater than when it is in the southern part of its orbit.
   2. The apparent speed of the Sun varies constantly: When the Sun is in the northern part of its orbit, it appears to travel more slowly than its mean motion, and when it is in the southern part of its orbit, it appears to travel more rapidly than its mean motion. At apogee, the Sun appears to be slowest, and at perigee, it appears to be fastest.
2. ***Assumption B***: The heating by the Sun is due to two distinct processes:
   1. The heat-generating motion: At **a~~\any~~** given time, this process has the exact same impact on all different geographical locations. This process depends on two parameters:[[42]](#footnote-42)
      1. The Sun’s distance from the Earth: The closer it is to the Earth, the greater its warming effect, and *vice versa*
      2. The (apparent) speed of the Sun: The faster it is, the greater its warming effect, and *vice versa*.
   2. The heat-generating reflection: the more dominant process; the heat is generated only by the illuminating bodies, and its effect depends on the angle at which the Sun’s rays strike the earth: the closer the rays are to a right angle, the more warmth is generated by the reflection of their light. ***Therefore***: At any\a given time, the heat-generating reflection has a different impact on different geographical locations.
3. ***According to 1, and 2a***: Regardless of geographical location, the further south the Sun is in its orbit, the more heat is generated by the cause of motion (the Sun’s motion appears to be faster, and the Sun is closer to the Earth); the further north the Sun is in its orbit, the less heat is generated by the cause of motion (the motion appears to be slower, and the Sun is farther from the Earth).
4. ***According to 2b and 3****:* 
   1. For the Earth’s northern hemisphere: the further north the Sun is in its orbit, the less heat is generated by the cause of motion, and the more heat is generated by the cause of reflection;[[43]](#footnote-43) the further south the Sun is in its orbit, the more heat is generated by the cause of motion, and the less heat is generated by the cause of reflection.

***Therefore***: **In the Earth’s northern hemisphere both heating processes are constantly offsetting each other**, thus, creating optimal thermal conditions for human life.

* 1. For the Earth’s southern hemisphere: the further north the Sun is in its orbit, the less heat is generated by both heating processes; the further south the Sun is in its orbit, the more heat is generated by both heating processes. ***Therefore***: **In the Earth’s southern hemisphere, both heating processes are correlated**.

1. ***Assumption C***: The inhabited part of the Earth is solely in its northern hemisphere.
2. **According to 4a and 5**: In the inhabited part of the Earth, the two heating processes are constantly offsetting each other. ***Therefore****:* The inhabited part of the Earth enjoys optimal thermal conditions for human life.

According to Levi, the constant offsetting between the two complementary heat-generating processes is what allows the persistence\perdurability of the inhabited world and of all human beings. This offsetting persists through seasonal changes. Levi explains that the dominance of the cause of reflection over the cause of motion is what causes the summer to be hotter than winter despite the constant offsetting between the two processes. He provides an example in order to demonstrate this dominance: “The border of the second region of the air is cold, although it is closer to the sphere’s motion, namely because the reflection does not reach there”. The notion that the warming effect of the Sun’s reflected light does not reach the “second region of the air” was probably borrowed from Averroes’ Epitome of the *Meteorology*,[[44]](#footnote-44) and can also be found in at least one more Hebrew treatise that was written in the thirteen-century, *Ruaḥ ḥen*.[[45]](#footnote-45) This example clarifies again that according to Levi, the heat generated by the Sun’s rays is not caused by the Sun’s rays crossing the air, but only by their reflection once they strike the earth itself.[[46]](#footnote-46) Levi also describes the combined effect of the two heating processes on the northernmost part of the Earth: the Sun’s rays always strike its surface in a very acute angle. As the angle finally increases (a little), the Sun’s distance from the Earth increases, and the Sun’s motion appears to be slower, therefore the amount of heat caused by motion decreases. This is why, according to Levi, the northernmost part of the Earth always stays cold.

It should be noted that Levi’s “offset mechanism” **posits** that the amount of heat caused by motion depends on the Sun’s apparent speed, (and) not on its actual speed. But Levi does not explain why ~~one should\does it rely on its apparent speed~~. As the Sun’s actual speed is constant, one **can** criticizes Levi’s mechanism arguing that the actual amount of heat (that?) the Sun produces by means of its **speed** **should\must** be constant as well. However, even if we take it into consideration, this critique is not sufficient to refute Levi’s argument: the amount of heat caused by motion will still change based on the Sun’s varying distance from the Earth.

As mentioned above, the same mechanism was already described, though in more general terms, in Averroes’ Epitome of the *Meteorology*, known to Levi through Moses Ibn Tibbon’s Hebrew translation. However, neither Averroes’ original nor Ibn Tibbon’s translation integrates the theologico-philosophical notion of providence into this specific scientific context.[[47]](#footnote-47) Levi, in contrast, opines that God, in His great wisdom, placed (הניח, an active verb) the Sun’s apogee at the north, and concludes that the “constant offsetting mechanism” is – at least – a result of “His providence over the sublunar world”. Divine providence, then, extends to the sublunary world through the effect of the Sun, and ensures the persistence\perdurability of the inhabited world. However, in Levi’s view, providence is not only responsible for ensuring the persistence\perdurability of the world and its species. In the second section of *Livyat ḥen*, Levi accepts the notion of (naturalistic) particular providence, and he argues that it is only exercised over humans and in direct relation to the individual’s intellectual attainment.[[48]](#footnote-48) Thus, the “offset mechanism” should only be considered as one aspect of Levi’s naturalistic approach to providence. This aspect is also illustrated in the metaphysical book of *Livyat ḥen*, where the link between celestial influences and divine providence is also discussed.[[49]](#footnote-49) However, in this case, the providential activity of the supralunar realm is not exclusively attributed to the Sun. In this passage, Levi also refers to the heating effect of the planets and fixed stars;[[50]](#footnote-50) the astrological concept of triplicities; the place and order of the three uppermost planets; as well as to other notions related to the structure of the heavens, all in order to demonstrate that the supralunar realm is designed in such a way that it allows the persistence\perdurability of the sublunar world.[[51]](#footnote-51)

In light of all this, the following question should be raised: Do the heavenly bodies, according to Levi, exist only for the sake of the sublunar world? The answer to this question is negative. From the metaphysical book of *Livyat ḥen*, we learn that the supralunar realm was indeed designed by God for the benefit of the sublunar realm, but the heavenly bodies also exist for their own sake.[[52]](#footnote-52) The same conclusion could be drawn from Levi’s use of the phrase “according to the second intention”, which appears in the paragraph quoted above.[[53]](#footnote-53) This phrase alludes to a distinction between primary and secondary “intensions” or “purposes”, which goes back to Alexander of Aphrodisias’ *De providentia*.[[54]](#footnote-54) Levi was probably familiar with this distinction through the works of Averroes, who frequently used it.[[55]](#footnote-55) In a nutshell, the distinction between a primary and a secondary intention intends to solve the following problem: If we accept the notion of providential influence of the heavenly bodies, we must admit that the heavenly bodies serve, in some sense, the sublunar world. Now, it is unacceptable that the prime concern of a superior substance will be for the inferior one. On the other hand, if we admit that the beneficial influence of the heavenly bodies is *per accidens*, we will have to abandon the notion of providence, as it could not, per definition, be accidental. The notion of a “second intention” offers a solution to this problem: The heavenly bodies exist for their own sake, but they also have a secondary purpose: they serve as an instrument through which providence is exerted over the sublunar world.

