Claroscuro Nº 20 (Vol. 2) - 2021

Revista del Centro de Estudios sobre Diversidad Cultural
Facultad de Humanidades y Artes
Universidad Nacional de Rosario
Rosario – Argentina
E-mail: claroscuro.cedcu@gmail.com

Title: *ṭupšarrūtu* and the Historiography of Science

Título: *ṭupšarrūtu* y la historiografía de la ciencia

Author(s)/Autor(es): Francesca Rochberg

Fuente: Claroscuro, Año 20, Nº 20 (Vol. 2) - Diciembre 2021, pp. 1-27.

DOI: 10.35305/cl.vi20.53

Publicado en: https://claroscuro.unr.edu.ar/

ṭupšarrūtu and the Historiography of Science

Francesca Rochberg[*]

Abstract

Over the course of many centuries, cuneiform scribe-scholars produced a textual culture of learning that organized knowledge of the phenomenal world as defined by their particular interests. The ancient term for this culture was *ṭupšarrūtu* "the art of the scribe". That we grant this culture the designation scientific is not without problems from the perspectives both of modern philosophy of science and of conventional historiography of science. This essay reflects on the anachronisms entailed in transposing such ideas about science to the premodern cuneiform world and the consequences these ideas have on a historiography of science inclusive of cuneiform scientific texts.
Key-words: *ṭupšarrūtu*; scribal knowledge; demarcation; representation; presentism

***ṭupšarrūtu* y la historiografía de la ciencia**

Resumen

A lo largo de muchos siglos, los eruditos-escribas del cuneiforme produjeron una cultura textual del aprendizaje que organizó el conocimiento del mundo fenoménico según lo definido por sus intereses particulares. El término antiguo para esta cultura fue *ṭupšarrūtu* "el arte del escriba". Que concedamos a esta cultura una designación científica no está exento de problemas desde las perspectivas tanto de la filosofía moderna de la ciencia como de la

[*]University of California, Berkeley, EE.UU. E-mail: rochberg@berkeley.edu
Recibido: 27/10/2021, Aceptado: 10/11/2021

historiografía convencional de la ciencia. Este artículo reflexiona sobre los anacronismos que conlleva la transposición de tales ideas sobre la ciencia del mundo cuneiforme premoderno y las consecuencias que estas ideas tienen en una historiografía de la ciencia que incluye textos científicos cuneiformes.
Palabras clave: *ṭupšarrūtu*; conocimiento escribal; demarcación; representación; presentismo.

1 *ṭupšarrūtu* and its Sciences

Taken as a totality, the sciences of the cuneiform world of ca. 2000 B.C.E. to ca. 100 C.E., inclusive of divination, astronomy, astrology and medicine, have an unacknowledged significance for the historiography of science. Their importance is due to the unique combination of the kinship of certain aspects of the tradition with conventional ways of identifying science as well as presenting a radical otherness in other respects. The sciences in question comprise the knowledge corpora and associated practices of *ṭupšarrūtu*, the term for the component scribal scholarly disciplines that organized knowledge of the phenomenal world and the practices that depended upon that organization.

This paper discusses a number of key historiographical debates and the relevance of taking account of *ṭupšarrūtu* and its sciences for addressing them from a wider historical perspective than modern science[1]. I take the position that the term science is applicable to many of the forms of cognitive and intellectual activity of the cuneiform scribal community engaged with the texts of *ṭupšarrūtu* in spite of the notable differences presented by this material with respect to more familiar kinds of sciences. Some of the epistemic goals and methods, and even the ontological commitments behind the texts of *ṭupšarrūtu* are irreconcilable with those of their counterparts in modern physical sciences, viz., those set by 20th century philosophers of science who were not normally concerned with the history of science.

ṭupšarrūtu and its sciences expose the questionable nature of a historiography of science that reduces the aims and characteristics of science

[1]This essay is only a very brief sketch of some of the relevant matters concerning both *ṭupšarrūtu* and the historiography of science. Every paragraph could be extended and amplified with more evidence from cuneiform texts, and further exploration of the scholarly literature, both in philosophy and history of science.

to those that stem from the turn of the modern era and developed to our own time. If science is to be defined only with reference to modern sciences, then the knowledge systems and practices of antiquity and the Middle Ages into the Renaissance pose problems of classification and identity, or they are deemed simply to be wrong, superseded stages on the way to the sciences of today. Some of the premodern sciences, such as Ptolemaic and Copernican astronomy, medieval natural magic and Renaissance astrology have already played a role in a reappraisal of the scientific revolution (Lindberg and Westman 1990). The more remote and distant sciences of *ṭupšarrūtu* present another and somewhat different opportunity for a reassessment of the meaning of science in historical contexts in general.

Morphologically an abstract noun from the professional designation "scribe" (DUB.SAR = ṭupšarru), *ṭupšarrūtu* is defined in the *Chicago Assyrian Dictionary sub verbo* meaning 2 as "scribal learning, scholarship". The forms of scribal scholarship encompassed by the term *ṭupšarrūtu* produced a distinct textual and intellectual culture. The question posed here is whether there is justification for seeing in *ṭupšarrūtu* not only the marks of a textual and intellectual culture but also of a scientific culture[2].

The textual evidence is available from the Neo-Assyrian period (7th century B.C.E.) and the Late Babylonian or Neo-Babylonian to Seleucid periods (5th to 2nd centuries B.C.E.) (Robson 2019, 52-53). Considerable changes in the institutional context of the highly specialized scribes with knowledge of astronomy, divination, and medicine occurred during the gap between these periods. During the 7th century, the scribes who produced and used the texts that comprised *ṭupšarrūtu* were court appointees and advisors to the Assyrian monarch in Nineveh. Following the fall of the Assyrian Empire in 609 B.C.E. the scholarly scribal culture in the period from the 6th century onward moved south into the major cities of Babylonia, mainly Babylon and Uruk, and into the temples of Marduk/Bēl (*Esagil*) and Anu (*Rēš*). Textual sources are more numerous from the 5th century onward, although the royal correspondence between the Assyrian monarch and his scholars (Hunger 1992 and Parpola 1993) sheds a kind of light sorely missing from the Late Babylonian period. In the new context of the temples, the fields of knowledge known before as the cornerstones of *ṭupšarrūtu*, namely, astronomy, celestial omens and medical texts, saw profound innovation and change as well. The most revolutionary of these

[2] The relationship between *ṭupšarrūtu* as cuneiform knowledge and our term science has been discussed before, in Rochberg 2016: 9-10, 34-35, 61-102 as well as in Robson 2019.

changes was in mathematical astronomy, but significant change is also evident in celestial divination, both natal omens and horoscopy, and in the combination of the new astrology with physiognomy, medicine, and even extispicy (Rochberg 2016: 73, 150-155).

In the colophons to scholarly texts stored in Assurbanipal's palace during the 7th century B.C.E., the tablets in the various fields of *ṭupšarrūtu* were described as *nisiq ṭupšarrūti* "the highest level of scribal scholarship," also *nēmeq Nabû* "the wisdom/skill of Nabû, patron deity of writing," and *tikip sattakki* "the cuneiform signs". Learning fell under the patronage of the gods, expressed as *nēmeq Nabû* "the wisdom/skill of Nabû", and *nēmeq Ea* "wisdom/skill of Ea", which is said of a scholarly tablet, and the scribe who wrote it as "one who understood the entirety (*kullatu*) of *ṭupšarrūtu*" (Hunger 1968: 103)[3]. Divine patronage of learning is seen in every corner of the texts that comprised *ṭupšarrūtu*.

