

PREPRINT – A.Y. Reed, “Was there Science in Ancient Judaism? Historical and Cross-Cultural Perspectives on Religion and Science,” forthcoming in *Studies in Religion/Sciences Religieuses*.

The topic of “science”¹ and ancient Judaism has attracted surprisingly little scholarly attention (Sela 2003: 2-3; Alexander 2002). Research in the History of Science has traditionally privileged classical Greek traditions, while ignoring the investigation of the structures and cycles of the natural world in the ancient Near East (Rochberg 2002). Likewise, discussions of “religion” and “science” have tended to characterize “religion” in terms of Protestant Christian beliefs with little appeal to historical or comparative perspectives (Peterson 2000: 19-21; Samuelson 2005; Morowitz 2005; also Engler 2003: 416-19, 446-56). Treatments of “science” in the context of Jewish history, moreover, have been framed in terms of the participation of Jews in the scientific endeavors of *other* civilizations; studies have discussed individual Jews who happened to be scientists and scientists who happened to be Jews during the flowering of Islamic sciences in the Middle Ages, the Renaissance in Christendom, and the Scientific Revolution in Europe in the 17th and 18th centuries (Ruderman 1995: 14-15). Despite the disproportionate quantity of such figures, a sustained scholarly interest in Judaism and the sciences has emerged only recently.²

In our ancient Jewish sources, there are many passages of potential relevance to the broader discussion, including evidence from the apocrypha and pseudepigrapha, Dead Sea Scrolls, Hellenistic Jewish writings, classical Rabbinic literature, and Hekhalot corpus (Ruderman 1995: 375-82). Yet, so far, historical research on the place of the sciences in Jewish cultures has been largely limited to the medieval and modern periods (Sela 2003: 3; Ruderman 1995: 375). On the rare occasions that ancient sources have been brought to bear on discussions of Judaism and “science,” they have not been examined on their own terms. These discussions have focused on those traditions that would later become normative, appealing to the classical Rabbinic literature (compiled ca. 200-600 CE)³ while disregarding pre-Rabbinic and non-Rabbinic writings (e.g. Neusner 1988; Fisch 1997; Singer 2004; cf. Alexander 2002). Rather than locating Rabbinic sources in their own cultural contexts, moreover, studies have mined them for background to later developments and/or for support in contemporary debates (e.g., Lamm 1990).

At this stage in the history of research, it is not yet possible to locate scientific interests and inquiry within the cultural landscapes of ancient Judaism in a manner that does justice to the diversity and diffusion of our evidence. This essay will attempt to map part of this terrain and to chart directions for further study. It will begin by considering some of the methodological challenges involved in seeking evidence for scientific interests and inquiries in our ancient Jewish sources. It will then survey material related to astronomy and cosmology in Second Temple and Rabbinic Jewish sources. My inquiry will consider evidence for the practices of these sciences. My focus, however, will fall on the changing perceptions of “science” in Second Temple and Rabbinic Judaism. I will thus explore the representation of astronomy and cosmology in relation to more obviously “religious” practices such as biblical interpretation.

Ancient astronomies and cosmologies may provide precedents to modern sciences, but they also point to the important distinctions in the perception, categorization, and social location of such inquiries in different times and cultures (Lloyd 2002: 21-43, 135-41;

1991:141-63). In disciplines related to the stars and the cosmos within other cultures, “scientific” interests are often inseparable from “religious” concerns (Lloyd 2002:143; McCluskey 1998:51-113; Rochberg 2002). The same, as we shall see, is true of ancient Jewish astronomy and cosmology. The observation, prediction, and description of celestial cycles are tightly tied to the ritual, liturgical, and festal sanctification of time. Likewise, the practice of investigating the structure of the cosmos is inextricable from the practice of interpreting the Torah. Biblical interpretation also plays an important role in explaining, justifying, and contextualizing ancient Jewish involvement in the sciences.

For our inquiry into the place of “science” in ancient Judaism, the inextricability of “religious” and “scientific” concerns proves significant. In my view, our historical understanding of this topic suffers from the imposition of a modern notion of ancient Judaism [1] which emphasizes “religious” (esp. ethical and ritual) components while dismissing “scientific” interests as the product of assimilation or cultural contamination and [2] which limits itself to canonical sources, rather than drawing on the entire range of our extant evidence. What happens when we approach possible references to scientific inquiry within our ancient Jewish sources in the same way that scholars approach similar evidence from other cultures? In my view, a consideration of “science” may offer a fresh perspective on ancient Jewish views of knowledge, authority, cultural identity, and the cross-cultural transmission of traditions. At the same time, examples from ancient Judaism may help to illumine the role of historical contingencies and cultural specificities in shaping “science” and “religion” more broadly.

1. “Judaism” and “science”

Most treatments of “science” and ancient Judaism can be found, not in historical research, but rather in discussions of current issues. Biblical and Rabbinic sources are cited by Jewish philosophers, ethicists, and scientists in the course of debates about bioethics, creationism, and “religion” and “science” (e.g., Samuelson 2001, 2002, 2005; Gould 1999; Pollack 2000; Schroeder 1997, 2001; Kass 1985). Some use the ancient Jewish encounter with Greek sciences to discuss the challenges now faced by Jews in North America (e.g., Singer 2004), while others collect biblical and Rabbinic references to medicine, mathematics, and astronomy to celebrate the antiquity of Jewish contributions to the sciences (e.g., Rosner 1995; Dobin 1977; Feldman 1965; cf. Patai 1994). Rabbinic precedents also play a prominent role in efforts to find common ground between Jewish tradition and modern sciences in the discourse about *Torah u-Madda* among Orthodox Jewish scientists (on which see Rosenberg 1988).

Just as many discussions of “science” and ancient Judaism are oriented towards contemporary concerns, so it is difficult to avoid apologetics, even in the course of historical investigation. Relevant in this regard is the concern to defend Judaism against the charge, common in antiquity and modernity alike, that the Jews as a people contributed nothing *of their own* to the scientific, political, philosophical, and artistic development of world civilization (e.g., Josephus, *Against Apion* 2.135–136, 146). The importance of this issue within modern Jewish thought can be seen, for example, in the writings of Hermann Cohen (1842–1919), the neo-Kantian philosopher who first systematized the idea of Judaism as “ethical monotheism.” In his *Religion of Reason out of the Sources of Judaism*, Cohen asserts that “The Jewish law ... is to be understood and judged fairly only from the viewpoint of the ethical one-sidedness which had as its consequence abstention from any

independent interest in natural sciences” (Kaplan [trans.] 1972: 346). In his view, this paucity is both negative and positive. Within human history so far, Judaism’s “ethical one-sidedness” has resulted in a lack of any Jewish contribution to the sciences. According to Cohen, however, this blinkered focus on the ethical had the benefit of freeing the Jewish people from polytheism and “magic,” which go hand-in-hand with the human fascination with nature. For him, the alleged Jewish antipathy towards the natural sciences signals the potential for a modern philosophy based in Judaism to transcend “science” and bring humankind—Jewish and non-Jewish alike—nearer to truth and our potential to know it.

Cohen’s views on the topic are of course complex, and their ramifications for discussions of “religion” and “science” quite fascinating in their own right. For our purposes, what proves significant is that the same concerns arise in historical scholarship on ancient Judaism. Perhaps the clearest example is “Why no Science in Judaism?” (1988) by Jacob Neusner, one of the most prominent and prolific historians of ancient Judaism today. The essay begins with the observation that those Jews who were “nurtured by the canonical writings of Judaism” made no contribution to framing modern sciences; Neusner thus turns to the classical Rabbinic literature to explain what he sees as “the failure of Judaism in terms of its own indigenous logic to generate philosophy, including science” (1988: 45-46). Here, the question is not whether Rabbinic Jews engaged in scientific inquiry or how they integrated these practices into other aspects of Jewish culture, but why they were incapable of thinking scientifically.⁴ In a manner reminiscent of Cohen, he answers with an appeal to the uniqueness of Judaism, which he contrasts both to ancient Greco-Roman culture and to a secular modernity with deep roots in Protestant Christianity.

Neusner argues that “‘the mind’ of the Judaism of the dual Torah [i.e., classical Rabbinic Judaism] did not generate the kind of thinking that produced science” because its canonical documents inculcated a cognitive mode that is essentially incompatible with scientific and philosophical inquiry (1988:55-56). In his view, the Rabbinic emphasis on “fixed associations” negates the desire and the ability to discern other types of causal and logical connections. Much like Cohen, however, he proposes that it gives them something better instead:

a different search altogether from the philosophical and the scientific, which was, and is, that search for God whose being formed the unity, the simplicity, the order, the regularity, to which, in the mythic language of faith, sanctification in the world and salvation at the end of time referred (Neusner 1988:69).

Neusner’s 1988 essay is clearly meant to provoke. His bold claims have met with much critique and have sparked much needed discussion (e.g., Fisch 1997; Ruderman 1997: 4; Alexander 2002: 226).⁵ For our purposes, his essay proves helpful inasmuch as it addresses head-on many issues left tacit in other treatments of “science” and Judaism. Also notable, in my view, is the principle of selectivity that Neusner applies to the evidence, as it relates to the broader question of how cultural specificities factor into our discussions of “science” and “religion.”

In effect, Neusner defines “Judaism” as non-scientific. He acknowledges that some Jews have participated in scientific endeavors, but he reads their involvement in scientific endeavors as an abandonment of Judaism in favor of the logics and minds of other cultures (e.g. 1988:45). In defining the Judaism from which Jewish scientists allegedly depart, he is also selective. He privileges classical Rabbinic Judaism and singles out a specific text,

namely, the Bavli (i.e., the Babylonian Talmud). In his view, the Bavli determined normative Judaism from its inception to the present day, inculcating the modes of thinking now native to Judaism (Neusner 1988:53). Just as he slips from describing “the mind of the Judaism of the dual Torah” to making generalizations about “the mind of Judaism,” so he begins by characterizing the Bavli and ends up characterizing normative Judaism, even in the present day, as the continuation of the discourse begun in the Bavli, within the constraints determined by the Bavli.