Finally, I would like to draw the reader’s attention to two Hebrew characters embedded in *LḤ* Va next to the quoted paragraph we have just examined, which shed some light on the connection between *Livyat ḥen* and Levi’s rhymed poem *Battei ha-nefeš ve-ha-leḥašim*.[[56]](#footnote-56) In *LḤ* Va, fol. 37v, at the beginning of the above-quoted paragraph, we find the sign "נב" (=52). An examination of all surviving manuscripts of *Livyat ḥen* III reveals that three of the manuscripts include dozens of these signs, which are nothing but references to the parallel distich in Levi’s eighth book (the astronomical-astrological book) of *Battei ha-nefeš ve-ha-leḥašim*.[[57]](#footnote-57) In distich 52 we find the following: "והגובה נתנו אל בצפון; להשוות חום תנועה אל יצורים". (= “And the apogee was placed by God in the north; to balance the heat [caused by] motion for [all] beings”).[[58]](#footnote-58) Without the detailed description in *Livyat ḥen*, this distich, I believe, remains obscure and much more difficult for translation. This is one example out of many in which *Livyat ḥen* can assist us with the clarification of obscured distiches of *Battei ha-nefeš ve-ha-leḥašim*.

**V. Gersonides, the Offset Mechanism, and Providence**

The mechanism discussed above was also familiar to a much better known Levi, i.e., Gersonides (Levi ben Gershom, 1288-1344). At the end of 1321, Gersonides wrote a supercommentary on Averroes’ Epitome of the *Meteorology*, in which the mechanism is described. Paraphrasing Ibn Tibbon’s Hebrew translation alongside his own remarks, Gersonides provides a description of the mechanism which is clearer than that of Averroes, but much less detailed than that of Levi ben Abraham.[[59]](#footnote-59) Immediately afterwards, in a passage that begins with the phrase “Levi [=Gersonides] said”, he criticizes and rejects the claim that heat can be generated by the motion of the heavenly bodies, and more specifically, by the motion of the Sun.[[60]](#footnote-60) Although Gersonides does not explicitly say so, with his rejection of one of the mechanism’s fundamental principles, the entire mechanism collapses. At the end of this passage, he states that the issue was already discussed at length in his *Milḥamot ha-šem*, where “we refuted Aristotle’s claims on the subject with great proofs”.[[61]](#footnote-61) This reference points to *Milḥamot ha-šem* V.II.6, where Gersonides rejects the Aristotelian-Averroean explanations for the heat generated by the Sun, and suggests an alternative explanation for the phenomenon on the basis two concepts: the Pseudo-Avicenna’s theory of rays; and the Averroean notion of “divine power” (found in Averroes’ Long Commentary on the *Metaphysics*; and appears once in his Epitome of *De caelo*).[[62]](#footnote-62)

Gersonides, then, rejects the offset mechanism. Needless to say, that he does not identify it, in any sense, with divine providence, as Levi ben Abraham does. Nevertheless, Gersonides, too, considered the celestial bodies, their arrangement and motion as instruments through which providence is exerted over the sublunar world.[[63]](#footnote-63) Gersonides probably based this notion on other commentaries of Averroes, with which he was well familiar, such as Averroes’ Epitome of the *Metaphysics* and Epitome of *Generation and Corruption*.[[64]](#footnote-64) As previous studies have shown, Gersonides was deeply inspired by Averroes’ notion of ‘preservation by nature’ found in Averroes’ Middle Commentary ofthe *Book of Animals*, and incorporated it into his supercommentaries, biblical exegeses and into *Milḥamot ha-šem*.[[65]](#footnote-65)

The resemblance between Gersonides’ ‘stellar preservation’ and Levi ben Abraham’s offset mechanism is well evident: In his *magnum opus*, Gersonides opines that “were it not for the preservation deriving from the heavenly bodies, he [=man, meaning: human life] would easily perish”.[[66]](#footnote-66) In a manner similar to Levi, Gersonides argues that the closer a planet is to the Earth, the greater its effect.[[67]](#footnote-67) Like Levi, he explicitly mentions the varying effect of the Sun on the sublunar world in the context of ‘stellar preservation’.[[68]](#footnote-68) However, Gersonides’ rejection of the Averroean explanations for the Sun’s heating effect, and his reliance on the concepts of rays and “divine power” for explaining this phenomenon, indicate that the two scholars differ in their theoretical background as well as in their view of the mechanism through which providence is exerted. There is yet another premise of Gersonides, which contradicts a fundamental principle of Levi’s mechanism: contrary to Levi’s assumption, Gersonides argues that when the motion of a planet is fast, it does not produce a strong effect on the sublunar world.[[69]](#footnote-69)

The **difference\s** between the two accounts is even more prominent when we consider the motivations that triggered the two scholars to deal with the subject. While Levi ben Abraham reports what he has found in his various sources; Gersonides aims to show that astrology is compatible with the Aristotelian-Averroean natural philosophy.[[70]](#footnote-70) Gersonides also seems to be more **aware** **of\to** the tension between astral determinism and free will (suggesting that humans have the capacity to act according to their intellect, which allows them to escape astral determinism).[[71]](#footnote-71) Accordingly, Levi ben Abraham’s account has no pretensions to originality; while Gersonides’ account is much more creative and indeed original. It should also be noted that Gersonides’ naturalistic account of providence is much more extensive and systemized than Levi’s. According to Gersonides, providence is also responsible for world’s historical events,[[72]](#footnote-72) as well as for social order.[[73]](#footnote-73) Moreover, Gersonides’ discussion\account on providence is not limited to the scope of human life. In his view, providence is also exerted on more basic levels of the *scala naturae*, down to the level of matter itself: the celestial bodies balance the opposite elements composing sublunar substances.[[74]](#footnote-74) Furthermore, it is not limited to the scope of physical bodies: according to Gersonides, the celestial bodies also govern human thoughts.[[75]](#footnote-75) These features of providence are absent from *Livyat ḥen* III:12.