In particular, the patron of writing, the god Nabû, and his goddess Tašmētu are frequently mentioned (Robson 2019: 53-85). So is Ea, patron of wisdom and knowledge of incantations and magic, resident of Apsû, the subterranean watery region where knowledge of magic and incantations originated. Rituals for the *bārû* appealed directly to the divine patrons of divination, Šamaš and Adad, who communicated their decisions by writing on the liver (Starr 1983). The idea of divine wisdom is also attested in Late Babylonian astronomical ephemerides, where the contents of the tablet are described in colophons (Neugebauer 1955: 18, also in Hunger 1968: 42)[4], much as in the Neo-Assyrian colophons, as *nēmeq anūti* ("the wisdom of Anu-ship"). As *anūtu* is the abstract form of the divine name Anu, the divine head of the pantheon and god of the heavens, *nēmeq anūti* is the highest order of wisdom and knowledge/skill. *nēmeq anūti* was also held to be a secret of the great gods, and the possession of the *ummânu*, the absolute scribal masters of *ṭupšarrūtu*. On the upper edge of ephemerides from Late Babylonian Uruk, the sky god and his goddess, Anu and Antu, were invoked, Bēl and Bēltīja in the texts from Babylon (also in a horoscope text, Rochberg 1998: 93[5]), with the formula *ina amat Anu/Bēl u Antu/Bēltīja lišlim* "By the command of Anu/Bēl and Bēl/Bēltīja, may it go well/remain intact".

In the main, *ṭupšarrūtu* consisted of a wide variety of omen compendia (Steinert 2018: 10 and note 15). These included seven major compilations of omens based on the observation of many details of human experience,

[3]Texts 330 and 331.
[4]Colophon U and Text 98, respectively.
[5]Text 14.

terrestrial and celestial phenomena, although intrusions of one into another may be found for all seven (as outlined in Rochberg 2004: 54): *Enūma Anu Enlil* ("When Anu and Enlil," the celestial omen series), *Šumma ālu* ("If a city," the terrestrial omen series), *Sakikkû* (omens devoted to symptoms of an illness, both prognostic and diagnostic), *Alamdimmû* ("If the form," the series for physiognomy and morphoscopy, with its poorly attested subseries *Nigdimdimmû* "If the appearance," and *Kataduggû* "If the utterance"). An important discussion of the relations and connections among the series *Sakikkû*, *Alamdimmû*, *Nigdimdimmû*, *Kataduggû*, *Šumma sinništu* ("If a woman"), *Šumma liptu* ("If a spot [on the body]") and even *Šumma ālu* is (Schmidtchen 2018). *Šumma izbu* ("If an anomalous birth," the series for omens from malformed fetuses and other irregularities of births), *Ziqīqu* (the series for dream omens), and *Iqqur īpuš* ("He demolished, he built," the series for the propitiousness of dates for undertaking various activities, or for someone born on certain dates).

These series comprised omens from so-called unprovoked signs, things that happen independently of the diviner's actions to "provoke" them. The omens resulting from the diviner's provocations were the result of actions that appealed to the gods Šamaš and Adad, providing them with a medium of communication, such as the sacrificed sheep, or dropping oil into water, releasing smoke from a censer, or sprinkling flour. Of the provoked omens, extispicy (inspection of the entrails) had an extensive series for omens from the inspection of various entrails, such as the liver, gall bladder, intestines, and lung. The provoked omens came under the heading *bārûtu*, meaning inspection by extispicy. Accordingly, the *bārû* ("diviner," literally "the one who makes an inspection") was the diviner specializing in provoked omens from the exta, oil, and smoke.

Apart from the vast collection and systematization of omens and their different series, *ṭupšarrūtu* also encompassed the methods of astronomy and medicine. The former consisted of various texts devoted to the astronomical methods of observation, schematization, and prediction (a survey of which can be found in Hunger and Pingree 1999), the latter of two interrelated and interdependent forms of the science of healing, namely, *āšipūtu* (knowledge and practice of conjuration) and *asûtu* (medical practice and knowledge of medicines). The *āšipu* was a specialist in techniques of appealing to the gods to heal the sick, such as incantations and rituals for ridding the patient of whatever consequences he would suffer from bad omens (*namburbû*), including those responsible for illness. The *āšipu* did not just come in after diagnosis to heal through ritual and incantation, but was a master of the medical omen series *Sakikkû* and the physiognomic series *Alamdimmû*. Together these omen compendia combined knowledge of symptoms, diagnostics, prognosis of illness in the case of certain symptoms, and all the anatomical regularities and irregularities of the human body. The *asû* specialized in the practice of administering "medicine," or the many preparations made from a wealth of *materia medica*, as well as the use of bandages. The texts of *asûtu* were catalogued in the Assur Medical Catalogue (Steinert 2018a: 11, 13-14; Steinert 2018b: 172-184; Steinert 2018c for the edition of the text; Panayotov 2018, 89-120). As Mark Geller and Ulrike Steinert have shown (Geller 2010: 9; Steinert 2018b: 187-192), there was considerable overlap between the two kinds of medical practice, and thus the separation of the two into medicine (*asûtu*) and magic (*āšipūtu*) makes for a false dichotomy and a misclassification of the evidence.

The question of the continuation of *ṭupšarrūtu* through to the end of cuneiform writing can be addressed in the context of astronomy, which was integral to the textual traditions of *ṭupšarrūtu*. In the Neo-Assyrian period, the *ṭupšar Enūma Anu Enlil* was a high-ranking scholar of the celestial omen series titled *Enūma Anu Enlil* and thus a central figure in *ṭupšarrūtu* and its influence at court. But not only did astronomy develop and change from the Neo-Babylonian period forward, the roles of the scribes also changed from advisors at the Assyrian royal court in Nineveh to the holders of priestly roles in the Babylonian temples at Babylon and Uruk (Rochberg 1993). In the Late Babylonian period the omens from *Enūma Anu Enlil*, *Šumma izbu*, and *Alamdimmû*, as well as astronomical ephemerides were written by *āšipu*s, *kalû*s, and *ṭupšar Enūma Anu Enlil*s.

Science in the intellectual culture of the cuneiform *eruditi* of Babylonia and Assyria has been a growing part of modern Assyriology since the decipherment of Babylonian astronomical texts in the late 19th century. The field began with decipherment and reconstruction, was followed by a herculean effort to publish astronomical and astrological cuneiform texts either in hand copy (e.g., Sachs 1955, with Schaumberger, Pinches and Strassmaier) or transliteration, translation, analysis and commentary (e.g., Neugebauer 1955 and 1975; Ossendrijver 2012; and the monumental Sachs and Hunger (1988; 1989; 1996) and Hunger (2001; 2006; 2014). Since the later 20th century, in addition to the continuation and expansion of textual analysis of astronomical tablets, research has considered contextual questions of social and intellectual dimensions (Rochberg 1993, 2004, 2016; Haubold, Steele, and Stevens 2019, Robson 2019; Bowen and Rochberg, 2020).