Also significant is Neusner’s contrast between the ethical and “religious” orientation of Jewish modes of thinking and the philosophical and “scientific” orientation of the Greek modes of thinking, which he sees as inspiring all sciences, past and present. Such distinctions recall the dichotomous understanding of Hellenism and Judaism once common in theologically-informed studies on Christian Origins; there, the assertion of a contrast between Judaism and Hellenism served as a means to elevate Christianity as a unique synthesis of ethical monotheism and philosophical rationalism—as the best of both Jerusalem and Athens (see Martin 2001:29-49; Meeks 2001:18-20; Alexander 2001). To be sure, Neusner has very different reasons for contrasting the Hebrew and the Hellene. In one sense, however, his approach to Judaism and “science” is an inversion of the same dichotomy. Rather than denigrating Judaism’s allegedly strict limitation to the realm of the religious, he—like Cohen—celebrates it. As a result, however, he must downplay the diversity of our ancient Jewish sources and the diversity of intellectual interests displayed within them.

This selectivity is characteristic of the broader discussion, as is the contrast between the “religion” and morality of the Jews and the “science” and rationality of the Greeks (e.g. Caizza 2005; Morowitz 2005; cf. Samuelson 2005; Singer 2004:81). As noted above, the place of “science” in ancient Judaism has been mainly explored for apologetic, rather than historical, aims. Discussions have thus focused on texts that are now normative and approached the past in terms of models with which to understand the Jewish encounter with Western secularism in the modern day. Such issues have current relevance, and ancient Jewish sources play an important part in contemporary discussions. Nevertheless, it remains critical, here as elsewhere, to distinguish historical inquiry from modern issues. Even contemporary debates may perhaps benefit from a more accurate historical perspective on “science” in ancient Judaism, shorn of the biases of past scholarship as well as the apologetics of the present.

Were there, then, any scientific concerns within ancient Judaism? At this point, it should be clear that our answers will depend on how we choose to define “science” as well as how we choose to define “Judaism.” If we choose to limit our definition of “science” to branches of knowledge that are wholly autonomous from supernatural claims to truth, then it is true that we find few hints of scientific concerns in ancient Jewish literature. Such a definition, however, would also exclude almost all pre-modern sciences, including those of the Greeks (Alexander 2002: 224-25).

Strictly speaking, the meaning of the term “science” as it is used in modern parlance originated only in the nineteenth century, such that its semantic range embodies a series of changes in the conceptualization of knowledge during the Renaissance and the Scientific Revolution (Brooke 1991:19, 286-289). Although this development was multivalent and complex (Tambiah 1990:8-18; Brooke 1991:52-81; Henry 2002:1-13; Dear 2005), it suffices for our present purposes to note that one of the major factors was the growing

prestige of practical disciplines such as astronomy, chemistry, mathematics, and medicine; in medieval Christendom, these practices had been tainted with negative connotations and subordinated in status to the twin disciplines of Theology and Philosophy, which took more theoretical approaches to the structure of the cosmos and the causes of natural phenomena. Inasmuch as our modern concepts of “science” were shaped by the interpenetration of these disciplines in the early modern period, it would be anachronistic to approach the study of ancient Judaism with a notion of “science” as distinct from “religion” and “magic.” Indeed, research in the History of Science has demonstrated the importance of “magical” disciplines in cultivating the observational and experimental approach to nature upon which modern Western sciences are founded; pre-modern cultures rarely share our current concepts of the boundaries between astrology and astronomy, alchemy and chemistry, magic and medicine (Lloyd 2002: 21-43; Lindberg 2002:49-55; Ruderman 1995: 376-82; Sela 2001).

In his groundbreaking research into Jewish attitudes towards “science” in the early modern period, David Ruderman thus critiques “theoretical-typological discussions” such as Neusner’s that “reduce reality to a single categorization or abstract definition, flattening the differences of specific times and places into homogenous, immutable, and predictable entities called science and Judaism” (1995:4). Likewise, it may be best to approach ancient Judaism with a broader definition of “science,” which encompasses the many different ways in which knowledge gained from the observation of the natural world was systematized in specialized discourses within pre-modern cultures (Lloyd 2002: 1-3, 21, 142-47; Alexander 2002: 224-25). In contrast to a reified and essentialist definition of “science” that assumes its autonomy from the religious, political, and cultural values of a society, such an inclusive definition prompts us to look to our ancient sources to determine their own categories—as well as the social place and intellectual status of these modes of inquiry in relation to other domains of expertise (Barton 1997: 8-20; cf. Engler 2003).

How, then, do we determine the “Jewish-ness” of scientific material? Here too, comparison with other cultures may be helpful. Our evidence suggests that intercultural exchange contributed significantly to scientific developments in the diverse cultures of the ancient Mediterranean and Near East. It is somewhat specious to dismiss references to scientific interests in ancient Jewish sources as merely the taint of foreign influence on Judaism, since it is nearly impossible to extricate any other culture’s sciences from the web of foreign influences that shaped them (Neugebauer 1957: 67-68, 86-87, 169-71, 187; Evans 1998: 343; Cumont 1960: 9-16; Sabra 1987). Accordingly, it is problematic to speak of “Greek science,” “Babylonian science,” or “Jewish science” in any essentialist manner; we can discuss culturally-distinct disciplines and traditions of scientific inquiry, but the production and products of scientific knowledge are not limited to any single culture.

The cross-cultural pollination of scientific knowledge is explicitly discussed in our ancient sources. A number of Greek authors, for instance, readily admit the Greeks’ debt to the alien wisdom of the Egyptians and Babylonians, and they explain much in their own culture in terms of the more ancient civilizations whose knowledge they adopted. Since the time of Herodotus, it was a trope of Hellenistic historiography that the development of certain sciences could have only taken place in civilizations of great antiquity with stable, monarchic systems that enabled the long-term observation of the planets and the stars (e.g., Herodotus, *Histories* 2.4; Plato, *Timaeus* 22c-23b; Diodorus 1.9.6; 1.9.6; 1.81.4-5). The assertion of the Greek debt to ancient nations like Egypt and Babylonia is thus coupled

with the critique of oriental monarchy as a primitive stage in the political evolution of humankind, at the pinnacle of which stand the Greeks.

When we investigate ancient Judaism, we should similarly be attuned to the culturally-distinctive ways in which scientific knowledge—both foreign and indigenous in origin—was integrated within Jewish cultural systems and justified with appeal to Jewish traditions. Some Jews appear to have been actively involved in the cosmopolitan, cross-cultural exchange of knowledge in Hellenistic, Roman, and Persian empires. Porphyry, for instance, quotes a passage by Theophrastus (ca. 300 BCE) that depicts the Jews as philosophers who engaged nightly in astronomical observations (*On Abstinence* 2.26). That this image of the Jew is not merely a variation on the Hellenistic trope of the foreign sage is suggested by our evidence for ancient Jewish scientists. Galen uses the Hippocratic commentaries of the Jewish physician Rufus of Samaria (ca. 1st c. CE), and Zosimus (Sync. 297) and others make mention of the Alexandrian alchemist “Mary the Jewess” (ca. 1st/2nd c. CE), who is widely credited with the invention of several kinds of laboratory apparatus.⁶ Likewise, we find references to astronomers and physicians as well as astronomical, geographical, mathematical, and medicinal topics in ancient Jewish literature, including—and perhaps especially—in the Bavli (Feldman 1965; Beller 1988).

For our purpose, however, the more pressing question is how these areas of expertise were perceived in relation to other kinds of knowledge that were more obviously marked as “Jewish.” In what follows, we will investigate this question by considering the examples of astronomy and cosmology. References to both are widespread in Jewish literature. Moreover, such references occur in connection with what is perhaps the most paradigmatic of Jewish discourses, namely, biblical interpretation.⁷ By examining the intersections between astronomy and cosmology, on the one hand, and biblical interpretation, on the other, we may be able to shed light on the ways in which these scientific practices were perceived within ancient Jewish cultures.

We will begin with the example of astronomy. The ancient Jewish study of the stars seems to have combined foreign and native elements. Accordingly, as we shall see, biblical interpretation was used to claim a Jewish pedigree for Babylonian, Egyptian, and Hellenistic astronomy but also to read astrology as a foil for the articulation of Jewish chosenness. Our earliest post-biblical references to astronomy use biblical figures to integrate insights from Mesopotamian scientific traditions into Jewish calendrical astronomy. Hellenistic Jewish references assume Jewish involvement in the cross-cultural production and dissemination of knowledge about the stars in the Greco-Roman world. References in the classical Rabbinic literature may attest the development of a native Jewish tradition of mathematical astronomy, which was both celebrated and shrouded in secrecy.

Further to illumine the place of scientific inquiry in classical Rabbinic culture, we will then consider the example of cosmology. Our discussion will center on the interpenetration of exegetical and scientific inquiry in the Rabbinic discourse about *Ma’aseh Bereshit* (lit. “Work of Creation”). Perhaps tellingly, this term denotes both [1] the story of God’s creation of the cosmos in the first chapter of Genesis and its investigation through biblical interpretation and [2] the cosmos and its investigation through observation and analysis. This Rabbinic category combines elements of what we call “religion” and what we call “science.” The category, moreover, is marked as esoteric. By considering Rabbinic references to *Ma’aseh Bereshit* in light of post-Talmudic scientific treatises and medieval

claims to know the secrets of Rabbinic sciences, we will investigate whether and how these claims may speak to the social location of the study of the cosmos and its cycles within classical Rabbinic culture.

2. *Astronomy and Astrology: Jewish Identity and the Study of the Stars*

Although almost wholly absent from the Hebrew Bible (Bar-Ilan 2004), an interest in the study of the stars can be found across virtually the entire continuum of pre-modern Jewish literature. Astronomy is, in fact, the topic of our earliest extant extra-biblical text, the *Astronomical Book* (*1 Enoch* 71-82). This Aramaic apocalypse dates from the third century BCE and describes the reception of secret knowledge about the movements of the sun, moon, and stars by the biblical figure Enoch during his tours of heaven. Interestingly, its astronomy is based on an ancient Babylonian system and reflects none of the new advances that had been adopted in the rest of the Hellenistic world (Neugebauer 1985: 58-61; Stone 1988: 161-63). With regard to the issue of scientific knowledge and cultural specificity, this proves particularly intriguing, hinting at a situation far more complex than Neusner's view of "science" as Greek as opposed to Jewish knowledge: if the authors of the *Astronomical Book* resist the encroachment of Hellenistic culture in Ptolemaic Palestine by rejecting Greek sciences, they ironically do so by preserving Babylonian sciences (Stone 1988: 163-64; Reed 2005: 67-69; cf. Alexander 2002: 231-36).