**Conclusion**

While the two-section structure of *Livyat ḥen* might imply that Levi ben Abraham sharply distinguishes science from theology, his treatise is, in fact, full of interactions between the two. One such interaction is illustrated in *Livyat ḥen* III:12 with Levi’s integration of the theologico-philosophical notion of providence into a scientific context. Based on three scientific assumptions, Levi describes a mechanism that constantly offsets the impact of two distinct heat-generating processes on the inhabited part of the Earth. This mechanism provides optimal thermal conditions for human life, and by doing so, it secures the persistence\perdurability of the inhabited world. In this regard, Levi identifies this mechanism with God’s general providence or, at least, with one aspect of it.

In addition to a comprehensive study of the mechanism, this paper provides some insights into the character of *Livyat ḥen* III. First, it has shown that Levi borrows scientific notions from distinct bodies of knowledge: Ptolemaic (e.g., Jacob Anatoli’s Hebrew translation of Al-Farghānī’s *Elements*) and Aristotelian (e.g., Moses Ibn Tibbon’s Hebrew translation of Averroes’ Epitome of *On the Heavens*). An examination of *Livyat ḥen* III reveals that in addition to these two scientific traditions and to astrological treatises, Levi also relies on literature on astral magic.[[76]](#footnote-76) This eclectic approach led to the integration of conflicting ideas into *Livyat ḥen* III, and occasionally to inconsistency. In some cases it is evident that Levi is aware of the scientific incompatibilities between his sources, as he does not hesitate to discuss them with his readers (e.g., the disagreement between Aristotle and Ptolemy described in part III of this paper). Nevertheless, as we have noted above, this awareness does not necessarily lead him to determine between two conflicting options.

Second, although the bulk of the scientific content of *Livyat ḥen* III cannot be said to be original, as it is mostly a collection of different sources, this paper has nevertheless illustrated that the author’s own voice is not entirely absent. Throughout *Livyat ḥen* III, Levi re-edits his sources, while occasionally responding to their claims; discussing scientific incompatibilities; and adding his own remarks. As noted above, it was probably Levi’s original idea to attribute the theologico-philosophical notion\aspect of providence to the mechanism discussed in this paper. Levi’s remarks, though, are sometimes associative, and not always consistent with one another.

These two insights imply that one purpose of *Livyat ḥen* III is to present\~~provide~~ in a single composition a wide-as-possible collection of astronomical and astrological notions as they were reflected in the Hebrew scientific literature of the late-thirteenth-century (in both original treatises and translations from Arabic).[[77]](#footnote-77) Accordingly, *Livyat ḥen* III should be considered as a highly valuable testimony of the Hebrew scientific literature that was available in late-thirteenth-century Provence. It also provides us with the opportunity to examine what impression Hebrew writings and different scientific notions have made on Provençal Hebrew readers, such as Levi ben Abraham, and to understand how these readers have interpreted, used and spread the scientific knowledge this literature contains.

1. \* I am grateful to Shlomo Sela, the editors of *Aleph*, and the two anonymous referees for *Aleph* for their valuable comments and suggestions on earlier versions of this paper.

