

On 18-25 July 2026 I attended an Oxford University Summer School for Adults on the topic of "**130 Years of Discovery: Nuclear and Particle Physics from Becquerel to Gianotti**", by Susan Bigge.

This is my pre-course assignment (c.1500 words) on the topic...

"Scientists often develop classification models/systems to organise information. Choose one (not related to nuclear and particle physics) and explain its development, use and limitations (possible examples include the periodic table in chemistry, taxonomy in biology and several rock classification systems in geology)".

Some years ago I prepared my own notes on Mesopotamian Science and Technology¹, and what I've done here is to try to focus on one particular ancient classification model/system. I admit I've had to back-fit the references, and like most people today I've used AI to critique my text. I make no claim to originality of thought.

Initially I thought I would look at the zodiac² from Babylonian astronomy³ (mid-1st millennium BC), but finally I decided on...

Babylonian Omen Classification as an Early System of Knowledge

Scientists and scholars have often attempted to organise knowledge by creating systems of classification. Such systems make it possible to collect observations, identify patterns, preserve information, and make predictions. One of the earliest and most ambitious examples emerged in

¹ <https://blog.bernardsmith.eu/mesopotamia-i/>

² <https://en.wikipedia.org/wiki/Zodiac>

³ https://en.wikipedia.org/wiki/Babylonian_astronomy

ancient Mesopotamia⁴, particularly in Babylonia⁵, where priest-scribes developed extensive lists, catalogues, tables, and omen collections⁶ covering astronomy⁷, medicine⁸, language⁹, religion¹⁰, politics¹¹, agriculture¹², and everyday life¹³. These systems of classification represented one of humanity's first sustained attempts to organise the natural and social world into structured bodies of knowledge¹⁴.

Unlike later Greek scientific traditions¹⁵, Babylonian scholarship did not generally seek universal laws or abstract theories to explain nature¹⁶. Instead, Babylonian scholars classified observations, accumulated precedents, and searched for recurring patterns linking phenomena together. Their greatest intellectual achievement was therefore not theoretical science in the modern sense, but the creation of vast and systematic classificatory systems. Among these, omen classification¹⁷ became especially important because it united astronomy, medicine, religion, politics, and historical record-keeping into a single framework for understanding reality.

⁴ <https://en.wikipedia.org/wiki/Mesopotamia>

⁵ <https://en.wikipedia.org/wiki/Babylonia>

⁶ Goetze, Albrecht (1966) *Old Babylonian Omen Texts*, Yale University Press

⁷ https://en.wikipedia.org/wiki/Babylonian_astronomy

⁸ <https://www.geschkult.fu-berlin.de/en/e/babmed/index.html>

⁹ https://en.wikipedia.org/wiki/Lexical_lists

¹⁰ https://en.wikipedia.org/wiki/Babylonian_religion

¹¹ <https://oracc.museum.upenn.edu/saao/aebp/Essentials/Countries/Babylonia/index.html>

¹² https://en.wikipedia.org/wiki/Agriculture_in_Mesopotamia

¹³ <https://yalebooks.yale.edu/2024/08/06/daily-life-in-ancient-babylonia-insights-from-the-temple-of-ishtar/>

¹⁴ James C. Scott (2017), *Against the Grain: A Deep History of the Earliest States*, Yale University Press

¹⁵ https://en.wikipedia.org/wiki/Science_in_classical_antiquity#Classical_Greece

¹⁶ https://en.wikipedia.org/wiki/Models_of_scientific_inquiry

¹⁷ Francesca Rochberg (2004), *The Heavenly Writing: Divination, Horoscopy, and Astronomy in Mesopotamian Culture*, Cambridge University Press

The origins of Babylonian classification systems can be traced back to the invention of writing in Sumer¹⁸ around 3000 BC¹⁹. Early cuneiform²⁰ writing began largely as pictographic accounting and administrative notation. The earliest tablets contain inventories of grain, livestock, labour obligations, and trade goods. However, these practical inventories gradually evolved into more elaborate lexical and scholarly lists. By the Early Dynastic period (ca. 2900-2350 BC)²¹, scribes were already compiling lists of trees, plants, animals, metals, stones, professions, geographical names, body parts, stars, and divine beings.

These lists reflected a deep Mesopotamian belief that order itself was fundamental to civilisation and to divine creation. The world created by the gods was assumed to possess structure, and human knowledge depended upon discovering and preserving that structure through classification. In this sense, making lists was not merely administrative but intellectual and religious. Ordered lists represented an attempt to reveal the underlying order imposed by the gods upon the universe²².

At first these classificatory systems were relatively simple and one-dimensional. Lists consisted primarily of inventories without explanatory relationships between entries. Kings, animals, gods, and places were simply arranged sequentially rather than conceptually. Historical and mythical rulers could appear side-by-side in the same king lists. Plants might be grouped according to practical usage rather than biological similarity. The Babylonians did not initially develop abstract categories equivalent to later Greek ideas²³ of “natural kinds” or “laws of nature”.