Furthermore, the *Astronomical Book* places a Jewish stamp on this wisdom by means of biblical interpretation. By appealing to the terse yet suggestive comments about Enoch in Genesis, it uses a biblically-based etiology to present its own teachings about the cycles of the heavenly luminaries as revealed wisdom. True knowledge about the heavenly luminaries is traced to revelations received by this mysterious, ancient figure—who, according to Genesis, lived for 365 years, "walked with God," and was taken by Him in the days before the Flood (Gen 5:21–24).

The "scientific" concerns of the *Astronomical Book* have "religious" motivations, apparently rooted in its priestly concern for cosmic order and the calendar (VanderKam 1984: 90-106). Similarly, the *Book of the Watchers* (3rd c. BCE) uses Enoch to proclaim the cycles of the stars and seasons as paradigms for human ethics (*1 Enoch* 2-5), while the *Book of Jubilees* (2nd c. BCE) uses him to argue for the correctness of the solar calendar for determining the proper times for Jewish fasts and festivals (4:17-18, 6:32-38). In the latter, for instance, Enoch is depicted as the first man who learned to write and who "wrote down the signs of heaven according to the order of their separate months"; he is the one who "set in order the months and recounted the Sabbaths of the years as we [i.e., the angels] made known to him" (*Jubilees* 4:17-18).

The relevance of Enochic astronomy for the sectarian disputes of the Second Temple period is clear from the preservation of these books by the Qumran community, alongside a number of documents concerning the proper calculation of the calendar (CD 16,2-4; 4Q317; 4Q319-330; Glessmer 1999; Talmon, Ben-Dov, and U. Glessmer 2001). In the *Book of the Watchers* and *Jubilees*, the celebration of astronomical wisdom is paired with the denigration of the observation of the celestial bodies for divinatory aims (*1 Enoch* 8:3; *Jubilees* 8:2-4; Reed 2005: 37-44).⁸ In the Dead Sea Scrolls, however, we find astrological and other mantic materials (e.g. 4Q186, 4Q318, 4Q534, 4Q561) alongside astronomical and calendrical materials. Whereas the authors of the *Book of the Watchers* and *Jubilees* seem to bear suspicions towards celestial divination, the Qumran community appears to

have included those with interests in a broader range of sciences, including astronomy as well as astrology and physiognomy. Taken together, these Aramaic and Hebrew texts attest a range of interests not represented within the Hebrew Bible, evincing the cultivation of Mesopotamian scientific traditions among Judaeans scribal and priestly circles in the Land of Israel (Albani 1994; Glessmer 1996; VanderKam 1998:71-90; Geller 1998; Ben-Dov and Horowitz 2005; also Albani and Glessmer 1997).

In Jewish literature penned in Greek, we also find cases in which the conceptualization of “religious” knowledge integrates “scientific” traditions. Just as the *Astronomical Book* and *Book of the Watchers* use Enoch to integrate Mesopotamian sciences, so Jews in the Diaspora appealed to biblical heroes to express their participation in the multi-cultural scientific enterprises of the Hellenistic world. Building on the international character of the ancient Israelite Wisdom tradition, for instance, the Wisdom of Solomon (1st c. CE Egypt) appeals to King Solomon to voice its view of divine wisdom as including topics treated by Hellenistic philosophers, physicians, and astronomers:

the structure of the world and the activity of the elements; the beginning and end and middle of times, the alternations of the solstices and the changes of the seasons, the cycles of the year and the constellations of the stars, the natures of animals and the tempers of wild beasts, the powers of spirits and the reasoning of men, the varieties of plants and the virtues of roots (7:17-21).

Similarly, *2 Enoch* (1st c. CE Egypt?) uses the biblical trope of God’s six days of creation and the extrabiblical trope of Enoch’s tours of heaven to articulate a version of the Enochic calendar, astronomy, and cosmology shaped by dialogue with Greek and Egyptian ideas.

Some Jews also engaged in the broader discourse about the place of various nations within universal history. Just as the Egyptian and Babylonian historians seem to have cultivated the Greek view of their nations as reservoirs of ancient wisdom in order to assert their superiority over the regnant culture, so Hellenistic Jewish historians defended the Jewish contribution to world civilization (Sterling 1992; Reed 2004: 136-45). In Greek discussions about the antiquity of “barbarian” nations, scientific knowledge played a major role (e.g., Herodotus 2.4.1-2; Diodorus 1.69.2-7, 1.96.1-3, 1.98.1-4; Vitruvius, *On Architecture* 9.6.2). Likewise, Egyptians and Babylonians claimed credit for the invention of *technai* like astronomy, mathematics, and writing (e.g. Berossus *apud* Sync. 29.11-16, 53-36, 390; Chaeremon, frg. 2, in van der Horst 1984: 8-13). In response, some Jews appealed to Abraham to argue too for the antiquity of the Jews and their participation in sciences more ancient than the Greeks.

A pivotal proof-text was Genesis 12:10-20, which tells of Abraham traveling to Egypt soon after arriving in the Promised Land. Although the biblical account contains no reference to the stars, a number of exegetes read Abraham’s origins in “Ur of the Chaldees” (Gen 11:28, 31) in terms of the study of the stars, consistent with the astrological associations of the term for “Chaldean” in Aramaic, Greek, and Latin. Writing in the second century BCE, for instance, Artapanus (*apud* Eusebius, *Praep.ev.* 9.17.2-9) and Pseudo-Eupolemus (*apud* Eusebius, *Praep.ev.* 9.18.1) understand this biblical narrative in terms of their own cosmopolitan contexts: they depict Abraham as a Chaldean scientist and suggest that his sojourn in Egypt was the occasion for the patriarch’s transmission of Mesopotamian astrological and/or astronomical wisdom to Egypt, from whence the Greeks came to learn it.⁹ The father of the Jews is thus depicted as ultimately responsible for the scientific achievements of the Egyptians and Greeks.

In the writings of the first-century CE Jewish historian Josephus, we similarly find cosmopolitan conceptions of “science” exploited for the sake of cultural prestige. Josephus follows earlier Jewish exegetes in locating the origins of systematic astronomical observation with long-lived patriarchs from before the Flood—in his case, with the sons of Seth (*Antiquities* 1.69–70). He also follows Artapanus and Pseudo-Eupolemus in interpreting Abraham’s sojourn in Egypt in Gen 12:10-20 as the occasion for his transmission of Chaldean mathematics and astronomy to Egyptian priests (*Antiquities* 1.154-168; Reed 2004: 129-36). Josephus, however, simultaneously uses scientific wisdom to elevate Abraham and uses Abraham to undermine scientific wisdom. Answering Genesis’ silence about God’s motivation for choosing Abraham, Josephus recounts how Abraham deduced the truth of monotheism from the observation-based conclusion that the heavenly luminaries cannot be divine, since their movements across the heavens are irregular (*Antiquities* 1.155–156; cf. *Jubilees* 12:16-22). According to Josephus, the Egyptians—and, hence, the Greeks—owe their scientific achievements to this Jewish sage. Yet Abraham’s astronomy led him to discover something far greater, namely, the very monotheism that sets the Jews apart from other nations (Reed 2004: 127-29).

In Josephus’ account of Abraham, no mention is made of the study of the stars for divinatory purposes. In other first-century sources, such as the *Third Sibylline Oracle* (218-228) and Philo of Alexandria’s *On Abraham* (69-71), it is astrology, more specifically, which serves as a foil for articulating Abraham’s chosenness. These authors use astrology to delineate the differences between Israel and other nations. In adopting this attitude towards astrology, however, they also participate in a trans-creedal discourse about “science” and the study of the stars—albeit in a different way than Artapanus and Pseudo-Eupolemus. It is perhaps not coincidental that Jewish denigration of astrology peaks at the same time as the devaluation of astrology in the Roman Empire, after its sudden rise in prominence as a tool of imperial propaganda under Augustus and its subsequent marginalization due to fears about its potential misuse as a tool of rebellion (Barton 1997: 27-62; Reed 2004: 145-56). The first-century Roman author Pliny, for instance, makes pointed efforts to distinguish between astronomy, which he elevates to the status of “science,” and astrology, which he depicts as tainted both by its non-Roman origins and by its association with “magic” (*Natural History* 30; Reed 2004: 153-56; Veltri 1998). Likewise, Josephus associates Abraham with the scientific study of the stars, but he laments the popularity of the divinatory study of the stars by the Jews of his time; he even associates the outbreak of the Jewish Revolt against Rome with the misinterpretation of celestial signs (*War* 6.288–309).

We find a similar dynamic in the classical Rabbinic literature (Veltri 1998). In the context of discussions about astrological determinism and the chosenness of the Jewish people, late antique Rabbis connect Abraham with the sciences of his Chaldean past. In Rabbinic tradition, the discussion is dissociated from Abraham’s Egyptian sojourn (e.g., *Genesis Rabbah* 40.6), and no explicit reference is made to the scientific traditions of any other nations. Rather, Abraham’s relationship to the study of the stars is explored through Genesis 15, which recounts God’s establishment of the covenant with Abraham and which includes his statement to Abraham to “Look toward heaven, and number the stars” (15:5).

The fifth-century midrashic compilation *Genesis Rabbah* preserves several interesting examples. In one tradition, attributed to R. Samuel b. Isaac, Abraham is depicted as an astrologer, and astrological determinism is both confirmed and circumvented:

And Abram said: “Behold! To me you have given no seed” (Gen 15:3). R. Samuel b. Isaac commented: “[Abraham said:] My planetary fate [*mazzal*] oppresses me and declares, ‘Abram cannot beget a child.’” The Holy One, blessed be he, said to him: ‘Let it be even as your words: Abram and Sarai cannot beget. But Abraham and Sarah can beget!’” (*Genesis Rabbah* 44.10)

Even as R. Samuel asserts that God freed Abraham and Sarah from the childlessness fated to them by planetary forces, he does not dismiss the efficacy of astrology. It is only by means of a divine name-change (i.e., Abram to Abraham and Sarai to Sarah; Gen 17:5, 15) that the patriarch and his wife are granted new fates. Although God is more powerful than the stars, he still works with the astrological system.

Other traditions are more explicit in reading God’s chosenness of Abraham in terms of his freedom from the bondage of astrological determinism:

“And he brought him forth outside” (Gen 15:5). R. Joshua said in R. Levi’s name: “Did he then lead him forth from ‘outside’ the world, that it says, ‘and he brought him forth outside’ (Gen 15:5)?” It means that he showed him the streets of heaven, as you read [in Scripture]: ‘While as yet he had not made the earth nor the outer spaces’ (Prov 8:26).”