   For an overview of *Livyat ḥen* and its author, see Warren Zev Harvey, “Levi ben Abraham of Villefranche’s Controversial Encyclopedia,” in *The Medieval Hebrew Encyclopedias of Science and Philosophy*, ed. Steven Harvey (Boston: Kluwer Academic Publishers, 2000), pp. 171-188; Howard Kreisel, *Judaism as Philosophy. Studies in Maimonides and the Medieval Jewish Philosophers of Provence* (Boston: Academic Studies Press, 2015), pp. 116-124, 156-160; see also Kreisel’s four introductions to his editions (Heb.), described\mentioned in n. 3. [↑](#footnote-ref-1)
2. On *Livyat ḥen* III and its extant manuscripts, see Gad Freudenthal, “Sur la Partie Astronomique du Liwyat Ḥen de Lévi ben Abraham ben Ḥayyim,” *Revue des études juives* 148 (1989): 103-112. Of the nine extant manuscripts of *Livyat ḥen* III, only three contain its twelfth chapter, where the mechanism examined in this paper is described: Vatican, Biblioteca Apostolica, MS ebr. 383 (Institute of Microfilmed Hebrew Manuscripts [=IMHM] 464), fols. 32r-42v; New York, The Jewish Theological Seminary of America, MS 2559 (IMHM 28812), fols. 12r-20v; Paris, Bibliothèque Nationale de France, MS héb 1047 (IMHM 14650), fols. 180r-182r (Henceforth, *LḤ*, Va; *LḤ*, N; *LḤ*, P, respectively). *LḤ*, P contains a shorter version of the astronomical chapters. Therefore, references to *Livyat ḥen* III below are usually to *LḤ*, Va or *LḤ*, N (or both), although they were also checked in *LḤ*, P. [↑](#footnote-ref-2)
3. On the structure of the second *ʿammud* see Kreisel, *Judaism as Philosophy*, pp. 156-160. Howard Kreisel’s edition of *Livyat ḥen*’s second *ʿammud* (which also includes a part of book V of the first ʿ*ammud*, i.e., the book on metaphysics)is accompanied by introductions and notes in four volumes: Levi ben Avraham*, Livyat Ḥen: The Work of Creation* (Jerusalem: World Union of Jewish Studies, 2004) (Heb.); Levi ben Avraham*, Livyat Ḥen: The Quality of Prophecy and the Secrets of the Torah* (Beer-Sheva: Ben-Gurion University of the Negev Press, 2007) (Heb.); Levi ben Avraham*, Livyat Ḥen: The Work of the Chariot* (Jerusalem: World Union of Jewish Studies, 2013) (Heb.); Levi ben Avraham*, Livyat Ḥen: The Secrets of the Faith and the Gate of the Haggadah* (Beer-Sheva: Ben-Gurion University of the Negev Press, 2014) (Heb.). [↑](#footnote-ref-3)
4. Levi ben Avraham*, Livyat Ḥen: The Secrets of the Faith and the Gate of the Haggadah*, ed. Kreisel, VI.II:14-15, pp. 110-131. For Kreisel’s discussion on these chapters, see ibid., pp. לט-מה (39-45 in Hebrew characters). [↑](#footnote-ref-4)
5. In Averroes’ Epitome of the *Meteorology*, the mechanism is described only in general terms. See below, n. 47. A naturalistic account of providence can be found elsewhere in Averroes’ works. In his Epitome of the *Metaphysics*, Averroes, following Alexander of Aphrodisias, also ~~makes-a-connection~~ links between\associates the Sun’s heating effect and\with divine providence. However, in this case, Averroes’ claim seems more general, and in the context of providence he does not explicitly mentioneither the Sun’s eccentric model or the mechanism discussedhere. See Gad Freudenthal, “The Astrologization of the Aristotelian Cosmos: Celestial Influences on the Sublunary World in Aristotle, Alexander of Aphrodisias, and Averroes,” in *New Perspectives on Aristotle’s De caelo*, eds. Alan C. Bowen and Christian Wildberg (Leiden: Brill, 2009), pp. 241-244, 254. [↑](#footnote-ref-5)
6. Levi discusses the astrolabe in *Livyat ḥen* III:14, 15, 18, 23, 29, 38 and 39. These discussions demonstrate a strong reliance on the second and third versions of Abraham Ibn Ezra’s *Sefer Keli ha-neḥošet* as well as on Jacob ben Makhir’s *Rova*ʿ *yisra*ʾ*el*. Here are two examples from *Livyat ḥen* III:15: (i) *LḤ*, Va fol. 59v lines 5-11 is a literal quotation from Jacob ben Makhir’s *Rova*ʿ *yisra*ʾ*el*: cf. Paris, Bibliothèque Nationale de France, MS héb 1027 (IMHM 15719), fol. 83v lines 6-12. (ii) The text in *LḤ*, Va, fol. 59r line 16 – fol. 59v line 4 follows the third version of *Sefer Keli ha-neḥošet*: cf. Munich, Bavarian State Library, MS cod. hebr 256 (IMHM 1212), fol. 31v line 12 – fol. 32r line 1. [↑](#footnote-ref-6)
7. See *LḤ*, Va, fol. 68r-68v; *LḤ*, N, fol. 41v. Cf. *Ptolemy’s Almagest*, trans. and annot. by G. J. Toomer (London: Duckworth, 1984), III:4, p. 153; Abraham Bar Ḥiyya, *Ṣurat ha-ʾareṣ*, ed. Rafael Lasri (Jerusalem: Hamachon Letchuna Vekidush Hachodesh, 2009), pp. 69-70. On the Ptolemaic solar theory and its two optional models, see James Evans, *The History and Practice of Ancient Astronomy* (New York: Oxford University Press, 1998), pp. 210-212. [↑](#footnote-ref-7)
8. *LḤ*, Va, fol. 70v. [↑](#footnote-ref-8)
9. *LḤ*, N, fol. 42r, lines 13-21; *LḤ*, Va, fol. 69r, lines 3-11. [↑](#footnote-ref-9)
10. *LḤ*, Va, fols. 69v-70r. Most of this description is absent from *LḤ*, N (fols. 42v-43r). [↑](#footnote-ref-10)
11. Cf. Abraham Bar Ḥiyya, *Ṣurat ha-ʾareṣ*, ed. Lasri, chapter 2, pp. 70-72. Throughout *Livyat ḥen* III, Levi incorporates many paraphrases from *Ṣurat ha-ʾareṣ*. Many examples can be given. See, e.g., *LḤ*, Va, fol. 192v line 3 – fol. 193r line 20; cf. Abraham Bar Ḥiyya, *Ṣurat ha-ʾareṣ*, ed. Lasri, pp. 140-141. In some cases Levi explicitly mentions *Ṣurat ha-ʾareṣ*’ title (**or:by its title?**) (e.g., *LḤ*, Va, fols. 199r line 21; 200r last line; 209v line 20). [↑](#footnote-ref-11)
12. *LḤ*, Va, fol. 70r. [↑](#footnote-ref-12)
13. This question becomes even more challenging when we take into consideration the Aristotelian principle that anything that brings something from potentiality to actuality must already be in a state of actuality, or as Aristotle puts it: “it is that which is hot that produces heat, and in general that which produces the form possesses it”. See Aristotle, *Physics*, trans. by R. P Hardie and R. K. Gaye, in *The Complete Works of Aristotle. The Revised Oxford Translation*, vol. 1, ed. Jonathan Barnes (Princeton New-Jersey: Princeton University Press, 1984), VIII.5, 257b6-10, p. 430. And in Aristotle’s *Metaphysics* (IX.8, 1049b24-29): “For from the potential the actual is always produced by an actual thing […], everything that is produced is something produced from something and by something, and is the same in species as it”. [↑](#footnote-ref-13)