¹⁸ <https://en.wikipedia.org/wiki/Sumer>

¹⁹ Denise Schmandt-Besserat (1992), *Before Writing: From Counting to Cuneiform*, University of Texas Press

²⁰ <https://en.wikipedia.org/wiki/Cuneiform>

²¹ [https://en.wikipedia.org/wiki/Early_Dynastic_Period_\(Mesopotamia\)](https://en.wikipedia.org/wiki/Early_Dynastic_Period_(Mesopotamia))

²² Marc Van De Mieroop (2015), *Philosophy before the Greeks: The Pursuit of Truth in Ancient Babylonia*, Princeton University Press

²³ https://en.wikipedia.org/wiki/Science_in_classical_antiquity#Classical_Greece

Nevertheless, the sophistication of these systems increased steadily over many centuries. As Akkadian²⁴ gradually replaced Sumerian²⁵ as the dominant spoken language after about 2000 BC, bilingual lexical lists emerged comparing Sumerian and Akkadian vocabulary. Between roughly 2400 and 2200 BC scribes produced lists of grammatical forms, synonyms, and homonyms. By the Late Bronze Age (ca. 2500-1200 BC)²⁶, four-column multilingual lists existed incorporating languages such as Sumerian, Akkadian, Hurrian²⁷, Hittite²⁸, and Ugaritic²⁹. These lexical compilations became the earliest known dictionaries and linguistic reference systems in human history³⁰.

The same desire to classify extended into many other fields. Babylonian medicine produced lists of symptoms, diseases, medicinal plants, minerals, and therapeutic procedures. Law codes³¹ classified crimes and punishments. Calendrical systems³² organised agricultural and religious life. Yet the most extensive and intellectually important Babylonian classificatory system concerned omens³³.

The Babylonian omen tradition was based upon the belief that the gods communicated their intentions through observable signs embedded within nature. Celestial events, weather phenomena, animal behaviour, bodily abnormalities, dreams, and unusual occurrences were all interpreted as

²⁴ https://en.wikipedia.org/wiki/Akkadian_language

²⁵ https://en.wikipedia.org/wiki/Sumerian_language

²⁶ https://en.wikipedia.org/wiki/Ancient_Near_East#Late_Bronze_Age

²⁷ <https://en.wikipedia.org/wiki/Hurrians>

²⁸ <https://en.wikipedia.org/wiki/Hittites>

²⁹ <https://en.wikipedia.org/wiki/Ugaritic>

³⁰ Samuel Noah Kramer (1897–1990)

³¹ https://en.wikipedia.org/wiki/List_of_ancient_legal_codes

³² https://en.wikipedia.org/wiki/Babylonian_astrology

³³ Francesca Rochberg

indicators of future events. The role of the scholar-priest was therefore to observe, record, classify, and interpret these signs.

The omen collections themselves were extraordinarily large. Thousands upon thousands of omens were compiled into organised series. These series usually followed a highly formalised “if-then” structure. A typical omen began with an observed condition (“If a lunar eclipse occurs...”) followed by its predicted consequence (“...the king will die” or “...there will be famine”). The aim was not simply divination in a mystical sense, but the systematic accumulation of precedents linking signs with outcomes.

One of the largest and most famous collections was the *Enûma Anu Enlil*³⁴, a massive compendium of celestial omens probably compiled between the second and first millennia BC. This work consisted of approximately seventy tablets devoted primarily to astronomical and meteorological phenomena. Lunar eclipses³⁵, planetary positions, cloud formations, winds, halos around the Moon³⁶, and unusual weather conditions were all classified and associated with political, agricultural, or military consequences.

The *Enûma Anu Enlil* illustrates the fundamentally classificatory nature of Babylonian scholarship. The Babylonians did not attempt to explain eclipses physically in terms of orbital mechanics. Instead, eclipses were categorised according to timing, direction, colour, duration, and accompanying celestial conditions. Each variation carried its own predictive significance. The value of the system lay in the accumulation of detailed precedents rather than causal explanation.

³⁴ https://en.wikipedia.org/wiki/Enuma_Anu_Enlil

³⁵ https://en.wikipedia.org/wiki/Lunar_eclipse

³⁶ [https://en.wikipedia.org/wiki/Halo_\(optical_phenomenon\)](https://en.wikipedia.org/wiki/Halo_(optical_phenomenon))

This omen tradition produced one of the most sustained observational enterprises in ancient history³⁷. Beginning around the 8th century BC, Babylonian astronomer-scribes compiled astronomical diaries recording the positions of the Moon and planets, eclipses, solstices³⁸, equinoxes³⁹, meteorological conditions, commodity prices, river levels, and important political events on a month-by-month basis. **These records continued for approximately seven centuries.**

The scale and continuity of these observations were remarkable. Babylonian astronomers tracked the movements of the five visible planets, recognised periodicities in celestial motions, and developed increasingly accurate predictive techniques. They divided the sky into twelve zodiacal regions, many of whose names survive today. They discovered the Saros cycle⁴⁰ (223 synodic months⁴¹) of approximately eighteen years, enabling prediction of eclipses. By the Seleucid period⁴², they were producing **ephemerides predicting future planetary positions** using sophisticated arithmetic procedures.