R. Judah b. R. Simon said in R. Johanan’s name: “He lifted him up above the vault of heaven; hence he says to him, ‘Look now toward heaven’ (Gen 15:5). “Look” signifies to look down from above!”

The Sages said: “[God said to him]: ‘You are a prophet, not an astrologer,’ as it says [in Scripture]: ‘Now therefore restore the man’s wife, for he is a prophet’ (Gen. 20:7). In the days of Jeremiah, the Israelites wished to entertain this belief [i.e., in astrology], but the Holy One, blessed be he, would not permit them. Thus it is written: ‘Thus says the Lord: ‘Learn not the way of the nations, and be not dismayed at the signs of heaven,’ etc. (Jer. 10:2)—[meaning that God said to them:] ‘your ancestor Abraham wished to entertain this belief long ago, but I would not permit him!’”... (*Genesis Rabbah* 44.12)

Like Enoch in the *Astronomical Book*, *Book of the Watchers*, *Jubilees*, and *2 Enoch*, Abraham is here granted knowledge of the stars that surpasses any earth-bound scientist—after all, he has ascended to heaven (so too Pseudo-Philo, *L.A.B.* 18.5). Unlike the Chaldeans of his homeland, the father of the Jews has stood in heaven’s streets and peered down at the stars from above its vault. As in Josephus’ reading of Gen 12:10-20, however, this knowledge is simultaneously devalued. Not only is Abraham literally lifted out of the sphere of the stars’ sway, but the prophetic power of the patriarch and his progeny is contrasted with the divinatory practices of other nations. In the end, then, this midrash appeals both positively and negatively to Abraham’s association with the study of the stars, thereby asserting Israel’s “scientific” as well as “religious” superiority to other nations.

A similar ambivalence towards astrology is found in the Bavli. Tractate *Shabbat* 156a, for instance, contains a lengthy discussion of determinism that includes an appeal to the example of Abraham. The discussion begins with two traditions correlating the day and hour of a person’s birth with his/her personality traits and fate. A tradition of genethliological astrology, based on the planet (*mazzal*) of one’s birth,¹⁰ is here paired with a biblically-based theory of natal determinism, rooted in the account of God’s creation of the world in six days in Genesis 1. These traditions are followed by an affirmation of the power of the stars over human fate, attributed to R. Hanina: “The planetary influence (*mazzal*) gives wisdom. The planetary influence gives wealth. Israel stands under planetary influence [Lit. There is *mazzal* for Israel].”

R. Hanina's dictum is juxtaposed with dissenting opinions. Interestingly, the question is not whether celestial realities govern earthly lives but rather whether and how the chosen nation Israel may be exempted from this equation:

R. Johanan maintained: "Israel is immune from planetary influence (Lit. there is not *mazzal* for Israel)"... R. Johanan said: "How do we know that Israel is immune from planetary influence? Because it is said [i.e., in Scripture]: 'Thus said the Lord: Learn not the way of the nations, and be not dismayed at the signs of heaven, for the nations are dismayed at them' (Jer 10:2)—they are dismayed but not Israel!"

It is in this context that the redactors include a midrash on Genesis 15:

Rab too holds that Israel is immune from planetary influence. Rab Judah said in Rab's name: "How do we know that Israel is immune from planetary influence? Because it is said [i.e., in Scripture]: 'And he brought him [i.e. Abraham] outside' (Gen 15:5). Abraham pleaded before the Holy One, blessed be he, 'Sovereign of the Universe! 'One born in my house is my heir' (Gen 15:3).' 'Not so!' He replied, '[Your heir will be] one who will come forth out of your own loins' (Gen 15:4). 'Sovereign of the Universe!' he cried, 'I have looked at my astrological horoscope and find that I am not fated to beget child.' [God replied:] 'Go forth from your horoscope; for Israel is free from planetary influence. What is your calculation? Because *Zedek* [i.e., the Hebrew name for Jupiter] stands in the West? I will turn it back and place it in the East.' And thus it is written: 'Who has raised up *Zedek* from the East?' (Isa 41:2)—i.e., he summoned it for his [i.e., Abraham's] sake."

This tradition is similar to the tradition attributed to R. Samuel in *Genesis Rabbah* 44.10 (as quoted above; cf. *b. Nedarim* 32a). When Abraham here appeals to his horoscope to assert his childless fate, however, God responds by moving around the celestial bodies in order to change his fate.¹¹ The influence of the celestial bodies on human fate is left unquestioned. Yet, for Abraham, the Creator is willing to change creation.

In the classical Rabbinic literature, we also find hints of a view of the study of the stars that is closer to what we might call "science"—not only in its content and method but also in its level of social and intellectual prestige. After the destruction of the Second Temple (70 CE), the calendar remained a contested emblem of religious legitimacy (*m. Rosh Hashanah* 2.9; *b. Berakhot* 63a-b), and the fixing of new moons became a means of asserting the halakhic authority of the nascent Rabbinic movement (e.g., *m. Rosh Hashanah* 1.7). Initially, new moons seem to have been set by observation alone (e.g., *m. Rosh Hashanah* 1.5-7; 2.8; *t. Sanhedrin* 2.2-3). During Late Antiquity, however, Rabbis appear to have used mathematical methods for calculating new moons and *tequfot* (i.e., equinoxes and solstices) so as to determine the intercalation of months needed to maintain their lunisolar calendar (Beller 1988).¹² Not only are the necessary calculations complex, but Jewish calendrical requirements seem to have prompted the development of new methods of mathematical astronomy, independent from Babylonian and Greek traditions (Beller 1988; Neugebauer 1949:322-24).¹³ Whereas the first-century R. Gamaliel, for instance, is said to have had lunar diagrams to show witnesses to the phases of the moon (*m. Sanhedrin* 2.8), the third-century Mar Samuel is depicted as calculating the *tequfot* (*b. Eruvim* 56a; *b. Rosh Hashanah* 20b).

Interestingly, the Bavli includes the results of such calculations but no record of how they were reached (Feldman 1965). It does, however, attest the intellectual and social prestige granted to those who possessed such skills. In contrast to Second Temple literature, the classical Rabbinic literature does not justify calendrical knowledge with

appeal to heavenly ascent, angelic revelation, or biblical heroes; rather, late antique Rabbis legitimize mathematical astronomy largely with reference to Rabbinic heroes like Mar Samuel.¹⁴ Knowledge of how to intercalate years and fix new moons is associated with wisdom (*b. Sukkah* 28a). The rarity and the importance of such skills are evident in a saying attributed to Rav, to the effect that one may not speak to someone “who is able to calculate the *tequfot* and planetary courses [*mazzalot*] but does not” (*b. Shabbat* 75a).

The lack of details about this inner-Jewish scientific tradition in our sources may reflect Rabbinic attitudes towards this knowledge. Astronomical knowledge is celebrated but also guarded. Intriguing is the Bavli’s reference to a *baraita* (i.e., a first-century Rabbinic tradition) called the “secret of the calendar” (*sod ha-ibbur*) in tractate *Rosh Hashanah* 20b (cf. *b. Ketuboth* 112a). This *baraita* would become a topic of much interest in the Middle Ages, as would the other astronomical traditions to which the Bavli refers. The post-Talmudic treatise *Baraita de-Shmuel* (ca. 8th c. CE), for instance, came to be circulated as a record of Mar Samuel’s wisdom, and it provides details about the calculations behind some of the Bavli’s terse calendrical statements (so too *Pirque Rabbi Eliezer* 5-7). Likewise, medieval Jews such as Abraham Bar Hiyya (d. 1136) and Moses Maimonides (1135-1204) would claim to know the “secret of the calendar.”¹⁵

It is entirely possible that the Hebrew astronomical tradition of the Middle Ages owes some of its distinctiveness to a discipline of Rabbinic mathematical astronomy, as later interwoven with Islamic and Greek traditions (Goldstein 1965; Beller 1985; Neugebauer 1949). Whatever the precise historicity of later claims about Rabbinic calendrical and astronomical secrets, however, it is significant that late antique Rabbis even claimed to know scientific secrets about the stars and celestial cycles. It is also significant that medieval Jewish astronomers saw themselves as standing in a tradition of Rabbinic scientists (Ruderman 1997: 376). Contrary to Neusner’s view of “science” as non-Jewish and Judaism as non-scientific, the example of astronomy suggests that the ancient Jewish encounter with the sciences cannot be read simply in terms of the dangers of cultural assimilation, nor in terms of a perennial struggle between Judaism and Hellenism or “religion” and “science.” Some ancient Jews participated in cross-cultural scientific enterprises, justifying their practices through biblical interpretation. Others selectively appropriated the insights of Mesopotamian and Greek sciences for integration into Jewish traditions, reworking and developing them for their own aims. Still others, it seems, worked to cultivate culturally-distinctive scientific disciplines, independent from the scientific endeavors of other nations.

3. *Cosmogony and cosmology: The Rabbinic discourse on Ma’aseh Bereshit*

To explore the possibility that certain modes of scientific inquiry were practiced in classical Rabbinic culture as esoteric disciplines, it proves helpful to consider a category of knowledge that is emic to Rabbinic culture, namely, *Ma’aseh Bereshit*. As noted above, this category combines “religious” and “scientific” approaches to the cosmos and its creation. In some passages in the classical Rabbinic literature, *Ma’aseh Bereshit* is best translated as the “Account of Creation,” referring specifically to the account of God’s creation of the cosmos in six days in Genesis 1 (i.e, the hexameron, which commences with the word *bereshit*, “in the beginning”). In other passages, *Ma’aseh Bereshit* is better rendered as the “Work of Creation,” either in the sense of God’s act of forming the cosmos or in the sense of the cosmos itself, as the product of his creation (Halperin 1980:23).

Insofar as this category can encompass the investigation of the cycles of the sun, moon, and stars, analysis of references to *Ma'aseh Bereshit* may help to shed light on the Rabbinic conceptualization of the observational and theoretical investigation of the natural world (cf. Alexander 2002: 226).