14. In *On the Heavens*, Aristotle argues that “the heat and light which they [=the heavenly bodies] emit are engendered as the air is chafed by their movement”, while in the *Meteorology* he also suggests that “the fire surrounding the air is often scattered by the motion of the heavens and driven downwards in spite of itself”. See Aristotle, *On the Heavens*, trans. by W. K. C. Guthrie (Cambridge, Massachusetts: Harvard University Press, 1939), II:7, 289a20-35, pp. 179-181 (and See Guthrie’s note on this chapter, pp. 176-179); Aristotle, *Meteorology*, trans. E. W. Webster, in *The Complete Works of Aristotle. The Revised Oxford Translation*, vol. 1, ed. Jonathan Barnes (Princeton New-Jersey: Princeton University Press, 1984), I:3, 341a12-36, pp. 558-559. See also James Longrigg, “Elementary Physics in the Lyceum and Stoa,” *Isis* 66 No. 2 (1975): 211-229, p. 214. [↑](#footnote-ref-14)
15. See, for example, Gersonides, *Milḥamot ha-šem* (Berlin, 1923) [hereafter *MH*], V.II.6, pp. 201-205. For the opinions of some medieval scholastics on the issue, see Edward Grant, *Planets, Stars and Orbs. The Medieval Cosmos, 1200-1687* (Cambridge: Cambridge University Press, 1996), chapter 19, section V, esp. pp. 591-595, 605-611. For Averroes’ treatment of the subject, see below n. 17. [↑](#footnote-ref-15)
16. *LḤ*, N, fol. 12v; *LḤ*, Va, fol. 32v. All Hebrew quotations in this paper are based on *LḤ*, Va and *LḤ*, N, and were translated into English by the author. This quotation was also discussed in Rose S. Marx, “A 13th Century Theory of Heat as Form of Motion,” *Isis*, vol. 22, No. 1 (1934): 19-20, but was, unfortunately, misunderstood. [↑](#footnote-ref-16)
17. Cf. *Averroes’ Epitome of Aristotle’s De Caelo: Moshe ibn Tibbon’s Hebrew Translation.* Critical edition according to Hebrew manuscripts, collated with the Arabic edited text; ed. Sasson Horesh (Ph.D. dissertation, Jerusalem: The Hebrew University, 2006), pp. 47-48. Levi explicitly mentions Averroes’ Epitome of *On the Heavens* in *Livyat ḥen* III:2 (*LḤ*, Va, fol. 10v). For an overview of Averroes’ opinions on this issue in his various commentaries, see Gad Freudenthal, “The Medieval Astrologization of Aristotle’s Biology: Averroes on the Role of the Celestial Bodies in the Generation of Animate Beings,” *Arabic Sciences and Philosophy*, vol. 12 (2002): 111-137, on pp. 128-135; See also Gad Freudenthal, “Providence, Astrology, and Celestial Influences on the Sublunar World in Shem-Tov Ibn Falaquera’s *Deʿot ha-Filosofim*,” in *The Medieval Hebrew Encyclopedias of Science and Philosophy*, ed. Steven Harvey (Boston: Kluwer Academic Publishers, 2000), pp. 343-351. [↑](#footnote-ref-17)
18. The notion of “divine power” appears in Averroes’ Epitome of *On the Heavens* only once, and without any **explanation\s** of its meaning. Recently, Gad Freudenthal **(has?)** suggested that the reference to divine power in that work is a late interpolation made by Averroes himself. See Gad Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology: Providence and Israel’s Redemption within the Natural History of Humankind,” *Aleph*, vol. 19, No. 1 (2019): 59-130, on p. 92, n. 114. And see below, n. 62. [↑](#footnote-ref-18)
19. **These two questions were a matter of a scholastic debate**. See Griet Galle, “Scholastic Explanations of Why Local Motion Generates Heat,” *Early Science and Medicine*, vol. 8. No. 4 (2003): 336-370. [↑](#footnote-ref-19)
20. See part IV of this paper, especially Levi’s reference to the Sun’s “proximity of motion”, and to the two aspects of the cause of motion with respect to the northernmost part of the Earth. These factors are also mentioned in Aristotle’s *Meteorology* I:3, 341a19-29. And see below, n. 42. [↑](#footnote-ref-20)
21. Cf. *Averroes’ Epitome of Aristotle’s De Caelo*, ed. Sasson Horesh, p. 47, line 13 – p. 48, line 1. The last sentence in the above quotation implies that Levi ascribes the heating by motion solely to the moving sphere. However, later it becomes clear that the position of the Sun in its orb and its “proximity of motion” from the Earth, have a crucial impact on the amount of heat generated by motion. [↑](#footnote-ref-21)
22. *LḤ*, Va, fol. 33v, lines 11-12. The notion that the Earth has the ratio of a point to the heavens was made by Ptolemy. See *Ptolemy’s Almagest*, ed. Toomer,I:6, p. 43. [↑](#footnote-ref-22)
23. *LḤ*, Va, fols. 32v, lines 18-20; 33r line 8 – 33v line 1. [↑](#footnote-ref-23)
24. *LḤ*, Va, fol. 32v, lines 12-16. And see below, p. 12. [↑](#footnote-ref-24)
25. *LḤ*, Va, fol. 33r, lines 8-11; *LḤ*, N, fol. 13r, lines 8-10. [↑](#footnote-ref-25)
26. *LḤ*, Va, fol. 41v. For a description of this hypothesis in the Pseudo-Avicenna’s *De caelo et mundo*, See Ruth Glasner, “The Hebrew Version of *De celo et mundo* Attributed to Ibn Sīnā,” *Arabic Sciences and Philosophy* vol. 6 No. 1 (1996): 89-112, on pp. 102-103; idem, *Gersonides. A Portrait of a Fourteenth-Century Philosopher-Scientist* (Oxford: Oxford University Press, 2015), pp. 85-87; Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” pp. 80-81. [↑](#footnote-ref-26)
27. *LḤ*, Va, fol. 42r line 21– fol. 42v line 12. [↑](#footnote-ref-27)
28. For two aspects of Aristotelian natural philosophy that are incompatible with astrology, see Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” pp. 75-76. [↑](#footnote-ref-28)
29. Resianne Fontaine, “Between Scorching Heat and Freezing Cold: Medieval Jewish Authors on the Inhabited and Uninhabited Parts of the Earth,” *Arabic Sciences and Philosophy*, 10, (2000): 101-137. [↑](#footnote-ref-29)
30. *LḤ*, Va, fols. 34r-36r. And see Averroes’ Epitome in Paris, Bibliothèque Nationale de France, MS héb 935 (IMHM 31969), fol. 92r. [↑](#footnote-ref-30)
31. *LḤ*, Va, fols. 36v, lines 3-7; 44v-48r. Cf. Al-Farghānī’s *Elements*: Paris, Bibliothèque Nationale de France, MS héb 1022 (IMHM 15023), fols. 15r-17r. I identified many quotations and paraphrases from Anatoli’s translation of Al-Farghānī’s *Elements* in *Livyat ḥen* III. For example, Levi’s list of the 15 first-magnitude stars (in *Livyat ḥen* III:17) is based on Al-Farghānī’s list. See *LḤ*, Va, fol. 66v line 12 – fol. 67r line 5; cf. Al-Farghānī’s list in: Shlomo Sela, “Al-Farghānī on the 48 Ptolemaic Constellations: A Newly Discovered Text in Hebrew Translation,” *Aleph* 16.2 (2016): 249-365, on pp. 290-292, §2**. Levi mentions Al-Farghānī by (his?) name** in *Livyat ḥen* III:6, 12, 13, 17, 21, 22, 26, 29, 30, 32, 33, 34, 36. [↑](#footnote-ref-31)