The question of whether *ṭupšarrūtu* was a term for the sciences, or of a scientific culture, however, has not often been raised (a notable exception is Robson 2019). The answer depends on how we define science and what sources, modes of thought, methods and goals we decide belong to science. In my view, the cuneiform evidence of *ṭupšarrūtu* indicates that certain bodies of knowledge, as well as their associated practices, were component parts of a discrete but multifaceted culture[6]. It was at the same time a textual culture, an intellectual culture, and, I suggest as well, a scientific culture.

A meaningful synonymy between the terms *ṭupšarrūtu* and science (as *episteme* and *scientia*) is difficult to claim. The fact that *ṭupšarrūtu* incorporated fields of learning concerning observed, ordered and systematized phenomena under one encompassing heading, similar to the way modern science serves as a general category for the disciplines of physics, biology, astronomy, chemistry, and so on, is one way of looking at a functional similarity. Methodological similarities are also key, such as use of empirical and predictive methods across the board and the overall systematic character of the whole. Both similarities and dissimilarities to later science are found in the subject matters referred to by *ṭupšarrūtu*. Similar are astronomy and medicine, but divination, which looms large in the cuneiform corpus, is not at all similar to the fields fixed by modern science. However, the centuries up to the Early Modern period saw parallels in knowledge and practice that make for a consistent picture with the fields of *ṭupšarrūtu*, including such sciences as magic and astrology, and theories of causality not always based on physical or mechanical processes, such as, in particular, Hume's constant conjunctions, or connections made by analogies, or correlation, rather than physical causality (Rochberg 2011: 279-280). There are methodological resemblances (empirical, rational, predictive) that serve to unify all sciences, but to make the term science work in the cuneiform world, we cannot reduce the ancient evidence only to its similarities with later sciences. This takes a mere part of what science meant in ancient practice and conception as valid, leaving some of its central characteristics of *ṭupšarrūtu* on the margins.

Clearly *ṭupšarrūtu* is not a synonym for science in any modern conceptualization. Given this, the classic historiographical debates about science have not made use of cuneiform material[7]. The notion of the fields

[6] The unity of *ṭupšarrūtu* is also suggested by the relationship its series had to secret knowledge, which is discussed in Rochberg (2004: 214-217), and Lenzi (2008: 143).

[7] In the context of defining science McMullin (1984: 38-40) makes reference to Babylonian astronomy and omen texts and unifies them around their predictive goals.

and concerns of *ṭupšarrūtu* being in any way relevant to historiographical debates unsurprisingly has not emerged from outside the field of Assyriology. The following section will revisit the debates about the nature of science in terms of (1) realism and representation (2) demarcation (3) the pessimistic induction and (4) presentism in order to confront the impact on modern historiography of science if account is taken of the long tradition of *ṭupšarrūtu* in the cuneiform world[8].

2 Historiographical Debates

A monumental shift in the history and philosophy of science occurred with Thomas Kuhn's landmark book *The Structure of Scientific Revolutions* in 1962 (revised 3rd edition in 1996). Kuhn developed a contextualist approach by attaching science to communities rather than to Platonic ideas and transhistorical abstractions about science. Even *The Structure of Scientific Revolutions*, which construed science as a social as well as a historical phenomenon, did not make room for ancient non-Western scientific cultures. Kuhn's framework for identifying the communities that arbitrated paradigm debates was defined as Europe of the past four centuries. Cuneiform culture (or Egyptian), by his reckoning, would have been categorically and intrinsically unable to produce science. In his words (Kuhn 1996: 167-168):

> Every civilization of which we have records has possessed a technology, an art, a religion, a political system, laws, and so on. In many cases those facets of civilization have been as developed as our own. But only the civilizations that descend from Hellenic Greece have possessed more than the most rudimentary science. The bulk of scientific knowledge is a product of Europe in the last four centuries. No other place and time has supported the very special communities from which scientific productivity comes.

Kuhn's scientific communities were defined first and foremost for their concern "to solve problems about the behavior of nature" (Kuhn 1996: 168), and secondly that the paradigm debates themselves be driven by nature itself

[8] A broader sample of non-Western sciences (i.e., not descended from the Greek and Greco-Roman traditions), for example, from Egypt, China, India, Polynesia, as well as the indigenous cultures of the Americas, would also be relevant, but beyond the remit of this paper and the knowledge of this author.

"by making prior achievements seem problematic" (Kuhn 1996: 169). In this statement, Late Babylonian mathematical astronomy would presumably have come under the category of technology, or perhaps "rudimentary science". Indeed, if science is confined to solving problems driven by a conscious desire to understand the universal physical world we call nature, then societies like those of the cities of Babylon or Uruk in the 5th century B.C.E., or of Assyria in the 7th century B.C.E. did not participate in the history of science.

In its metaphysical implications, however, *Structure* challenged scientific realism, i.e., the claim that the epistemic goal of science was the representation of the truth about nature and the discovery of facts about reality. Bas van Fraassen (1980: 8) gives the following formulation (with my emphasis) of a definition of scientific realism: "Science aims to give us, in its theories, *a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true*. This is the correct statement of scientific realism"[9]. The very assumption that representation in science offered facts about nature is historiographically problematic because it assumes that the object of representation is not only facts about nature, but also that the facts are what modern science says they are.

Whether representation itself is the central goal of science across history and culture is another assumption that does not hold up under scrutiny. Richard Rorty (1979: 3) defined the inherent problem with the claim about scientific representation by saying that such a general theory

> will divide culture up into the areas which represent reality well, those which represent it less well, and those which do not represent it at all (despite their pretense of doing so).

Rorty's observation on the consequences of this philosophical attitude about representation is important as it implied an ontological critique of the world-version given to us by science, or what we call "external reality".

The problem is twofold. On one hand representation is not always "accurate depiction or denotation" of reality, but is interpretative in nature. On the other hand, the reality supposedly represented is equally interpretative and reflects distinct shifts and changes over time. Why can we not say that the various fields of *ṭupšarrūtu* represented and interpreted reality for the cuneiform scholars? Of course, that question makes no sense for a scientific realist, exactly the position the contextualists and

[9]There are other formulations, and van Fraassen takes account of many of them in the book from which this definition was quoted (van Fraassen 1980).

anti-realists oppose. Rorty's statement about areas of culture that do or do not represent reality, if extended to historical cultures, as opposed to areas within one culture (our own), underscores the fallacy in thinking that only representation of facts about nature can be a criterion for science in history.

The restoration of scientific ideas to a place of significance in accordance with the contextualist method of Thomas Kuhn (1962), Quentin Skinner (1969), and Alexandre Koyré (1957) before them, was a crucial step in the critique of ahistorical claims to a universal representational goal of scientific epistemology. Scientific ideas in historical context often fly in the face of realist aspirations for science to reveal knowledge of the true way of nature. Instead, they indicate that the particular and variable epistemic goals and scientific practices of historical communities were interdependent with other aspects of thought. The historiography of science, then, ideally would not focus only on the commonalities between premodern and non-Western sciences on one hand and modern Western scientific practices and bodies of knowledge on the other—although there are commonalities to be found—but allow the evidence to determine the terms of our understanding.