The term *Ma'aseh Bereshit* bears a special relevance for discussions of Judaism and “science” insofar as Maimonides would later adopt this term as a designation for the natural sciences (*Guide I*, Pines [trans.] 1933:6-7).¹⁶ His definition is a medieval innovation, which reads the traditional texts of Rabbinic Judaism through Jewish, Islamic, and Greek philosophical categories (e.g., *Ma'aseh Bereshit* as physics and *Ma'aseh Merkavah* as metaphysics). Nevertheless, his redeployment of this term raises the possibility of certain conceptual continuities with earlier Jewish tradition.

The special status of *Ma'aseh Bereshit* is first articulated in the Mishnah. An anonymous ruling in tractate *Hagigah* 2.1 reads:

The laws of prohibited sexual relationships may not be expounded (*drsh*) by three, nor *Ma'aseh Bereshit* by two, nor the *Merkavah* by one, unless he is a sage and understands on his own.

Anyone who speculates into four things, it would be merciful for him if he had not come into the world: what is above, what is below, what is before, what is after. Anyone who has no concern for the honor of his Creator, it would be merciful for him if he had not come into the world.

The focus on the act of interpretation (*derashah*) suggests that *Ma'aseh Bereshit* is here being used to refer to the biblical account of creation (Halperin 1980:24-25). Read as such, this mishnah aims to limit the public exegesis of Genesis 1 in a manner that falls between the proscription concerning sexually-explicit material in Leviticus (*aravot*) and the proscription concerning material that can readily be interpreted in a mystical light, namely, the description of the *merkavah* (i.e., God’s chariot) in the Book of Ezekiel (chs. 1 and 10).

One might ask, however, why Genesis 1 finds itself in such company. Inasmuch as the divine creation of cosmos is so central to the Jewish understanding of the power and singularity of God, one might wonder why late antique Rabbis made efforts to distinguish the exegesis of *Ma'aseh Bereshit* from the rest of their midrashic endeavors, marking it as an esoteric discourse not fit for the ears of an uneducated public.

Scholars have answered this question in different ways. At one extreme is Nicholas Séd, who interprets this mishnah as an early Rabbinic attempt to suppress an ancient, non-Rabbinic Jewish tradition of “mystical cosmology” (1981). He finds hints of this tradition in a wide variety of texts and constructs its doctrine by drawing from a broad range of sources, from the third century BCE *Astronomical Book* to post-Talmudic texts such as *Midrash Kohen* and *Seder Rabbah di-Vreshit*. The latter explicitly claim to record the contents of the ancient secrets of *Ma'aseh Bereshit*. Although *Midrash Kohen* and *Seder Rabbah di-Vreshit* bear the marks of a late date, Séd takes their claims at face value. To lend support to his theory of a unified cosmological tradition that was—always and everywhere—a component of Jewish mysticism, he cites the fact that *Seder Rabbah di-Vreshit* was transmitted alongside the writings about the *merkavah* in the Hekhalot corpus (i.e., a group of writings associated with pre-Kabbalistic Jewish mysticism). These materials, however, date from many centuries after the Mishnah. And, as Peter Schäfer has

shown, *Seder Rabbah di-Vreshit*'s claim to preserve the secrets of *Ma'aseh Bereshit* more plausibly reflects the influence of the Mishnah and Bavli (Schäfer 2004).

At the other extreme is Alon Goshen-Gottstein (1995). He questions the tendency to assume without argumentation that the Mishnah's juxtaposition of *Ma'aseh Bereshit*, the *merkavah*, and speculation into "what is above, below, before, and after" proves cosmology's status as a branch of Jewish mysticism (1995:185). Instead, he interprets the Mishnah's reticence towards this topic as answering a much narrower phenomenon: the possibility that exegetes may dishonor God by investigating the materials that preceded his cosmogonical act (i.e., pre-created matter or chaos, as possibly denoted by the term *tohu va-bohu* in Gen 1:2).¹⁷ Goshen-Gottstein justifies his limited reading of the mishnaic proscription with appeal to the semantic range of *Ma'aseh Bereshit*. In his view, the term *Ma'aseh Bereshit* "is not suited to a description of esoteric teaching" precisely because "it is hard to believe that an esoteric teaching would be signified by the same term used to refer to physical reality revealed to all" (1995:197-98; cf. Halperin 1980:98-99).

Séd and Goshen-Gottstein voice differing views of the meaning of *Ma'aseh Bereshit* in ancient Judaism. Both, however, assume that the key issue is the relationship between this category of knowledge and *merkavah* mysticism. This focus is consistent with the overwhelming interest in the *merkavah* in the scholarly discussion of *Mishnah Hagigah* 2.1 and its parallels. At least since the time of Gershom Scholem, scholars have attempted to mine these passages for evidence of ancient Jewish practices akin to the "descent to the chariot" described in the *Hekhalot* literature. For our understanding of the Rabbinic discourse about *Ma'aseh Bereshit*, however, the category of "mysticism" may not prove so helpful. In scholarship on ancient Judaism, this term is often so laden with connotations of social marginality, spiritual authenticity, and experiential religiosity that it has lost much of its usefulness for historical description; moreover, it often functions within the scholarly discourse as an umbrella-term for any esoteric field of knowledge or practice, thereby encouraging the conflation of different phenomena and the imposition of less rigorous standards for judging the historical continuities between similar phenomena that occur in diverse times and places (Reed 2005: 274-76).

These tendencies are evident, in my view, in Séd's reading of the evidence, which equates esotericism with mysticism and, thus, treats the Mishnah's ruling about *Ma'aseh Bereshit* as evidence for a single tradition of mystical cosmology with an unbroken development from the Second Temple period to the Middle Ages. Goshen-Gottstein is surely correct to expose the scant scaffolding of evidence upon which Séd hangs his conclusions. In divorcing the exegetical meaning of *Ma'aseh Bereshit* so wholly from its cosmological connotations, however, he may go too far in the other direction. Goshen-Gottstein sees a conflict between the use of the term *Ma'aseh Bereshit* to denote both the visible world and an esoteric tradition about the creation and structures of that world. This apparent paradox, however, may lie at the heart of the issue.

When we examine our sources, it is clear that the semantic field of *Ma'aseh Bereshit* encompasses cosmogony, cosmology, and exegesis, and that these meanings rarely function as isolated elements. Rather than reading the Rabbinic discourse about *Ma'aseh Bereshit* only in terms of its relation to mysticism, it might thus be better to consider it in terms of the interplay between secrecy, scientific inquiry, and biblical exegesis explored above. When approached from this perspective, the Mishnah's assertion of the esoteric nature of biblically-based cosmology need not hint at any mystical practice. The Mishnah's attitude

towards *Ma'aseh Bereshit* may be more akin to the Bavli's reference to the *baraita* about the "secrets of the calendar" (*sod ha-ibbur*): the rhetoric of secrecy may reflect an effort to articulate, isolate, and elevate a certain domain of expertise, while enhancing the authority and intellectual prestige of those few who can master it.

Moreover, some connection with scientific interests is suggested by the cases in which the term *Ma'aseh Bereshit* denotes the product of the six days of creation. In its instructions about when to bless God as "the one who made *Ma'aseh Bereshit*," the Mishnah includes only the observation of "mountains, hills, seas, rivers, and deserts" (*m. Berakhot* 9). The commentary in the Bavli, however, adds occasions of observation that assume intimate familiarity with Rabbinic mathematical astronomy. According to the Bavli, one should also bless God as "the one who made *Ma'aseh Bereshit*" when one "sees the sun at its turning point (*tequfah*), the moon in its power, the stars in their orbits, and the constellations (*mazzalot*) in their orderly progress" (*b. Berakhot* 59a). This is followed by R. Abaye's explanation of when exactly this occurs: "Every twenty-eight years when the cycle [*tequfah*] begins again and the *tequfat Nisan* falls in Saturn on the evening of Tuesday, going into Wednesday" (*b. Berakhot* 59a; see also *Leviticus Rabbah* 23:8). The proclamation of wonder at *Ma'aseh Bereshit* is linked to astronomical observation and calculation.

For the issue of secrecy, most notable are the Rabbinic traditions surrounding *Mishnah Megillah* 4.10. This passage lists potentially problematic biblical pericopes, including a series of pericopes that should be read but not translated in public. Genesis 1 is absent from the list in the Mishnah. It is the first element, however, in the parallel passage in the Tosefta (*t. Megillah* 3.31-38) and in the commentary in the Bavli (*b. Megillah* 25a-b). Both agree that one can read Genesis 1 in public and in translation. Interestingly, however, the Bavli then goes on to explain *why* exactly this point must be clarified: if we were *not* told otherwise, we would surely assume that *Ma'aseh Bereshit* (i.e. Genesis 1) should not be translated, since it might lead people "to inquire into 'what is above and what is below, and what is before and what is after'" (*b. Megillah* 25a-b). Such passages suggest that the Rabbinic exposition of cosmogony and cosmology ranged from [1] the exoteric, liturgical use of Genesis 1 to celebrate God as Creator and thereby participate in his creation (i.e., the public recitation of *Ma'aseh Bereshit* = Genesis 1) to [2] the acceptable but esoteric investigation of the cosmos (i.e., *Ma'aseh Bereshit* = the products of God's act of creation) to [3] forbidden, biblically-based cosmological speculation (i.e., speculation into "what is above, what is below").

We find efforts to map the exact boundaries of the charged middle ground (#2) in the parallel to *Mishnah Hagigah* 2.1 in the Tosefta (*t. Hagigah* 2.1-7) and in the commentaries to this mishnaic ruling in the Yerushalmi (*y. Hagigah* 77a) and Bavli (*b. Hagigah* 12b-13a). Each includes a midrash on Deut 4:32, which is cited, explicitly in the case of the Bavli and implicitly in the case of the Tosefta and Yerushalmi, to explicate the mishnaic ruling. The result is a rather striking example of the complex, intertextual dynamics that characterize classical Rabbinic Judaism. In this case, a biblical text is used to explain a mishnaic ruling, which itself concerns the interpretation of another biblical text.