32. *LḤ*, Va, fols. 36v-37r. [↑](#footnote-ref-32)
33. *LḤ*, N, fol. 19r, lines 13-19; *LḤ*, Va, fol. 41r, lines 16-21. [↑](#footnote-ref-33)
34. Levi ben Avraham*, Livyat Ḥen: The Work of the Chariot*, ed. Kreisel, p. 182; Levi ben Avraham*, Livyat Ḥen: The Work of Creation*, ed. Kreisel, pp. 272, 291; Levi ben Avraham*, Livyat Ḥen: The Quality of Prophecy and the Secrets of the Torah*, ed. Kreisel, p. 524 (in this case one can\might get the impression that the responsibility for the appearance of dry land is exclusively attributed to the Sun). And see, Gad Freudenthal “The Medieval Hebrew Reception of Avicenna’s Account of the Formation and Perseverance of Dry Land: Between Bold Naturalism and Fideist Literalism,” in *The Arabic, Hebrew, and Latin Reception of Avicenna’s Physics and Cosmology*, eds. Dag Nikolaus Hasse and Amos Bertolacci (Berlin: Walter de Gruyter, 2018), part V, pp. 292-295. Freudenthal **(has?)** suggested that Levi’s ascription of the appearance of dry land to the fixed stars in his *Work of Creation* follows Samuel Ibn Tibbon’s *Maʾamar yiqqawu ha-mayim* (Ibid., p. 294, n. 123). It should be noted, though, that the idea that most of the fixed stars are embedded in the heavens’ northern hemisphere (which is mentioned in *Livyat ḥen* III as well as in Levi’s fifth chapter of *The Work of the Chariot*), is not mentioned by Ibn Tibbon in the context of the appearance of dry land. [↑](#footnote-ref-34)
35. *LḤ*, Va, fol. 37r, lines 11-19; cf. Geminos’ *Introduction to the Phenomena*: Mantova, Comunita Israelitica MS ebr 4 (IMHM 785), fol. 19r. For more details on these four geographical relations, see James Evans and J. Lennart Berggren, *Geminos*’ *Introduction to the Phenomena: A Translation and Study of a Hellenistic Survey of Astronomy* (Princeton and Oxford: Princeton University Press, 2006), p. 210, n. 2. Levi mentions Geminos’ treatise a dozen times in *Livyat ḥen* III (11 times in the astronomical chapters, and once in the astrological chapter), and a few more times in the second section of *Livyat ḥen*, calling it "ספר המבוא" (*The Book of Introduction*) or "ספר המבוא לתלמי" (*Ptolemy’s Book of Introduction*). *The Book of Introduction* was misidentified in recent studies on *Livyat ḥen* (see Levi ben Avraham*, Livyat Ḥen: The Quality of Prophecy and the Secrets of the Torah*, ed. Kreisel, pp. 597-598, n. 48; Levi ben Avraham*, Livyat Ḥen: The Work of Creation*, ed. Kreisel, p. 118, n. 385), despite its correct identification as Geminos’ *Introduction to the Phenomena* established in Moritz Steinschneider, *Die hebraeischen Übersetzungen des Mittelalters und die Juden als Dolmetscher* (Berlin, 1893), p. 539. Levi was probably not the only one who mistakenly ascribed this treatise to Ptolemy. The colophon found in Moses Ibn Tibbon’s translation refers to it as: “Ptolemy’s book on the art of the sphere”. This colophon, together with Levi’s ascription and the fact that Levi knew Moses Ibn Tibbon personally (see Harvey, “Levi ben Abraham of Villefranche’s Controversial Encyclopedia,” pp. 184-185), all imply that Ibn Tibbon thought that he is translating a book that was composed by Ptolemy. Gerard of Cremona’s Latin translation ascribes this treatise to Ptolemy as well, at least according to the list of Gerard’s works drawn-up by his students after his death in 1187. In that list, the treatise is called *Liber introductorius Ptolomei ad artem spericam*, very similar to the name mentions in the Hebrew version’s colophon. On the title of Gerard’s Latin translation, see Charles Burnett, “The Coherence of the Arabic-Latin Translation Program in Toledo in the Twelfth Century,” *Science in Context* 14 (1/2) (2001): 249-288, on p. 278, §23. It seems reasonable to assume that the ascription to Ptolemy goes back to the Arabic manuscript tradition, and that both – Gerard and Ibn Tibbon – translated the text from an Arabic manuscript that had already ascribed the work to Ptolemy. Unfortunately, I could neither confirm nor refute this hypothesis, because it would seem that no Arabic manuscript of Geminos’ treatise had survived. It is worth mentioning that Geminos’ treatise follows the five-zone theory (chapter 12 in the Hebrew translation). On the Hebrew translation and a detailed account of one of its chapters, see Y. Tzvi Langermann, “From My Notebooks: Studies on the Hebrew Geminos: The Chapter on Weather Signs,” *Aleph*, vol. 10, No. 2 (2010): 357-395. [↑](#footnote-ref-35)
36. *LḤ*, N, fol. 17v, lines 6-19; *LḤ*, Va, fol. 38r, lines 2-14. [↑](#footnote-ref-36)
37. *LḤ*, Va, fol. 38r, line 21 – 38v, line 7. (This part is absent from *LḤ*, N) [↑](#footnote-ref-37)
38. In *LḤ*, Va 37v there is a marginal correction ‘בצפון’ (at north). However, according to *LḤ*, N, fol. 17r; *LḤ*, P, fol. 181r; and most importantly to the contexts, **the word should** be ‘בדרום’ (at south). [↑](#footnote-ref-38)
39. *LḤ*, Va, fols. 37v-38r; *LḤ*, N, fol. 17r-17v; cf. *LḤ*, P, fol. 181r. [↑](#footnote-ref-39)
40. In *Livyat ḥen* III the term *ʾezor* denotes the zodiac. However, in this case, since the Sun cannot travel away from the zodiac, I have modified it to “travels from the southern part of the zodiac”, according to the context. It is worth mentioning that in addition to *ʾezor*, Levi also uses other terms for denoting the zodiac: *ʾafudat ha-galgal*, *ʾafudat galgal ha-mazalot*, *ʾafudat ha-mazalot*, *ʾafuda*, and once he also uses the term *zodiyaq*. The first four terms are borrowed from Abraham Ibn Ezra’s terminology. See Shlomo Sela, *Abraham Ibn Ezra and the Rise of Medieval Hebrew Science* (Leiden: Brill, 2003), pp. 137-139. This is just one example in which Levi is inconsistent in his terminology. I intend to demonstrate and explain this inconsistency in a separate study. [↑](#footnote-ref-40)