It has taken years for the door to open as widely as it needs to in order to allow cuneiform sciences proper entry into the history of science. The astronomical sciences have come in first, but the full range of the sciences of *ṭupšarrūtu* are still waiting to get in. In opening that door, the historiography of science must come to terms with the epistemological manifold reflected in that tradition. Recognition of the epistemological manifold within which cuneiform texts of *ṭupšarrūtu* operated is essential to recognizing *ṭupšarrūtu* as a scientific culture[10]. Underpinning the epistemological manifold within which the Babylonian *eruditi* studied many phenomena as signs, and thus as objects to be observed, analyzed, schematized and theorized, was an ontological framework within which the phenomena of interest were known. Therefore, the historiography of science is dependent not only on a reconstruction of knowledge systems, a reconstruction of the epistemological manifold of its community of knowers,

[10]My use of the term epistemological manifold in the context of *ṭupšarrūtu* is inspired by, but differs from, the cultural manifolds of Geoffrey Lloyd and Nathan Sivin's comparative work on ancient Greece and China (Lloyd and Sivin 2003 and Sivin 2005). These refer to the conceptual frameworks, epistemic norms, and social institutions that supported science in the cultures of ancient Greece and China, and the entire complex that unified these parts in their respective contexts. In the present context the epistemological manifold also makes a whole out of various parts but refers specifically to the knowledge corpora and methods of knowing constituted by *ṭupšarrūtu*.

in the case of *ṭupšarrūtu*, the scribes, but also and equally important the ontological ideas grounding these epistemic systems (astronomy, astrology, divination, magic, medicine).

Because cuneiform sciences include such practices as divination, magic, and astrology, which in modern scientific culture have become the chief targets for the term pseudoscience, the debate on the problem of demarcation must also be discussed and laid to rest. The demarcation debate in reference to ancient astrology is misleading. Defining science in the context of *ṭupšarrūtu* does not pose any of the problems around which Karl Popper framed his "problem of demarcation". In his 1935 *Logic of Scientific Discovery* (reissued in 2002: 11), Popper said "the problem of finding a criterion which would enable us to distinguish between the empirical sciences on the one hand, and mathematics and logic as well as 'metaphysical' systems on the other, I call the problem of demarcation". Pseudoscience per se was not the issue, but demarcation addressed a broader question in the theory of knowledge at its most fundamental level. In this way, Popper challenged the Vienna Circle positivists' commitment to induction as a method of generating reliable knowledge from observation. Demarcation, therefore, was specifically geared to the positivist requirements for scientific epistemology as a way to differentiate science from all other forms of knowledge. Its extension to historical sciences was not the intent.

More recently, as is clear in the volume of papers in Massimo Pigliucci and Maarten Boudry (2013), the issue for demarcation has settled on how to decide on the line separating science from pseudoscience (Pigliucci 2013: 9). Before the goal of demarcation settled on the project of distinguishing science from pseudoscience (which term does not occur anywhere in the text of *The Logic of Scientific Discovery*), all the non-sciences were targeted, including metaphysics, and many of the ideologies of Popper's day (famously, psychoanalysis and Marxism, see Popper 1935). Such questions of epistemology and meaning (according to the positivists, only empirical statements were granted meaning, metaphysical statements not), have little to no bearing on our present historical investigations, as the mode in which cuneiform scribes sought meaning in phenomena was distinct from natural science (Rochberg 2016). Nevertheless, although the science/pseudoscience demarcation is anachronistic in the discussion of Babylonian astrology, or celestial divination, the question persists.

The demarcation project in its current incarnation is aimed at finding criteria separating real, or true, science, from false or pseudoscience. Discussion of demarcation in our times has focused on astrology and so-called creation science. But astrology in the premodern world was not the pseudoscience it is today. The fact that there are legitimate historical reasons for viewing ancient and medieval astrology, or alchemy, as science is not a weapon against modern scientific standards, but shows clearly the historicity of the methods, goals, and questions considered amenable to scientific methods and appropriate to scientific theory.

Our contemporary demarcation discourse is therefore not relevant to historical investigation, at least in the context of the cuneiform corpus, because the aim is to make the distinctions that define science against its imitations, as Pigliucci said, to establish a base-line definition that "we can all agree on about science" (Pigliucci 2013: 22). He said, "science attempts to gain an empirically based theoretical understanding of the world, so that a scientific theory has to have both empirical support ... and internal coherence and logic". (Pigliucci 2013:22). As to the "empirically based theoretical understanding," he adds, however (Pigliucci 2013: 23), that it is the empirical/theoretical plane whose relationship is unstable, and historical context is one of the main destabilizers.

What "we can all agree on about science" in history is not reducible to a convenient or formulaic definition on the model of modern science such that its deliberate imitations become an issue. Demarcation became a matter of science versus pseudoscience only after the middle of the 19th century, when the term science took on its more or less familiar sense, and the term pseudoscience was first used. In historical contexts prior to this, and extending into the ancient world of cuneiform texts, attributing the notion of a pseudoscience to such a world is what Nicholas Jardine (2000: 253 and passim) called "vicious anachronism".

An example of the employment of such ahistorical criteria for evaluating ancient and medieval sciences comes from nearly one hundred years ago from the staunch positivist, George Sarton. Given his own moment in history, his point of view is entirely understandable. He called (Sarton 1924: 85) astrology "a very remarkable scientific system," saying "a history of science which did not include an account *of the purer aspects* [my emphasis] of astrology and alchemy would be incomplete". Sarton's defense of these two ancient sciences comes in the context of his thorough condemnation of Lynn Thorndike's *A History of Magic and Experimental Science during the First Thirteen Centuries of our Era* (1923-1958), which included much within its purview that Sarton considered unscientific and worse, e.g., divination and magic. Sarton's judgment exemplified the demarcationist use of epistemic standards extraneous and foreign to the historical evidence in question;

textbook vicious anachronism. In this regard, Sarton's long demarcationist shadow was cast upon *Isis*, founded by him in 1912 as the History of Science Society's official journal, until finally in 2002 the term pseudosciences disappeared from its annual bibliography.

Another perspective on the history of science, known as the pessimistic (meta)-induction, rests on the idea, common to all these historiographical debates, that science is consistent across history and culture in its goal to know how nature works. The assumption of the continuity in the goals of science cannot be substantiated by the cuneiform texts of *ṭupšarrūtu*. This argument begins with the idea that the sciences of the past were largely wrong, or based on insufficient knowledge, and thus deficient in some way when compared to more recent sciences.

Despite the appearance of a grossly ahistorical measurement of premodern achievements by modern standards, the purpose of the pessimistic (meta)-induction was to claim that if the history of science shows us the error of our ways, we can suspect that our current scientific theories will also prove false in time (Laudan 1981, 1984; and Chang 2012: 224-227 for discussion). This idea challenged realism about science and turned the history of science into a "graveyard of dead scientific theories and abandoned theoretical posits" (disputed in Mizrahi 2016: 264).

The pessimistic induction engaged in a direct comparison of historical evidence against modern, and erased the differences between them that relate to historical differences in the representational goals of science. The phrase "graveyard of theories" was originally Peter Lipton's, who said (2005: 1265):

> The history of science is a graveyard of theories that were empirically successful for a time, but are now known to be false, and of theoretical entities—the crystalline spheres, phlogiston, caloric, the ether and their ilk—that we now know do not exist. Science does not have a good track record for truth, and this provides the basis for a simple empirical generalization. Put crudely, all past theories have turned out to be false, therefore it is probable that all present and future theories will be false as well. That is the pessimistic induction.