For this, Deut 4:32 is an apt choice. In this verse, Moses stresses the magnitude of God's power and mercy in delivering Israel from Egypt, in the context of explaining the commandments of the Torah by which the chosen nation will now live. Moses thus tells the Israelites to "ask into past days, which were before you, since the day that God created man

(*adam*) upon the earth, and ask from one end of heaven to the other, whether such a great thing as this has ever happened or was ever heard of.” Within the Tosefta, Yerushalmi, and Bavli, this intertext is used to interpret both the mishnaic limitation on public exposition of *Ma’aseh Bereshit* and its prohibition of speculation into “what is above,” etc. Although the limitations on *Ma’aseh Bereshit* are articulated with specific appeal to the text of Genesis 1, the introduction of Deut 4:32 as intertext prompts a shift in focus from biblical exegesis (“expounding”) to inquiry based in observation, theory, or speculation (“asking”).¹⁸

The intertextual appeal to Deut 4:32, however, does raise another problem. Deut 4:32 specifies that one should ask “since the day that God created (*bara*) man upon the earth,” potentially implying a ban on discussing the first five days of creation, since humankind was created on the sixth day. It is telling that our Rabbinic sources—explicitly in the case of the Yerushalmi (y. *Hagigah*. 77a) and implicitly in the case of the Bavli—circumvent this possible conclusion. They suggest instead that limitations are only placed on speculation about what happened before *Ma’aseh Bereshit* in its sense as the “Account of Creation” (i.e., before the Torah begins its account in Genesis 1:1). In both the Yerushalmi and Bavli, this is followed by an explanation of the Mishnah’s prohibition on speculation into “what is above,” etc., which appeals to the second clause of the biblical intertext. From Deuteronomy’s assertion that one should “ask from one end of heaven to the other,” the midrash concludes that one may speculate about the visible world *beneath* the heavens and *above* the abyss, but not into what lies *beyond* in either direction. The Yerushalmi follows this with a second interpretation of “from one end of heaven to the other” (Deut 4:32) which serves to emphasize that these prohibitions intend, not to limit the inquiry of the human mind, but rather to distinguish between esoteric and exoteric levels of discussion: one can investigate the time before creation by oneself, whereas the rest of creation can—and should—be expounded in public with a voice so loud that it sounds “from one end of the world to another” (y. *Hagigah* 77a).

In both the Yerushalmi and the Bavli, multiple traditions about the proper limits of inquiry into *Ma’aseh Bereshit* are collected and juxtaposed. In both, for instance, we find aggadic traditions that illustrate the danger of dishonoring God through biblically-based cosmological speculation, alongside midrashic traditions that engage in exactly those types of speculation. In the Yerushalmi, these traditions are prefaced by a tradition questioning the need for secrecy about *Ma’aseh Bereshit*; whereas the mishnaic proscription against public exposition of the *Merkabah* is upheld as universal opinion (*dibre hakkol*), the mishnaic limitation on public inquiry into *Ma’aseh Bereshit* is attributed to R. Akiva and contrasted with a dissenting opinion attributed to R. Ishmael, instructing that *Ma’aseh Bereshit* can be expounded (y. *Hagigah*. 77a). In the Bavli, the bounds of secrecy are both expressed and boldly transgressed. Discussion of the limits of *Ma’aseh Bereshit* occasions extensive discussion of the structure and contents of the multiple heavens and the multiple earths that lie above and below the visible world (Schäfer 2004; 2005).

We find a similar dynamic in the Rabbinic interpretation of Genesis 1 in *Genesis Rabbah* (Alexander 1992). This midrash is contemporary with the Yerushalmi and integrates many of the same comments about the limitations on investigation into *Ma’aseh Bereshit*. Nevertheless, *Genesis Rabbah* also dedicates many chapters to expounding and expanding on the Torah’s account of the six days of creation. On the one hand, the reader gets the impression that the task of interpreting the beginning of Genesis should never be taken lightly. On the other hand, *Genesis Rabbah* breaks nearly every ruling that it cites—

including the limitation on speculation about what occurred *before* the Torah begins its account of creation in Genesis 1:1 (Alexander 1992).

Genesis Rabbah is shaped by the “religious” aim of using Genesis to proclaim the glory of God as well as the centrality of the Torah and the nation Israel in his creation. Its traditions are framed, however, by an understanding of the Torah *both* as written revelation *and* as God’s blueprint for creation (*Genesis Rabbah* 1.1; cf. Prov 8:22); consequently, as P. S. Alexander has noted, “Torah and nature are congruent”—“[w]hen questions arise about the workings of nature, the Rabbis sometimes find the answers in Torah, sometimes in direct observation of nature itself” (2002: 230; e.g. *Genesis Rabbah* 4.4; 6.8).

In its use of the hexaemeron to discuss “scientific” as well as “religious” ideas about cosmogony and cosmology, *Genesis Rabbah* is hardly alone. On some level, this type of appeal to Genesis 1—as legitimizing frame for speculative wisdom and “scientific” knowledge—might lie behind the Mishnah’s strictures on speculation into *Ma’aseh Bereshit*, albeit in a fashion far less direct and univalent than Séd suggests. In pre-Rabbinic, Rabbinic, and post-Talmudic Jewish sources, we find retellings, interpretations, and commentaries on Genesis 1 that integrate “scientific” elements. In *Jubilees*, for instance, calendrical comments are appended to the description of God’s creation of the heavenly luminaries on the fourth day (2.2–16). In *2 Enoch*, a retold hexaemeron is similarly used to convey “scientific” knowledge (24–32). Even the Bavli contains an example of the redeployment of the hexaemeron to express the continuity between Torah and “science”; as noted above, *b. Shabbat* 156a records a passage from R. Joshua b. Levi’s notebook that uses Genesis 1 to foretell the character and fate of a person based on the day of the week on which s/he was born.

In post-Talmudic midrashic and cosmological traditions, the six days of creation play a similar role. *Midrash Konen* and *Seder Rabbah di-Vreshit*, two cosmological texts that were probably written soon after the compilation of the Bavli, begin with an extended hexaemeral retelling (cf. *Sefer Yetzirah*). This biblical framing device, interestingly, here introduces descriptions of the structure and contents of the heavens and the earths that draw heavily on the Bavli—and, specifically, its comments about the heavens in its commentary on *m. Hagigah* 2.1 (Schäfer 2004). These post-Talmudic texts, in effect, derive their “religious” and “scientific” authority from *Ma’aseh Bereshit* in every sense of the term: they appeal to the Torah’s account of creation but also claim to reveal the secrets of a tradition of Rabbinic inquiry into the cosmos.

Likewise, the expansive paraphrase of Genesis 1 in *Pirqe Rabbi Eliezer* (chs. 3-11; ca. 8th–10th c.) combines elements from the homiletical interests of *Genesis Rabbah* with the scientific knowledge associated with *Ma’aseh Bereshit* and *sod ha-ibbur* in the Bavli. Astronomical information is seamlessly integrated into midrashic traditions. When discussing the fourth day of creation, for instance, *Pirqe Rabbi Eliezer* includes a lengthy and detailed astronomical section (chapters 5-7) that discusses the cycles of the sun, moon, constellations, and *tequfot*. Like the *Baraita de-Shmuel*, to which its astronomy is closely related, *Pirqe Rabbi Eliezer* makes explicit many of the details of the mathematical astronomy left unexplained in the Bavli and earlier literature. In content, the hexaemeral retelling of *Pirqe Rabbi Eliezer* thus exemplifies the combination of “scientific” (astronomical, calendrical) and “religious” (midrashic, ethical, angelological) elements in the Rabbinic discourse about cosmogony and cosmology.

Some reflex of the esotericism of the earlier tradition may be present in *Pirqe Rabbi Eliezer's* etiology of intercalation. In contrast to earlier Rabbinic discussions of the calendar and astronomy, this midrash explains the origins of the human reception of intercalation in a manner that echoes Second Temple Jewish traditions. According to *Pirqe Rabbi Eliezer*, God revealed the secret of intercalation to Adam, who passed it on to Enoch, who passed it on to Noah, who passed it on to Shem, and so on, in a hidden line of Jewish scientific transmission. Despite this schematization of the secrecy of Rabbinic scientific tradition, however, *Pirqe Rabbi Eliezer's* own orientation is exoteric. Like the *Baraita de-Shmuel*, it claims to express what earlier Rabbinic sources kept silent.

In my view, the Rabbinic discourse about *Ma'aseh Bereshit* provides a poignant response to Neusner's contrast between Judaism and "science." In the classical Rabbinic literature, as well as post-Talmudic sources, it seems that scientific interest is rooted precisely in the "search for God whose being formed the unity, the simplicity, the order, the regularity, to which, in the mythic language of faith, sanctification in the world and salvation at the end of time referred" (Neusner 1988:69). Rabbinic opinions on *Ma'aseh Bereshit* may differ, but all presuppose that the human effort to understand the visible products of God's creation is inseparable from the practice of interpreting the Torah. Inquiry into the cosmos and the Torah, moreover, are both understood in Rabbinic terms and linked to the authority of the Rabbis (Schäfer 2005). There may be efforts to guard Genesis 1 against the hermeneutical whims of anyone deemed uneducated or "heretical," but the Rabbis themselves appear to resist the imposition of any limits on their own midrashic endeavors—and, perhaps more surprisingly, they seem to resist the imposition of any limits on observation-based and speculation-based inquiries into cosmogony and cosmology, even beyond the bounds of the biblical accounts (Schäfer 2005).

Like astronomy, cosmogony and cosmology is initially cordoned off as an esoteric discourse in Rabbinic culture. These realms of inquiry are deemed too dangerous and important to be public; they must be protected from "heretics" (*minim*), who are presented as all too eager to misconstrue Genesis 1 and misunderstand the natural world (Alexander 1992). In the earliest Rabbinic literature (esp. Mishnah), this rhetoric of secrecy is matched by a silence on cosmology. Later, the rhetoric remains, but the silence is gradually broken. The Yerushalmi and *Genesis Rabbah* delineate cosmogony and cosmology as a special topic of inquiry, but they also transgress the very limits that they set (Alexander 1992). The Bavli answers the dangers of speculation into the cosmos by offering an alternative: it outlines a strongly ethicized cosmology (Schäfer 2005). By the time of *Midrash Kohen*, *Seder Rabbah di-Vreshit*, and *Pirqe Rabbi Eliezer*, the stress on secrecy serves mainly to add to the esoteric luster of increasingly exoteric traditions about the events before creation and the structures of the cosmos.

That the association of cosmology and esotericism would continue resonate, even into the Middle Ages, is evident in the interpretation of *Mishnah Hagigah* 2.1 offered by Maimonides. Maimonides elevates the philosopher-scientist's study of *Ma'aseh Bereshit*, which, as noted above, he and later authors define in terms of the natural sciences. Yet he also appeals to this same passage to assert that learned Rabbis should guard this knowledge from uneducated Jews, just as the philosophers of other nations veil their teachings in metaphors to hide them from the populace (*Guide* I 17, Pines [trans.] 1933:42-43). Whether or not the content of this secret knowledge has shifted, its social status and prestige remains the same.