41. For the notion of “second intention”, see below p. 13. I am grateful to one of the anonymous referees for *Aleph* for his important suggestions regarding the English translation of this passage. [↑](#footnote-ref-41)
42. These two parameters are already mentioned in Aristotle’s *Meteorology* I:3, 341a19-29. Following Aristotle, these parameters can also be found in Averroes’ Middle Commentary of Aristotle’s *Meteorology*. See Fontaine, “Between Scorching Heat and Freezing Cold,” pp. 120-121. [↑](#footnote-ref-42)
43. This is a rough division of the world into two areas. The amount of heat caused by reflection also depends on the specific latitude of each location. For a location on the Earth’s northern hemisphere that is close to the equator, for example, the heat-generating reflection has a greater impact when the Sun is closer to the equator, and not when it is closer to the northernmost part of its orbit. [↑](#footnote-ref-43)
44. See Ibn Tibbon’s translation of the Epitome: Paris, MS héb 935, fols. 83v-84r. The phrase “the second region of the air” is also used by Samuel Ibn Tibbon in his *ʾOtot ha-šamayim*. See *Otot ha-Shamayim*. Samuel Ibn Tibbon’s Hebrew Version of Aristotle’s *Meteorology*, ed. and trans. Resianne Fontaine (Leiden: E.J. Brill, 1995), pp. 46-56. [↑](#footnote-ref-44)
45. Ofer Elior, *A Spirit of Grace Passed Before My Face: Jews, Science and Reading 1210-1896* (Jerusalem: The Ben-Zvi Institute, 2016) (Heb.), VII, §49, p. 253; and see Elior’s note on p. 41. I am grateful to the editors of *Aleph* for this reference. [↑](#footnote-ref-45)
46. See above, p. 6. [↑](#footnote-ref-46)
47. Cf. *Rasāʾil Ibn Rushd. Jawāmiʿ al-Āthār al-ʿulwiyya* (Hyderabad: Dāʾirat al-maʿārif al-ʿuthmāniyya, 1947), p. 8, lines 5-9; Ibn Tibbon’s translation: Paris, MS héb 935, fol. 80v. [↑](#footnote-ref-47)
48. Levi ben Avraham*, Livyat Ḥen: The Secrets of the Faith and the Gate of the Haggadah*, ed. Kreisel, pp. לט-מה (39-45 in Hebrew characters). [↑](#footnote-ref-48)
49. Levi ben Avraham*, Livyat Ḥen: The Work of the Chariot*, ed. Kreisel, appendix A., pp. 242-244. [↑](#footnote-ref-49)
50. Levi cites the following Talmudic dictum: “Were it not for the heat of *Kesil*, the world could not endure the cold of *Kimah*; and were it not for the cold of *Kimah* the world could not endure the heat of *Kesil*”(*Berakhot*, 58b)*.* [↑](#footnote-ref-50)
51. See above, n. 49. The central role of the celestial influences on the sublunar natural phenomena is well evident in *Livyat ḥen*. I intend to discuss Levi’s approach to astrology in a future study. For now, see Levi’s introduction to the astrological chapter of *Livyat ḥen* III: Paris, Bibliothèque Nationale de France, MS héb 1066 (IMHM33999), fols. 1r-4v, and esp. fol. 1v, lines 26-28. On the role of the celestial bodies in the work of creation in *Livyat ḥen*, see Freudenthal “The Medieval Hebrew Reception of Avicenna’s Account of the Formation and Perseverance of Dry Land,” part V, pp. 283-295. [↑](#footnote-ref-51)
52. See Levi ben Avraham*, Livyat Ḥen: The Work of the Chariot*, ed. Kreisel, appendix A., p. 243, line 14; and esp. p. 244, lines 5-7; p. 76. The question whether or not the heavenly bodies exist for the sake of the sublunar realm was also discussed by other Jewish scholars at the time: cf. Falaquera’s opinion: Freudenthal, “Providence, Astrology, and Celestial Influences,” pp. 355-356; Gersonides’ opinion: Glasner, *Gersonides. A Portrait of a Fourteenth-Century Philosopher-Scientist*, pp. 88-91. [↑](#footnote-ref-52)
53. See p. 10. This phrase is used only once throughout the astronomical chapters of *Livyat ḥen*, but appears several times in *Livyat ḥen*’sfifth book (the book on metaphysics). See, Levi ben Avraham*, Livyat Ḥen: The Work of the Chariot*, ed. Kreisel, appendix A., p. 237, n. 165; p. 243, line 6; p. 244 line 5. [↑](#footnote-ref-53)
54. R. W. Sharples, “Alexander of Aphrodisias on Divine Providence: Two Problems,” *The Classical Quarterly* vol. 32, no. 1 (1982): 198-211, on p. 199, n. 13. [↑](#footnote-ref-54)
55. See, for example, *Averroes on Aristotle’s Metaphysics: An Annotated Translation of the So-called Epitome*, ed. Rüdiger Arnzen (Berlin: Walter de Gruyter, 2010), pp. 178-179; *Averroes’ Epitome of Aristotle’s De Caelo*, ed. Sasson Horesh, p. 56; Levi ben Avraham*, Livyat Ḥen: The Work of the Chariot*, ed. Kreisel, appendix A., p. 237, n. 165. [↑](#footnote-ref-55)
56. *Battei ha-nefeš ve-ha-leḥašim* (completed in 1276) is a rhymed poem in ten chapters that intends to offer a concise introduction to philosophy, science, and religion. For an overview of this work see Harvey, “Levi ben Abraham of Villefranche’s Controversial Encyclopedia,” pp. 171-173; Kreisel, *Judaism as Philosophy*, pp. 120-121. For the parts that were published, see Levi ben Avraham*, Livyat Ḥen: The Secrets of the Faith and the Gate of the Haggadah*, ed. Kreisel, p. יד, n. 8. [↑](#footnote-ref-56)
57. In addition to *LḤ*, Va, these signs are embedded in *LḤ*, P and in London, The Montefiore Library, MS 484 (IMHM 6113). [↑](#footnote-ref-57)
58. Vatican, Vatican Library, MS Urbinati ebr. 43 (IMHM 682), fol. 162r. [↑](#footnote-ref-58)
59. See Paris, Bibliothèque Nationale de France, MS héb 962 (IMHM 32610), fol. 72r. Cf. Averroes’ original and Ibn Tibbon’s translation, mentioned in n. 47. It should be noted that there is no evidence that Gersonides was familiar with *Livyat ḥen*. It is neither mentioned by Gersonides nor listed in the catalogue of his private library. [↑](#footnote-ref-59)
60. Paris, MS héb 962, fols. 72r-73r. [↑](#footnote-ref-60)
61. Paris, MS héb 962, fol. 73r. [↑](#footnote-ref-61)
62. *MH*, V.II.6, pp. 201-205. And see, Y. Tzvi Langermann, “Gersonides on the Magnet and the Heat of the Sun,” in *Studies on Gersonides, a Fourteenth-Century Jewish Philosopher-Scientist*, ed. Gad Freudenthal (Leiden: Brill, 1992), esp. pp. 276-282. On the concepts of rays and “divine power”, see Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” pp.75-93; Glasner, *Gersonides. A Portrait of a Fourteenth-Century Philosopher-Scientist*, pp. 85-98, esp. pp. 85-87, 96. On Levi ben Abraham and the Pseudo-Avicenna’s theory of rays, see above, p. 7. [↑](#footnote-ref-62)