The pessimistic induction thus validated the writing of the history of science retrospectively and emphasized continuities. That the truth of theories in science is temporary, regardless of some of long-lived successes (Ptolemaic astronomy, humoral theory of disease, Newtonian physics), does little for the history of science, but it was not meant to contribute to a greater understanding of historical sciences. It took aim at the nature of modern science by visiting the graveyard of its old ideas and theoretical posits.

Indeed, the history of science when viewed as a graveyard of methods, ideas, and theoretical posits, even if we are keen to see the connective tissue of scientific methods and goals over time, places emphasis on modern assessments of how they failed to refer or to represent truth over what accounted for their success. This points up another issue with realism, namely, that the success of science and truth do not necessarily correlate. The meaning of both of these concepts, success and truth, are equally subject to historical and cultural criteria. The long-lived highly successful premodern sciences, such as the fields of *ṭupšarrūtu* or Ptolemaic astronomy and cosmology, are abundant testimony to this claim. The history of science has more to offer than comparisons to modern science, or evidence for answering the question of whether science itself displays a continuous progressive development over time. Georges Canguilhem (in Delaporte 2000: 45) put it succinctly when he said, "history is not an inverted image of scientific progress".

The last debate in the historiography of science to discuss here is that of presentism, which shares many ideas with the other claims arising from realism and representation, demarcation, and the pessimistic induction. Whereas 20th century scholars of Babylonian astronomy and astrology laid a foundation for all subsequent generations to build upon, some of that work carried either explicitly or implicitly a quotient of presentism (Neugebauer 1955 and 1989).

General histories of science that told the story of science retrospectively from the present and projected contemporary intellectual values upon past sciences came under especially heavy criticism by the historicist generation roughly between the 1960s and 1980s. This critique revived the terminology of Whig historiography, first defined by Herbert Butterfield (1931: 2), who said Whig histories meant "to praise revolutions provided they have been successful, to emphasize certain principles of progress in the past and to produce a story which is the ratification if not the glorification of the present". It was not so much a total repudiation of any relevance for the present, the inevitable and unchangeable vantage point of the historian, but, as he said (Butterfield 1931:11):

> It is part and parcel of the whig interpretation of history that it studies the past with reference to the present; and though there may be a sense ... in which it is inescapable, it has often been

> an obstruction to historical understanding because it has been taken to mean the study of the past with direct and perpetual reference to the present.

Instead of "hunting for the present in the past," Butterfield (1931: 10) stated the chief aim of the historian to be "the elucidation of the unlikeness between past and present" and the mediation "between other generations and our own".

In the context of historical sciences, Whig histories focused on and favored those aspects of a linear picture of scientific development pointing in the direction of modern sciences, and featured the episodes in the history of science that got something right. Results of this approach for premodern science were the omission, or sidelining, of significant episodes in the history of the sciences that did not join in the shaping of modern scientific thought, episodes exemplified by traditions of astrology, alchemy, divination and magic. Even where plainly some of the methods applied to the practice of astrology, or alchemy, were compatible with science, gatekeeping seemed particularly rigorous when it came to "scientific thought," especially concerning material versus non-material objects of inquiry, or material versus immaterial or "occult" causes. Accordingly, there was no place for cuneiform science outside of the mathematical methods of Late Babylonian astronomy. That these scientific methods were used for astrological purposes, and continued into the Hellenistic and medieval periods for the practice of horoscopy in Europe as well, only later gradually came into focus.

What the latter day critics of Whig histories of science found most problematic was, as Jardine (1986) discussed, that science in presentist terms was understood to be singular and absolute. The particular characteristics of scientific absolutism that Jardine (1986: 1) critiqued were especially its putative universal characteristics, including that it is characterized by a linear cumulative progress to truth. That model of the singular universal history of science met with methodological and historiographical challenges in large part because of the ahistorical nature of absolutism about science, and consequently, that model was discarded by any but naïve realists, of which few remain.

However, in the history of science of the cuneiform world, presentism remained a force in earlier literature, as when late mathematical Babylonian astronomy, truly the first of the exact sciences in antiquity, was regarded as ideologically separate from other Babylonian pursuits such as astrology and divination. Thus, said Neugebauer (1989: 392-93),

> No more drastic discontinuity in the history of ancient astronomy can be imagined than the creation of mathematical astronomy in the Babylonian ephemerides and procedure texts ... in the Seleucid period. If astronomical phenomena had been considered since the earliest Mesopotamian period as celestial omina ... the authors of the ACT material ... dropped all these traditional connections and analyzed lunar and planetary motion in a strictly mathematical fashion comparable only to the approach of Hipparchus and Ptolemy.

The confrontation of intellectual values between the astronomer-scribes who created or used mathematical tables and those who copied omens or earlier astronomical traditions (the series MUL.APIN, Hunger and Steele 2019) is not intrinsic to the sources, nor is the idea that an alleged separate group of "mathematical astronomers" dropped traditional ideas in order to establish their autonomy from tradition. Indeed, in the Seleucid Greek environment of the cities of Babylon and Uruk, temple scribes were dedicated to preserving textual traditions of diverse contents, not only of astronomy, but of omens, liturgy, magic, incantations and medicine as well.

More recently, historians of science have found it useful to engage in a different way with presentism (Jardine 2000, Tosh 2003, Harman and Métraux 2013). Laurent Loison (2016) defends a new presentism, defining this project of historical epistemology as "a way to solve the issue of presentism in the history of science". (Loison 2016: 29) As he put it,

> If one accepts that the objective of science is to produce true explanations, it seems difficult to dismiss all use of present knowledge to trace back and understand its history. This is why, as David Alvargonzàles claims, "history of science is essentially whiggish" (Alvargonzàlez, 2013)—at least to some extent. The question is therefore no longer *if* we have to make room for presentism, but rather *how* we should use presentism.

If, however, the relevance of presentism is predicated on accepting that the goal of science is "true explanations," it is not at all clear to me that such true explanations, or even explanation *per se*, can serve as the goal for all historical science, as Ernan McMullin already noted in 1984. The question of what is more characteristic of science, its exclusive capacity to provide a true description of the world, or its explanatory power was a serious point of difference at that time (Ellis 1985). Instead, the goal of explanation seems to be a particular indicator only of particular forms of science, produced in particular contexts. For astronomy in Babylonia, there are no explanations for the phenomena derivable from their mathematical predictive methods. There are no explanations in that context because explanation, in the sense of a physical causal account, was not relevant to Babylonian astronomy. The question of explaining disease, on the other hand, might lead to different conclusions. Surely *ṭupšarrūtu* could accommodate different ideas within the different fields of its sciences.

3 Defining Science in Light of *ṭupšarrūtu*

The term science, both by etymology (English science from Latin *scientia*, Middle French *science*) and historical usage (from the 14th century), has often been interchangeable with knowledge, or *a kind of* knowledge. The kind of knowledge associated with science for much of modern history and philosophy of science was defined in terms of methods and goals exemplified by early modern science. In view of this Lorraine Daston (2017: 142) observed how time was when the history of science "was not just *a* Eurocentric narrative; it was *the* Eurocentric narrative". She pointed to the fact that the field has by now greatly expanded its scope, redefined and realigned its inquiry to the point where, she asked (2017: 142), "if we are no longer historians of modern, Western science (all three words ripe for rethinking) and its analogues and antecedents in other times and places, then what *are* we historians of?"