Yet these astronomical observations⁴³ remained closely integrated with omen classification. Celestial events mattered because they were believed to reveal divine intentions concerning earthly affairs. Astronomy therefore existed partly in service to astrology and statecraft.

A famous example concerns the defeat of the Persian king Darius III by Alexander the Great in 331 BC⁴⁴. Babylonian records associated a lunar eclipse, meteorological events, and subsequent military

³⁷ Francesca Rochberg

³⁸ <https://en.wikipedia.org/wiki/Solstice>

³⁹ <https://en.wikipedia.org/wiki/Equinox>

⁴⁰ [https://en.wikipedia.org/wiki/Saros_\(astronomy\)](https://en.wikipedia.org/wiki/Saros_(astronomy))

⁴¹ https://en.wikipedia.org/wiki/Lunar_month#Synodic_month

⁴² https://en.wikipedia.org/wiki/Seleucid_Empire

⁴³ https://en.wikipedia.org/wiki/Babylonian_astronomical_diaries

⁴⁴ https://en.wikipedia.org/wiki/Battle_of_Gaugamela

developments into a coherent omen interpretation. The eclipse was interpreted as foretelling the downfall of the reigning king and the arrival of a western conqueror. Babylonian priest-scribes interpreted the celestial signs according to established omen precedents and advised political authorities accordingly.

Such records also reveal the broader scope of Babylonian classification systems. Astronomical diaries did not record celestial phenomena alone. They also documented commodity prices, river heights, weather conditions, military events, and public unrest. This reflected a worldview in which natural, political, and divine events were interconnected within a single ordered system.

Medicine was similarly integrated into omen classification. Babylonian diagnostic texts catalogued symptoms, prognoses, and treatments in highly structured forms⁴⁵. Diseases were often interpreted as manifestations of divine displeasure or demonic influence. Symptoms might be associated with particular gods, planets, or omens. Treatments combined medicinal substances, ritual actions, prayers, and incantations.

The Babylonians possessed extensive pharmacological knowledge. Medicinal plants, minerals, stones, oils, and resins were catalogued carefully, and many remedies bear similarities to later traditional medicines. However, there was little attempt to develop physiological theories explaining how these remedies functioned. Again, classification and empirical association were emphasised over causal explanation.

One of the most striking aspects of Babylonian scholarship was the extraordinary precision of observation achieved despite relatively crude instruments. Babylonian astronomers possessed no telescopes and only limited positional measuring tools. Planetary positions were often recorded simply in relation to zodiacal constellations rather than exact coordinates. Nevertheless, through

⁴⁵ Markham J. Geller (2010), *Ancient Babylonian Medicine*, Wiley-Blackwell

centuries of systematic observation and numerical analysis, they achieved impressive predictive accuracy.

Babylonian mathematical astronomy became especially sophisticated after about 400 BC. Astronomers developed arithmetic schemes for predicting lunar and planetary motions using step-functions and zigzag functions⁴⁶. In 2016 scholars⁴⁷ analysing cuneiform tablets argued that Babylonian astronomers may even have employed geometric techniques equivalent to calculating areas under curves in order to model Jupiter's motion. If correct, this would represent an unexpectedly advanced form of abstract⁴⁸ mathematical reasoning⁴⁹.

Despite these achievements, Babylonian classificatory systems possessed important limitations. Their scholarship remained primarily descriptive and accumulative. Knowledge expanded through the addition of further entries, omens, and precedents rather than through the reduction of phenomena to general explanatory principles.

Unlike the Greeks, the Babylonians did not generally construct geometric cosmological models intended to explain the structure of the universe. Greek astronomers developed systems based upon spheres, circular motions, and geometrical mechanisms. Babylonian astronomers instead focused on predictive tables derived from arithmetic regularities in observational data.

This distinction reflected deeper differences in intellectual orientation. Babylonian scholarship emphasised practical prediction, ritual significance, and preservation of inherited knowledge. Greek natural philosophy increasingly sought causal explanation and theoretical coherence. The

⁴⁶ https://en.wikipedia.org/wiki/Babylonian_mathematics#Geometry

⁴⁷ Mathieu Ossendrijver (2016), "Ancient Babylonian astronomers calculated Jupiter's position from the area under a time-velocity graph," *Science* **351** (6272)

⁴⁸ <https://en.wikipedia.org/wiki/Abstraction>

⁴⁹ <https://en.wikipedia.org/wiki/Logic>

Babylonians were less interested in asking why celestial bodies moved, than in determining when eclipses or planetary appearances would recur.