4. Conclusion: Medieval perspectives on “science” and ancient Judaism

At first sight, the inner-Jewish orientation of Rabbinic astronomy and the Rabbinic strictures on cosmological speculation might seem to stand in contrast to the more open perspectives of earlier Jews, who lived under Hellenistic rule, and later Jews, who lived under Islamic rule. Were we to assume, like Neusner, that “science” is essentially foreign to Judaism, we might be tempted to downplay the place of scientific inquiry in classical Rabbinic culture, explaining Hellenistic and medieval Jewish perspectives on “science” primarily with reference to Jewish participation in other cultures.

The example of Josephus, however, demonstrates the continuity between Rabbinic views of astronomy and astrology and those of earlier Jews writing under Roman rule. Furthermore, the astronomical and cosmological materials in the classical Rabbinic literature point to the possibility that Rabbis were actively involved in developing, disseminating, and cultivating scientific traditions in Late Antiquity. No doubt, the secrecy surrounding these traditions had rhetorical purposes, serving to enhance the intellectual prestige of the Rabbinic movement in the eyes of the populace as well as to mark their scientific practices as distinct from those of their non-Jewish neighbors (e.g. *b. Pesahim* 94b). Nevertheless, the nature of the Rabbinic references to this knowledge does lend plausibility to the claim that late antique Rabbis developed and taught scientific skills, which were perceived as esoteric knowledge and which were thus not included in full in the literature of classical Rabbinic Judaism.

If so, then post-Talmudic texts such as *Baraita de-Shmuel*, *Seder Rabbah di-Vreshit*, *Midrash Kohen*, and *Pirque Rabbi Eliezer* may preserve part of a process, begun already in the Bavli, whereby scientific discourses that were deemed esoteric in classical Rabbinic culture (*sod ha-ibbur*; *Ma’aseh Bereshit*) began to be consolidated in written form. These post-Talmudic texts number among a group of understudied Hebrew sources that strongly exhibit scientific concerns.¹⁹ Written between the eighth and tenth centuries CE, these sources are distinguished by their explicit and detailed discussion of the scientific concerns referenced in the Bavli and earlier Rabbinic literature. For the most part, they are anonymous or pseudonymous in authorship. They discuss scientific traditions using Rabbinic literary forms (e.g., using midrash and/or written in the style of the Mishnah) and make explicit reference to classical Rabbinic literature.

As noted above, *Baraita de-Shmuel* and *Pirque Rabbi Eliezer* claim to know the “secret of the calendar,” while *Seder Rabbah di-Vreshit* and *Midrash Kohen* claim to convey *Ma’aseh Bereshit*. Our earliest extant Hebrew text on mathematics is called *Mishnat ha-Middot* and dates from the same period (early 9th c.); it is associated with R. Nehemiah and includes material about geometry as well as biblical interpretation. Also from this time is the oldest Hebrew text on medicine, Asaf ha-Rofe’s *Sefer ha-Refuot* (ca. 9th c.). The text is prefaced by an account of the Jewish origins of medicine; the angel Raphael here reveals knowledge of medicine to Noah, who passes it along to his son Shem. Interestingly, Asaf’s book circulated under a title taken from the tales in the Bavli about King Hezekiah hiding a “book of remedies” (*sefer refuot*; *b. Berakhot* 10b; *b. Pesahim* 56a; cf. 2 Kings 20:7).

The consolidation of ancient Jewish scientific traditions around this time is similarly suggested by *Sefer Yetzirah* (early 9th c.; Langermann 2002; cf. Alexander 2001: 229). Although this text presents a detailed and complex cosmology that is largely unconnected

with Rabbinic tradition, it similarly circulated under a title that recalls a tradition in the Bavli, namely, a reference to the laws of creation (*hilkhot yetzirah*) studied by R. Hanina and R. Oshaia (*b. Sanhedrin* 67b; cf. *Sefer Yetzirah* §64 [colophon]). And, intriguingly, one of its few explicit connections to Jewish tradition is an appeal to God’s covenant with Abraham in Genesis 15 (§61).

The reasons for this shift from esoteric to exoteric engagement with the sciences remain to be explained, and further research on these sources is sorely needed. We can, however, speculate about some of the possible factors. For instance, contact with Byzantine and Islamic traditions may have prompted fresh efforts at synthesizing Jewish and other sciences. Tzvi Langermann characterizes the eighth, ninth, and tenth centuries CE as a period that saw a “surge of interest in science” in Islamic culture in particular (2002: 175). Even as the authors of these post-Talmudic texts may partake in a broader cross-cultural trend, it is significant they chose to write in Hebrew, rather than Arabic. This choice, as Langermann notes, suggests that they penned their books for an exclusively Jewish audience (2002: 175). If so, then it is particularly striking that they may preserve strands of the Rabbinic sciences to which the Bavli and other classical Rabbinic sources so tersely refer, at the same time that they claim non-Jewish sciences for the Jews and attempt to interweave traditions, old and new, native and foreign.²⁰

Interestingly, this same period may also see a re-infusion of traditions from Second Temple Judaism into Jewish culture (Reed 2005: 238-72). A number of pre-Rabbinic texts and traditions that were abandoned by earlier Rabbis became integrated into Rabbinic culture—including *Jubilees* and parts of the Enochic literature as well as the writings of Josephus. This makes it all the more intriguing, in my view, that the accounts of the Jewish origins of the sciences in post-Talmudic texts seem to find their closest parallels in Second Temple sources. Like the *Astronomical Book* and Josephus, *Pirque Rabbi Eliezer* associates calendrical knowledge with biblical figures who lived before the Flood. And, in a manner reminiscent of *Jubilees* (10:12), Asaf ha-Rofe explains the origins of medicine with reference to Noah.

Whatever the precise reasons for the early medieval shift in Jewish attitudes towards “science,” an important transitional moment may be preserved by understudied post-Talmudic texts like *Seder Rabbah di-Vreshit*, *Midrash Konen*, *Baraita de-Shmuel*, *Mishnat Middot*, and Asaf ha-Rofe’s *Sefer ha-Refuot*; the same may be said of *Pirque Rabbi Eliezer* and *Sefer Yetzirah*, two works that are typically studied in terms of midrash and mysticism rather than “science.” By collecting and re-interpreting ancient Jewish traditions about cosmology, astronomy, and medicine, these texts may have even helped to mediate ancient Jewish scientific traditions to medieval Jews, supplementing the Bavli, oral tradition, and other sources. In turn, this process of collection and consolidation may have facilitated the appropriation and naturalization of Islamic sciences by Jews in the Middle Ages (Langermann 1999: I 3-5).

Not least because of the influence of modern Jewish philosophers such as Hermann Cohen, it is often assumed that the history of Jewish engagement with the sciences is simply a story about assimilation and resistance to other cultures (e.g. Singer 2004; Neusner 1988). Just as Judaism and “science” are presumed to stand in contrast, so scholars tend to privilege “religious” aspects when studying the history of Jewish thought and cultures. Yet, however much modern philosophers and historians might try to isolate the “religious” elements of our ancient Jewish sources from “scientific” and other elements, it

is only with difficulty that we can untangle these threads. Our evidence reflects the surprisingly seamless integration of both types of interests, in different ways, within different varieties of ancient Judaism.

In the Middle Ages, the valuation of astronomical wisdom would increase with the rise of Islamic sciences and with the emergence of new calendrical controversies within Judaism that infused the study of the stars, once again, with polemical as well as practical relevance (Goldstein 2001; Sela 2001; Sela 2004). Many educated Jews would turn with renewed interest to the cosmological, astronomical, and astrological traditions in the classical Rabbinic literature, seeking Jewish models for understanding and articulating their own participation in the cosmopolitan discourse about the sciences in Islamic empires (Langermann 1999; Goldstein 2001; Ruderman 1995:17, 23-33, 376-77). These include many of the same thinkers—figures such as Saadia Gaon, Abraham ibn Ezra, and Moses Maimonides—who were responsible for synthesizing, developing, and codifying classical Rabbinic traditions about more obviously “religious” issues like halakha and biblical interpretation.

In my view, the medieval perspective on the question of “science” and ancient Judaism is quite telling—both with regard to their views of “religion” and “science” and with regard to our own. In contrast to modern scholars like Neusner, medieval Jewish thinkers from Saadia to Maimonides read the Bavli with an eye, not only to its aggadic and halakhic traditions, but also to its mathematics and astronomy. Whereas modern discussions of Judaism and “science” have tended to ignore materials that are non-canonical or not obviously “religious,” it seems that medieval Jews approached texts like *Baraita de-Shmuel*, *Pirqa Rabbi Eliezer*, and *Sefer Yetzirah* as part of their intellectual and cultural heritage.²¹

Their scientific interests in the structure of the cosmos and the movements of the stars are linked to their participation in the Islamic intellectual culture of their time. Nevertheless, it remains significant that such learned Jews saw themselves as heirs to an ancient Jewish tradition of scientific inquiry. Judah Halevi (1075-1141), for instance, proclaims that “our Sages were, without doubt, acquainted with the revolutions of the sun and the other planets,” inasmuch as “all branches of science were required for the practice of Jewish Law” (*Kitab al Khazari* II 64; Hirschfeld [trans.] 1905:121-23; also III 41, IV 25 [pp. 173, 228-38]). In a manner reminiscent of the appeal to Abraham by Hellenistic Jews, he even posits the Jewish origins of “all sciences,” by appealing to the international influence of King Solomon:

Did he not, with the assistance of divine, intellectual, and natural power, converse on all sciences [cf. Wisd 7:17-21; as quoted above]? The inhabitants of the earth traveled to him, in order to carry forth his learning, even as far as India. Now the roots and principles of all sciences were handed down from us [i.e., the Jews] first to the Chaldaeans, then to the Persians and Medians, then to Greece, and finally to the Romans. (II 66; Hirschfeld [trans.] 1905: 124).

Likewise, Maimonides asserts that, in the classical Rabbinic period, the members of the Sanhedrin were not only well versed in the Torah, but also “possessed some knowledge of the general sciences such as medicine, mathematics, calendar regulation and astronomy (*tequfot u-mazzalot*)” as well as astrology and divination (*Mishneh Torah, Sanhedrin* 2.1; Sela 2001:68).