In considering whether knowledge was a reasonable replacement for science in non-Western premodern worlds, Daston rightly noted that the history of knowledge is not quite the same thing. From the vantage point of cuneiform science, I agree that replacing science with knowledge does little to shift our historiographical perspective. Moreover, the conflation of science with knowledge overemphasizes the importance of epistemology. The dimension of practice, of social setting and modes of transmission of knowledge and practice inside and outside of a particular tradition, and the ontological frameworks that shift and change over the course of the history of science, these are all dimensions of what the history of science now aims to trace and understand.

In the early days of the incorporation of Babylonian science within the canon of the history of science, McMullin's 1984 summary of the developmental course of science classified Babylonian science as predictive but Greek science as demonstrative and aimed at causal explanation. He put each under the rubric of natural science, and while much of his discussion of both Babylonian and Greek science focused on astronomy, he made mention of medicine as further evidence of the interest of the Greeks in causes, quoting Geoffrey Lloyd on *The Sacred Disease* (McMullin 1984: 41 quoting Lloyd 1979: 16). This sharply contrastive schema dividing predictive science (McMullin's P-science) from demonstrative science (McMullin's D-science) was a few years too early to take into account the discovery within Greek astronomical papyri (Neugebauer 1988; Jones 1999) of predictive methods based on Babylonian systems of linear arithmetic calculation that were used by Greek astronomers of Roman Egypt and Late Antiquity. Whereas we had long known that Greek cinematic astronomy made use of Babylonian parameters underpinned by Babylonian observations, the internal complexity of the Greek astronomical tradition, in which the cinematic and geometric hypotheses of the planets coexisted with Babylonian arithmetical methods, was only understood from 1988.

Raymond Williams (1983: 276-280) discussed the many and various meanings of the word science and its evolution over time. As McMullin would later do, Williams began his definition of science methodologically and emphasized first demonstration and then, as a later development, empiricism and experiment. He said (Williams 1983: 278),

> changes in ideas of Nature encouraged the further specialization of ideas of method and demonstration towards the 'external world', and the conditions for the emergence of science as the theoretical and methodical study of *nature* were then complete.

This meaning, Williams noted, hardened in the early to mid-19th century, by which time, scientific knowledge meant a focus on physical phenomena and expressly excluded theological and metaphysical interests. By now, the definition of the scope and central goals of science as being one with naturalism, where "the external world" is coextensive and coterminous with nature, is the conventional view. The repudiation and elimination of supernatural phenomena as not belonging to the external, or real world, according to Peter Harrison (Harrison and Roberts 2019: 6-7) is even older, originating in the European Middle Ages, although with vastly different implications[11]. The use of the term science in the context of the cuneiform

[11] As Harrison explains (Harrison and Roberts, 2019: 8), "Thomas Aquinas (1225–74) was to popularize the term 'supernatural' (*supernaturalis*) to label this mode of

world requires a rethinking and reorientation of our definition of science *in general* and of the criteria by which we recognize it.

A sharp contrast between the epistemic aims of naturalism and the epistemological manifold of *ṭupšarrūtu* has been discussed (Rochberg 2016). In spite of the sharp contrasts and discontinuities with natural philosophy, there is also evidence of continuities with the sciences of later Greek, Greco-Roman, and even later European traditions. As late as the Early Modern period, for example, the relationship of astronomy and astrology was akin to that in cuneiform culture. To quote Noel Swerdlow (2012: 369), "at the time of Copernicus ... and until sometime in the seventeenth century, to the best of my knowledge there was no one concerned with astronomy who was not also concerned with astrology". The astronomical sciences, therefore, comprising both the technical methods of astronomy and the interpretive ones of astrology, were in some significant ways continuous from Babylonian antiquity to the Renaissance.

Such continuities found from the ancient to the modern sciences must not edge out the parts that do not map onto the expected parameters of science from a modern perspective. Some of those parts lie in the ontologies implied in primary sources. As an example, for a science that was once as valid and central to scientific communities as astrology was, what makes it of interest to the history of science is not whether its principal ontological posit—stellar influence—was wrong or right, but how it was understood.

Stellar influence was itself indication of a particular world construction, originating in the Greek and Greco-Roman world, very possibly transformed from but traceable to an idea developed in Babylonian medicine and magic. The significance to the history of science is what astrological sources reflect of the world conceived of by its practitioners. To quote Erica Reiner (1995: 15),

> Stars function in a dual role in relation to man: they exert a direct influence and serve as mediators between man and god. Directly, through astral irradiation, they transform ordinary substances into potent ones that will be effective in magic, medicine, or ritual, as *materia medica*, amulets, or cultic appurtenances.

divine action [i.e., outside the bounds of the causes God created in nature]. The natural–supernatural distinction thus began to crystallize in the thirteenth century as a means of distinguishing two kinds of divine activity: one in which God works with the order he embedded into things; the other when he acts miraculously and independently of created causes".

The "astral irradiation" Reiner referred to seems to connote something conceptually prior to the later notion of stellar influence. The idea of stellar influence, for centuries regarded as a law of nature, may well have had a genetic relationship to the Babylonian system, but its differences have important ontological implications.

The notion of stellar influence, formalized in the 2nd century C.E. in Ptolemy's *Tetrabiblos* 1.4 (Robbins 1940; Feke 2018: 181), understood this influence as a physical power ($\delta\upsilon\nu\alpha\mu\epsilon\zeta$) of the stars. The stars and planets could be viewed as causes by virtue of the movement of planetary rays ($\alpha\kappa\tau\iota\nu\epsilon\zeta$) through the aether of the celestial spheres. This theoretical accounting for astrological influence derives from an entirely different ontological order from what is reflected in cuneiform medical and magical texts. The ontological framing for divinatory and other sciences in *ṭupšarrūtu* is as important as the contents of its textual corpus (Rochberg 2016: 61-102).

Because a rethinking and reorientation of the definition of science is useful for fine-tuning the historiography of science, I find the term science is entirely justified for cuneiform culture. I take a page from Jardine's argument for a legitimate use of anachronism (Rochberg 2000: 252):

> I shall be out to show that anachronism, use of categories alien to the period in question, is often entirely in order precisely when our interest is, like [Quentin] Skinner's, in the historical identity of deeds and works. Their original historical significances, their meanings in their own times and places, are not confined to the significances that were (or could have been) attached to them at those times and places.

Because we are interested in the meaning of the cuneiform knowledge culture, or *ṭupšarrūtu* as a culture of science, I concur with Jardine's justification of a certain legitimate use of our modern scholarly category "science," and I find it useful for integrating cuneiform knowledge into the bigger picture of the history of science.

It is, therefore, not for lack of a better term that I employ the term science to refer to the fields and texts of *ṭupšarrūtu* . My use of the term is justified neither on the grounds that the writers of cuneiform scientific texts had a conception that what they were doing was "science" (far from it), nor, as already indicated, that cuneiform science gains membership credentials by being like modern Western sciences, as it was both like and unlike some of those sciences. Use of the term science in connection with *ṭupšarrūtu* does not depend upon the clear continuities from Babylonian astronomy to Greek, or take its justification solely from some of its methodological tools, i.e., the empirical, quantitative, predictive, rational, and epistemic, considerations that link the cuneiform world of knowledge (Rochberg 2016) to science in later periods.