63. See, for example, Glasner, *Gersonides. A Portrait of a Fourteenth-Century Philosopher-Scientist*, esp. chapter 7, pp. 81-98; Y. Tzvi Langermann, “Gersonides on Astrology,” in *The Wars of the Lord*, vol. 3, trans. Seymour Feldman (Philadelphia: Jewish Publication Society of America, 1999), pp. 506-519; Gad Freudenthal and Resianne Fontaine, “Gersonides on the Dis-/order of the Sublunar World and on Providence,” *Aleph*, vol. 12, no. 2 (2012): 299-328; Shlomo Sela, “Gersonides’ Astrology and Abraham Ibn Ezra,” *Aleph*, vol. 17, no. 2 (2017): 251-333; Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology”. [↑](#footnote-ref-63)
64. On Averroes’ account of providence in these commentaries, see Freudenthal, “The Astrologization of the Aristotelian Cosmos,” pp. 241-244. Averroes’ Epitome of the *Metaphysics* is listed in the catalogue of Gersonides’ private library. See Gérard E. Weil, *La bibliothèque de Gersonide* (Louvain and Paris: E. Peeters, 1991), p. 47, item §29. Levi composed a supercommentary on Averroes’ Epitome of *Generation and Corruption* at to the end of 1321. [↑](#footnote-ref-64)
65. See Ahuva Gaziel, “Gersonides’ Naturalistic Account of Providence in Light of the *Book of Animals*,” *Aleph*, vol. 12, no. 2 (2012): 243-271; Warren Zev Harvey, “Gersonides and Spinoza on Conatus,” *Aleph*, vol. 12, no. 2 (2012): 273-297. [↑](#footnote-ref-65)
66. Levi ben Gershom (Gersonides), *The Wars of the Lord*; An Annotated Critical Edition of Treatises 1-4, eds. Ofer Elior and Charles Touati (Tel Aviv: The Haim Rubin Tel Aviv University Press, 2018) [hereafter *MH2*], IV.6, p. 399; (*MH*, p. 170); cf. above, p. 10. The English quotation is taken from Gersonides, *The Wars of the Lord*, vol. 2, trans. Seymour Feldman (Philadelphia: Jewish Publication Society of America, 1987), p. 183. [↑](#footnote-ref-66)
67. *MH*, V.II.8, pp. 207-208; cf. above, p. 11, argument 2.a.i. [↑](#footnote-ref-67)
68. *MH2*, II.2, p. 221 (*MH*, p. 96). [↑](#footnote-ref-68)
69. See the quotation in Glasner, *Gersonides. A Portrait of a Fourteenth-Century Philosopher-Scientist*, p. 83; cf. above, p. 11, argument 2.a.ii. [↑](#footnote-ref-69)
70. Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology”. [↑](#footnote-ref-70)
71. See Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” esp. pp. 111-116; Charles H. Manekin, “Freedom Within Reason? Gersonides on Human Choice,” in *Freedom and Moral Responsibility: General and Jewish Perspectives*, ed. Charles H. Manekin (College Park: University of Maryland Press, 1997), pp. 165-204. [↑](#footnote-ref-71)
72. Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” pp. 122-123. [↑](#footnote-ref-72)
73. According to Gersonides, **providence is responsible** for the (almost) optimal distribution of the crafts among the people **of\in** any given society. See Sela, “Gersonides’ Astrology and Abraham Ibn Ezra,” pp. 294-296; Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” pp. 116-121. [↑](#footnote-ref-73)
74. Freudenthal and Fontaine, “Gersonides on the Dis-/order of the Sublunar World,” esp. pp. 314-316. [↑](#footnote-ref-74)
75. *MH2*, II.2, p. 219; (*MH*, p. 95). Shlomo Sela has suggested that Gersonides borrowed this idea from the first version of Abraham Ibn Ezra’s *Sefer ha-Šeʾelot*. And see, Sela, “Gersonides’ Astrology and Abraham Ibn Ezra,” pp. 289-294; Langermann, “Gersonides on Astrology,” p. 516; Freudenthal, “The Physical and Epistemological Foundations of Levi ben Gershom’s Astrology,” pp. 66-67, and esp. pp. 93-96. It should be noted, however, that according to Gersonides, the human[**’s?]** theoretical intellect is excluded from the influence of the heavenly bodies. See ibid., pp. 111-116. Levi ben Abraham, too, refers to the possibility of reading human thoughts, quoting Ibn Ezra’s *Sefer ha-Šeʾelot*, though not in the context of providence. See Paris, MS héb 1066, fols. 61v-63r. [↑](#footnote-ref-75)
76. E.g., Levi explicitly refers to *Sefer ha-Ṣurot* in *Livyat ḥen* III:40 (Paris, MS héb 1066, fol. 71v). The context is a practice for healing one’s kidneys **using** a golden lion-shape talisman. This specific practice was carried out by both Christian and Jewish physicians in Montpellier (e.g., in 1301 Arnold of Villanova treated the kidney of no other than Pope Boniface VIII using this practice), and **(it?)** was criticized by Abba Mari of Lunel. SeeJoseph Shatzmiller, “In Search of the *Book of Figures*: Medicine and Astrology in Montpellier at the Turn of the Fourteenth Century,” *AJS Review*, vol. 7/8 (1982/1983): 383-407; idem, “The Forms of the Twelve Constellations: A 14th Century Controversy,” in *Shlomo Pines Jubilee Volume on the Occasion of his Eightieth Birthday*, Part II (Jerusalem, 1990) (Heb.), pp. 397-408. *Sefer ha-Ṣurot* was also mentioned by Levi in the second section of *Livyat ḥen*. See, Levi ben Avraham*, Livyat Ḥen: The Quality of Prophecy and the Secrets of the Torah*, ed. Kreisel, p. 480; Levi ben Avraham*, Livyat Ḥen: The Secrets of the Faith and the Gate of the Haggadah*, ed. Kreisel, pp. 230-231 (where Levi states that he quotes *Sefer ha-Ṣurot*, and ascribes it to Galen; but his literal quotation is actually **(taken)** from the pseudo-Apollonius of Tyana’s *Great Introduction*. Cf. Paris, Bibliothèque Nationale de France, MS héb 1016 [IMHM 15715], fol. 14r-14v). And see, Dov Schwartz, *Astral Magic in Medieval Jewish Thought* (Ramat Gan: Bar-Ilan University Press, 1999) (Heb.), pp. 246-248; Reimund Leicht, “Toward a History of Hebrew Astrological Literature,” in *Science in Medieval Jewish Cultures*, ed. Gad Freudenthal (Cambridge: Cambridge University Press, 2011), p. 289. [↑](#footnote-ref-76)
77. This conclusion is also indicated by the fact that Levi did not limit himself to merely basic astronomical content or to any specific branch of astrology. *Livyat ḥen* III also includes instructions for using an astrolabe; a detailed discussion on the Jewish calendar and chronologies (including a short commentary on parts of Maimonides’ *Laws of the Sanctification of the Month*); extensive technical sections describing mathematical algorithms, which are the basis for different astronomical tables; a star catalogue; and a comprehensive treatment of all branches of medieval astrology. [↑](#footnote-ref-77)