These medieval Jews are, no doubt, remaking earlier Rabbis in the image of their own ideals. Nevertheless, their view of ancient Jews as learned exegetes, halakhists, and scientists may come closer to the historical truth than modern concepts of ancient Judaism as essentially antithetical to “science.”

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Notes

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¹ Recent research in the History of Science has increasingly problematized the assumption that the modern Western notion of “science” is a universal and timeless category, questioning traditional approaches to the History of Science as a univalent narrative about inevitable progress towards the modern West. I am wary, however, of adopting a relativist view that wholly eschews “science” as a comparative category, not least because of the cross-cultural character of scientific inquiry and its results (see below). Hence, I attempt to follow the middle approach mapped by scholars like Peter Dear. In response to the “the twin dangers of hyperhistoricization and essentialist universalism,” Dear stresses the need to “acknowledge[e]... that science is not one thing, a natural kind, while at the same time recognizing that the symbol ‘science’ is culturally very real indeed” (2005:405). In his view, we can study the prehistory of modern Western sciences without assuming it is “an essentially timeless subject, always and everywhere the same kind of thing”; it can, rather, be approached as “a subject constituted by its temporal story” (2005:405).

I attempt to embody this approach in my terminology. Dear proposes that “something might be gained from using the plural term ‘sciences’... for collections of individual knowledge enterprises (whether qualitative or mathematical), and using the blanket term ‘science’ only to designate this kind of ideological construct” (2005:406). Accordingly, I use the plural term to denote the investigation of the natural world and systemization of knowledge about it. I use the singular term, surrounded by quotation marks, to denote the conceptual category of “science,” as configured differently in different historical and cultural contexts; the singular term “religion” is used in the same manner.

² See Ruderman 1987; 1995; Langermann 1999 (esp. I). Note also the issues of *Science in Context* (10 nos. 3-4) dedicated to “Judaism and the Sciences” in 1997 as well as the journal *Aleph: Historical Studies in Science and Judaism*, founded in 2001. See the foreword by Gad Freudenthal to *Aleph* 1 no. 1. *Aleph* has helped to synthesize the results of research on this topic from different fields as well as to help communicate the rich results of Israeli research to North American and European scholars.

³ By “classical Rabbinic literature,” I here mean the Mishnah (ca. 200 CE), Tosefta (ca. 300 CE), the Yerushalmi (Jerusalem Talmud; ca. 500 CE), and Bavli (Babylonian Talmud; ca. 600 CE) together with the midrashic collections compiled in the period between the Mishnah, the first authoritative document of the Rabbinic movement, and the Bavli, an extensive commentary on the Mishnah that serves as the summa of classical Rabbinic Judaism.

⁴ Contrast Neusner 1989, which tries to find emic Jewish categories akin to the modern Western triad “religion,” “science,” and “magic” within the classical Rabbinic literature. There, the term “science” is used interchangeably with “rational learning” (esp. 68).

⁵ Menachem Fisch, for instance, penned an extended response to Neusner written from the perspective of the Philosophy of Science (1997; see esp. xiii-xv). Fisch focuses on the suggestion that Rabbinic logic is different from other systems of thought and counters Neusner’s arguments by highlighting the similarities between the rationality of the Rabbis and the modes of thinking that have sparked scientific and technological discoveries in other cultures (1997:3-39). Many elements of Fisch’s argument are persuasive. Nevertheless, their usefulness for historical inquiry may be undermined by his focus on “logic” and “rationality,” which risks imposing modern values on ancient texts that took form in socio-historical contexts very different than our own (cf. Singer 2004; Neusner 1989). Fisch replicates, moreover, Neusner’s focus on the classical Rabbinic literature.

⁶ Most notable among the inventions attributed to “Mary the Jewess” is the double-boiler (still called the *Bain-Marie* in French). Interestingly, she is associated with a position that holds that only Jews can

practice alchemy. See Patai 1994:60-94. On Rufus, see my entry in the forthcoming *Biographical Encyclopedia of Ancient Natural Scientists*, edited by Paul Keyser and Georgia Irby-Massie.

⁷ Also significant—and understudied—are the intersections between science and halakha in ancient Judaism, on which see, e.g., Veltri 1997; 1998.

⁸ Note, however, the contrasting attitudes towards medicine in *1 Enoch* 7-8 and *Jubilees* 10. In the former, root-cutting is taught by the fallen angels; in the latter, God reveals to Noah how to “cure by means of the earth’s plants” (10:12) to protect him and his sons against demons.

⁹ Like *Jubilees*, Pseudo-Eupolemus asserts that the study of the stars was invented by Enoch, whom he equates with the Greek mythological figure of Atlas (*apud* Eusebius *Praep.ev.* 9.18.1), thereby underlining that the antiquity of the Jews and their historical records.

¹⁰ The practice of other types of astrology by late antique Rabbis is clear from a tradition attributed to Mar Samuel in *b. Eruvin* 56a, which predicts the weather in a season with reference to the planet of a *tequfah* as well as the planet of the preceding new moon. See Beller 1988:65.

¹¹ Cf. the astronomical explanation for the Flood in *b. Rosh Hashanah* 11b-12a. R. Joshua explains that God made the constellation of Pleiades rise at daybreak and removed two stars from it, thereby causing the Flood to come upon the earth. This is presented as an example of God’s “change of *Ma’aseh Bereshit*”—here, it is for the sake of justice that God changes creation.

¹² I.e., *tequfat Nisan* = vernal equinox; *tequfat Tammuz* = summer solstice; *tequfat Tishri* = autumn equinox; *tequfat Tebeth* = winter solstice. On *tequfot* see e.g. *b. Sanhedrin* 11b-13a; Beller 1988; Stern 1996:104-9. In order to reconstruct such methods, scholars must supplement the classical Rabbinic material with details from writings of later medieval Jews. At times, however, it can be unclear to what degree they accurately preserve methods used by late antique Rabbis and to what degree they use other scientific traditions to explain the Bavli *post facto*; compare, e.g. Neugebauer 1949 and Beller 1988.

¹³ Some self-consciousness of differences between Rabbinic and non-Jewish astronomy is suggested, e.g., by *b. Pesahim* 94b: “Our Rabbis taught: The Sages of Israel maintain: ‘The *galgal* (celestial sphere?) is stationary, while the planets (*mazzalot*) revolve.’ But the sages of the nations of the world maintain: ‘The *galgal* revolves and the planets are stationary’... The Sages of Israel maintain: ‘The sun travels beneath the sky by day and above the sky at night.’ But the sages of the nations of the world maintain: ‘It travels beneath the sky by day and below the earth at night.’ Rabbi said: ‘And their view is preferable to ours, since wells are cold by day but warm at night!’”

¹⁴ The lunisolar calendar was, however, naturalized by means of a connection, via Genesis 1 and related chronographical traditions, to the creation of the world as well as key moments in Jewish history; see e.g. *b. Rosh Hashanah* 8a-11a. The use of this system of intercalation in patriarchal times, by the tribe of Issachar, is posited in *Genesis Rabbah* 72.5 and *Esther Rabbah* 4.1, and its practice by Solomon is assumed by *Exodus Rabbah* 15.21. Examples of the use of the *tequfot* in biblical interpretation include *Genesis Rabbah* 13.12 and *Leviticus Rabbah* 26.4.

¹⁵ Bar Hiyya pens a calendrical treatise called *Sod ha-Ibbur*, which explicitly discusses ancient calendrical traditions not preserved in the Bavli (93-94). Maimonides depicts the “secret of the calendar” as part of the Oral Torah given by God to Moses on Mount Sinai (see Goldstein 2001:36-37).

¹⁶ Cf. Judah Halevi, *Kitab al Khazari* IV 25 (Hirschfeld [trans.] 1905:173, 232-33).

¹⁷ Goshen-Gottstein here cites the case of Ben Zoma, who is said to have speculated about *Ma’aseh Bereshit*, inferred from reading Gen 1.2 that barely a hand’s breadth separated the upper and lower waters there mentioned, was declared a heretic by R. Joshua, and then promptly died (*t. Hagigah* 2.6; *y. Hagigah* 77a-b; *b. Hagigah* 15a; *Genesis Rabbah* 2.4; Goshen-Gottstein 1995:190–91, 198-201; cf. Sed 1981).

¹⁸ When the Tosefta, Yerushalmi, and Bavli restate the problem, they use the verb from Deut 4:32 (*sheal*, meaning “ask” or “inquire”) in place of the verb used in the Mishnah (*derash*, meaning “interpret” or “expound”)—a lexical shift that underlines the claimed connection between the biblical and mishnaic passages, while also enhancing the connection between exegesis of the story of creation at the beginning of Genesis and scientific inquiry into the structures of the cosmos.

¹⁹ See Langerman 2002: 169-76, which offers a brief but programmatic treatment of *Baraita de-Shmuel*, *Sefer Yetzirah*, *Mishnat ha-Middot*, and *Yetzrat ha-Walad* as attesting the “first chapter in the history of Hebrew scientific literature” (p. 170). He notes that these texts are distinguished from later medieval Jewish

scientific writings by their anonymous authorship and their anthological collection of diverse traditions in a manner akin to the Mishnah (pp. 174-75).

²⁰ Asaf ha-Rofe, for instance, puts a Jewish stamp on Greek medicine (Lieber 1984), and *Mishnah ha-Middot* bears a close relationship to al-Khwārizmī's *Algebra* (Langermann 2002: 172).

²¹ The earliest commentaries on *Sefer Yetzirah* (tenth century = Sa'adia Gaon, Dunash Ibn Tamim, Shabbetai Donnolo) all treat this text as a "scientific" work; see Alexander 2002: 227-28; Langermann 1999: II 11-12; 2002: 172. Note also Donnolo's appeal to *Baraita de-Shmuel* as a work of Jewish astronomy, on which see Scharf 1976:14-51, and Halevi's reference to *Pirqa Rabbi Eliezer* as "a famous work on astronomy, calculation of the spheres and earth and other profound astronomical subjects" in *Kitab al-Khazari* III 65 (Hirschfeld [trans.] 1905:189), on which see Goldstein 2001:44, 47, 55-57. Goldstein follows David Luria in suggesting that the passages to which Halevi refers are not present in extant forms of the midrash, even despite the presence of these concerns in chapters 5-7. It is not improbable, however, that it once included even more astronomical and astrological material, especially in light of the textual fluidity of this midrash and its close relationship to *Baraita de-Shmeul*.