The texts and fields of inquiry subsumed under *ṭupšarrūtu* can be termed scientific for the principal reason that science is the term best suited to refer to practices and methods of inquiry and resulting systems of knowledge of what a particular community perceives as its phenomenal world. We cannot presume that every scientific culture will have nature as its epistemological and ontological framework. The idea of nature itself has a long history. If the integrity of the modern practice of science is to be judged on its own values, aims and norms, so too should ancient science be judged on its own terms, and in terms of its world of phenomena, not on the measure of modern Western science and its repertoire of natural phenomena.

Bibliography

ALVARGONZÀLEZ, David (2013) "Is the History of Science Essentially Whiggish?", *History of Science* 51: 85-99.

BOWEN, Alan C. and ROCHBERG, Francesca (eds.) (2020) *Hellenistic Astronomy: The Science in its Contexts*. Leiden and Boston: Brill.

BUTTERFIELD, Herbert (1931) *The Whig Interpretation of History*. London: Bell.

CHANG, Hasok (2012) *Is Water H2O?: Evidence, Realism and Pluralism*. New York: Springer.

DASTON, Lorraine (2017) "The History of Science and the History of Knowledge", *KNOW* 1:131-154.

DELAPORTE, François, (ed.) (2000) *A Vital Rationalist: Selected Writings from Georges Canguilhem*. Transl. Arthur Goldhammer. New York: Zone Books.

ELLIS, Brian David (1985) "What Science Aims to Do", in: Churchland, P.M. and Hooker, C.A. (eds.), *Images of Science: Essays on Realism and Empiricism*. Chicago: University of Chicago Press: pp. 48-78.

Feke, Jaqueline (2018) *Ptolemy's Philosophy: Mathematics as a Way of Life*. Princeton: Princeton University Press.

Geller, Markham J. (2010) *Ancient Babylonian Medicine: Theory and Practice*. Malden, MA, Oxford, West Sussex: Wiley-Blackwell.

Harman, Oren and Métraux, Alexandre (eds.) (2013) "Approaches, Styles, and Narratives: Reflections on Doing History of Science", *Science in Context* 26 (Special Issue).

Harrison, Peter and Roberts, Jon H. (eds.) (2019) *Science Without God?: Rethinking the History of Scientific Naturalism*. Oxford: Oxford University Press.

Haubold, Johannes; Steele, John and Stevens, Kathryn (eds.) (2019) *Keeping Watch in Babylon: The Astronomical Diaries in Context*. Leiden and Boston: Brill.

Hunger, Hermann (1968) *Babylonische und Assyrische Kolophone*. Neukirchen-Vluyn, Kevelaer: Neukirchener Verlag des Erziehungsvereins, Butzon & Bercker.

Hunger, Hermann (1992) *Astrological Reports to Assyrian Kings*. State Archives of Assyria 8. Helsinki: The Neo-Assyrian Text Corpus Project.

Hunger, Hermann (2001) *Astronomical Diaries and Related Texts from Babylonia*, Volume 5– *Lunar and Planetary Texts, including materials by Abraham J. Sachs*. Denkschriften (Österreichische Akademie der Wissenschaften, Philosophisch-historische Klasse) 299. Bd. Wien: Verlag der Österreichischen Akademie der Wissenschaften.

Hunger, Hermann (2006) *Astronomical Diaries and Related Texts from Babylonia*, Volume 6 –*Goal Year Texts, including materials by Abraham J. Sachs*. Denkschriften (Österreichische Akademie der Wissenschaften, Philosophisch-historische Klasse) 346. Bd. Wien: Verlag der Österreichischen Akademie der Wissenschaften.

Hunger, Hermann (2014) *Astronomical Diaries and Related Texts from Babylonia*, Volume 7 –*Almanacs and Normal Star Almanacs, including materials by Abraham J. Sachs*. Denkschriften (Österreichische Akademie der Wissenschaften, Philosophisch-historische Klasse) 466. Bd. Wien: Verlag der Österreichischen Akademie der Wissenschaften.

HUNGER, Hermann and PINGREE, David (1999) *Astral Sciences in Mesopotamia. Handbook of Oriental Studies.* Section I *The Near and Middle East*, Vol. 44. Leiden, Boston, Köln: Brill.

HUNGER, Hermann and STEELE, John (2019) *The Babylonian Astronomical Compendium MUL.APIN.* London: Routledge.

JARDINE, Nicholas (1986) *The Fortunes of Inquiry.* Oxford: The Clarendon Press.

JARDINE, Nicholas (2000) "Uses and Abuses of Anachronism in the History of Science", *History of Science* 38: 251-270.

JONES, Alexander (1999) *Astronomical Papyri from Oxyrhynchus*, 2 vols. Memoirs of the American Philosophical Society, 233. Philadelphia: American Philosophical Society.

KOYRÉ, Alexandre (1957) *From the Closed World to the Infinite Universe.* Baltimore, Md.: Johns Hopkins Press.

KUHN, Thomas (1962, 1996 3rd ed.) *The Structure of Scientific Revolutions.* Chicago: The University of Chicago Press.

LAUDAN, Larry (1981, 1984) "A Confutation of Convergent Realism", *Philosophy of Science* 48: 19-49; republished in: Leplin, J. (ed.) (1984) *Scientific Realism.* Berkeley: University of California Press, pp. 218-249.

LENZI, Alan (2008) *Secrecy and the Gods: Secret Knowledge in Ancient Mesopotamia and Biblical Israel.* State Archives of Assyria Studies 19. Helsinki: The Neo-Assyrian Text Corpus Project.

LINDBERG, David C. and WESTMAN, Robert S. (1990) *Reappraisals of the Scientific Revolution.* Cambridge and New York: Cambridge University Press.

LIPTON, Peter (2005) "The Medawar Lecture 2004: The Truth about Science", *Philosophical Transactions of the Royal Society* B 360, 1259—1269.

LLOYD, Geoffrey E.R. (1979) *Magic, Reason, and Experience.* Cambridge: Cambridge University Press.

Lloyd, Geoffrey and Sivin, Nathan (2003) *The Way and the Word: Science and Medicine in Early China and Greece*. New Haven, CT: Yale University Press.

Loison, Laurent (2016) "Forms of Presentism in the History of Science. Rethinking the Project of Historical Epistemology", *Studies in History and Philosophy of Science* 60: 29-37.

McMullin, Ernan (1984) "The Goals of Natural Science", *Proceedings and Addresses of the American Philosophical Society* 58: 37-54.

Mizrahi, Moti (2016) "The History of Science as a Graveyard of Theories: A Philosophers' Myth?", *International Studies in Philosophy of Science* 30: 263–278.

Neugebauer, Otto (1955) *Astronomical Cuneiform Texts*. 3 vols. London: Lund Humphries.

Neugebauer, Otto (1975) *A History of Ancient Mathematical Astronomy*. 3 vols. New York:Springer Verlag.

Neugebauer, Otto (1988) "A Babylonian Lunar Ephemeris from Roman Egypt", in: Leichty, E.; De Jong Ellis, M. and Gerardi, P. (eds.), *A Scientific Humanist: Studies in Memory of Abraham Sachs*. Occasional Publications of the Samuel Noah Kramer Fund 9, Philadelphia: University Museum.

Neugebauer, Otto (1989) "From Assyriology to Renaissance Art", *Proceedings of the American Philosophical Society* 133: 391-403.

Ossendrijver, Mathieu (2012) *Babylonian Mathematical Astronomy: Procedure Texts*. Berlin: Springer Verlag.

Panayotov, Strahil V. (2018) "Notes on the Assur Medical Catalogue with Comparison to the Nineveh Medical Encyclopaedia", in: Steinert, U. (ed.), *Assyrian and Babylonian Scholarly Text Catalogues*. Die babylonisch-assyrische Medizin in Texten und Untersuchungen 9. Berlin: De Gruyter, pp. 89-120.

Parpola, Simo (1993) *Letters from Assyrian and Babylonian Scholars.* State Archives of Assyria 10. Helsinki: The Neo-Assyrian Text Corpus Project.

Pigliucci, Massimo (2013) "The Demarcation Problem: A (Belated) Response to Laudan", in: Pigliucci, M. and Boudry, M. (eds.), *Philosophy of Pseudoscience: Reconsidering the Demarcation Problem.* Chicago and London: University of Chicago Press.

Pigliucci, Massimo and Boudry, Maarten (eds.) (2013) *Philosophy of Pseudoscience: Reconsidering the Demarcation Problem.* Chicago and London: University of Chicago Press.

Popper, Karl (1935, 2002) *Logic of Scientific Discovery.* Vienna, New York: Verlag von Julius Springer, Routledge.

Reiner, Erica (1995) *Astral Magic in Babylonia.* Philadelphia: American Philosophical Society.

Robbins, Frank E. (1940) *Ptolemy: Tetrabiblos.* Loeb Classical Library No. 435. Cambridge, Ma: Harvard University Press.

Robson, Eleanor (2019) *Ancient Knowledge Networks: A Social Geography of Cuneiform Scholarship in First-Millennium Assyria and Babylonia.* London: UCL Press.

Rochberg, Francesca (1993) "The Cultural Locus of Astronomy in Late Babylonia", in: Galter, H. D (ed.), *Die Rolle der Astronomie in den Kulturen Mesopotamiens. Beiträge Zum 3. Grazer Morgenländischen Symposion, 23.-27. September 1991.* Grazer Morgenländische Studien 3. Graz: GrazKult, pp. 31-45.

Rochberg, Francesca (1998) *Babylonian Horoscopes.* Philadelphia: American Philosophical Society.

Rochberg, Francesca (2004) *The Heavenly Writing: Divination, Horoscopy and Astronomy in Mesopotamian Culture.* Cambridge and New York: Cambridge University Press.

Rochberg, Francesca (2011) "Divine Causality and Babylonian Divination," in Frame, G.; Leichty, E.; Tigay, J. and Tinney, S. (eds.), *A*

Common Cultural Heritage: Studies on Mesopotamia and the Biblical World in Honor of Barry L. Eichler. Bethesda, MD: CDL Press, pp.279-294.

ROCHBERG, Francesca (2016) *Before Nature: Cuneiform Knowledge and the History of Science*. Chicago and London: University of Chicago Press.

RORTY, Richard (1979) *Philosophy and the Mirror of Nature*. Princeton: Princeton University Press.

SACHS, Abraham J. (1955) *Late Babylonian Astronomical and Related Texts*, with the co-operation of J. Schaumberger, Copied by T.G. Pinches and J.N. Strassmaier. Providence: Brown University Press.

SACHS, Abraham J. and HUNGER, Hermann (1988) *Astronomical Diaries and Related Texts from Babylonia*, Volume 1 – *Diaries from 652 B.C. to 262 B.C.*, Denkschriften (Österreichische Akademie der Wissenschaften. Philosophisch-Historische Klasse) 195. Bd. Wien: Verlag der Österreichischen Akademie der Wissenschaften.

SACHS, Abraham J. and HUNGER, Hermann (1989) *Astronomical Diaries and Related Texts from Babylonia*, Volume 2 – *Diaries from 261 B.C. to 165 B.C.*, Denkschriften (Österreichische Akademie der Wissenschaften. Philosophisch-Historische Klasse) 210. Bd. Wien: Verlag der Österreichischen Akademie der Wissenschaften.

SACHS, Abraham J. and HUNGER, Hermann (1996) *Astronomical Diaries and Related Texts from Babylonia*, Volume 3 – *Diaries from 164 B.C. to 61 B.C.* Denkschriften (Österreichische Akademie der Wissenschaften. Philosophisch-Historische Klasse) 246. Bd. Wien: Verlag der Österreichischen Akademie der Wissenschaften.

SARTON, George (1924) "Review of Lynn Thorndike, A History of Magic and Experimental Science during the First Thirteen Centuries of our Era (1923)", *Isis* 6: 74-89.

SCHMIDTCHEN, Eric (2018) "Esagil-kīn-apli's Catalogue of Sakikkû and Alamdimmû", in: Steinert, U. (ed.), *Assyrian and Babylonian Scholarly Text Catalogues*. Die babylonisch-assyrische Medizin in Texten und Untersuchungen 9. Berlin: De Gruyter, pp. 137-157.

SIVIN, Nathan (2005) "A Multi-dimensional Approach to Research on Ancient Science", *East Asian Science, Technology, and Medicine* 23:10–25.

SKINNER, Quentin (1969) "Meaning and Understanding in the History of Ideas", *History and Theory* 8: 3-53.

STARR, Ivan (1983) *The Rituals of the Diviner.* Bibliotheca Mesopotamica 12. Malibu: Undena Publications.

STEINERT, Ulrike (2018a) "Introduction: Catalogues, Corpora and Canons in Mesopotamian Scholarship", in: Steinert, U. (ed.), *Assyrian and Babylonian Scholarly Text Catalogues.* Die babylonisch-assyrische Medizin in Texten und Untersuchungen 9. Berlin: De Gruyter, pp. 7-22.

STEINERT, Ulrike (2018b) "Catalogues, Texts and Specialists: Some Thoughts on the Assur Medical Catalogue, Mesopotamian Medical Texts and Healing Professions", in: Steinert, U. (ed.), *Assyrian and Babylonian Scholarly Text Catalogues.* Die babylonisch-assyrische Medizin in Texten und Untersuchungen 9. Berlin: De Gruyter, pp. 158-202.

STEINERT, Ulrike (2018c) "The Assur Medical Catalogue (AMC)", in: Steinert, U. (ed.), *Assyrian and Babylonian Scholarly Text Catalogues.* Die babylonisch-assyrische Medizin in Texten und Untersuchungen 9. Berlin: De Gruyter, pp. 203-291.

SWERDLOW, Noel (2012) "Copernicus and Astrology, with an Appendix of Translations of Primary Sources", *Historical Perspectives* 20: 353-378.

THORNDIKE, Lynn (1923-1958) *A History of Magic and Experimental Science during the First Thirteen Centuries of our Era.* 8 vols. New York, London: Columbia University Press, Oxford University Press.

TOSH, Nick (2003) "Anachronism and Retrospective Explanation: In Defense of a Present-Centred History of Science", *Studies in History and Philosophy of Science* 34: 647-659.

VAN FRAASSEN, Bas (1980) *The Scientific Image.* Oxford: Clarendon Press.

WILLIAMS, Raymond (1983, rev.ed.) *Keywords: A Vocabulary of Culture and Society.* New York: Oxford University Press.