The omen system itself also suffered from conceptual weaknesses. Correlation was often treated as causation. A celestial event and a political disaster might be linked because they had previously occurred together, regardless of whether any physical connection existed. Genuine empirical observations were therefore mixed with symbolic interpretation, religious belief, and imaginative speculation.

The enormous scale of the omen collections could also become intellectually restrictive. Thousands of omens accumulated over centuries without simplification or theoretical integration. The classificatory system preserved and organised knowledge effectively, but it could discourage the search for underlying mechanisms or broader explanatory frameworks.

Nevertheless, it would be a mistake to dismiss Babylonian scholarship as irrational or “unscientific”. Scientific inquiry fundamentally depends upon careful observation, accurate record-keeping, recognition of regularities, and the ability to make predictions. In all these respects Babylonian scholars achieved remarkable success. Their astronomical diaries constitute **one of the earliest sustained scientific data-collection programmes in human history**.

Moreover, Babylonian classification systems profoundly influenced later civilisations. Greek astronomers inherited Babylonian astronomical data and predictive techniques. The zodiac passed into Hellenistic and later Western astrology. Babylonian numerical methods influenced Greek and Islamic astronomy. Their lexical traditions anticipated later dictionaries, encyclopaedias, and scholarly reference systems.

Most importantly, Babylonian omen classification demonstrated that large-scale systems of organised knowledge could be constructed through cumulative observation over many generations.

The Babylonians showed that the world could be studied systematically, patterns could be identified, and future events could be predicted from recorded regularities.

In this sense, Babylonian omen classification represents one of the earliest major intellectual enterprises in human history. Its strength lay in its extraordinary capacity for observation, organisation, and preservation of information. Its weakness lay in its limited concern for causal explanation and theoretical abstraction. Yet despite these limitations, Babylonian classificatory systems laid essential foundations for the later development of astronomy, medicine, historical record-keeping, and scientific thought itself.

Here a few things we have inherited from Babylonian civilisation:-

- Base-60 (sexagesimal) number system, with 60 seconds per minute, 60 minutes per hour, and 360 degrees in a circle
- Degrees, arcminutes, arcseconds
- The 12-sign zodiac, zodiac constellations, horoscopes / natal astrology
- Planet-based weekday traditions, ephemerides (astronomical tables), eclipse prediction methods, mathematical astronomy
- Positional/place-value notation, multiplication tables, reciprocal tables, tables of squares and cubes
- Algebraic problem solving, quadratic equation methods, geometric calculation techniques, algorithmic step-by-step calculation procedures
- 12-month lunar calendar structure, leap-month (intercalation) systems
- Systematic celestial observation records, numerical predictive models
- Astronomical coordinate methods, cataloging of stars and planets, early cartography/world maps
- Written law codes, contracts and legal documentation, land surveying methods

- Accounting/bookkeeping systems, compound interest calculations, tax records and administrative bureaucracy
- Libraries and archival systems, scholarly scribal traditions, long-term scientific record keeping
- Water clocks and time measurement techniques, standardised weights and measures
- And finally, the Epic of Gilgamesh tradition that influenced later literature practices.

The largest specific number known from surviving Babylonian tablets is probably from a set of “number-crunching” tablets studied by historian Mathieu Ossendrijver⁵⁰. One tablet contains a number equal to: $9^{11} \times 12^{39}$, written in sexagesimal with about 30 digits. Scholars describe it as likely “the longest number attested in ancient Mesopotamia, and probably in all antiquity”.

Another famous example is a tablet starting with 9^{46} which is also quite big, roughly 8.9×10^{43} in decimal notation. For comparison, that is far larger than the estimated number of grains of sand in many ancient thought experiments⁵¹.

As for the largest calculation, the best candidate is a Late Babylonian tablet known as BM 34601⁵², which appears to show a full long multiplication (similar to modern multiplication) of a 13-digit sexagesimal number 5×3^{25} . The calculation used columns of partial products much like modern arithmetic. Historians describe it as the only known Babylonian example of this kind of explicit long multiplication.

The really gigantic numbers appear mostly in scholarly tablets, not tax records or engineering documents. Such numbers were not needed, but once they had a powerful positional number system, they may simply have wanted to explore what it could do.

⁵⁰ <https://arxiv.org/abs/1306.5989>

⁵¹ https://en.wikipedia.org/wiki/The_Sand_Reckoner

⁵² https://en.wikipedia.org/wiki/Babylonian_mathematics#Arithmetic

Another example, the famous tablet Plimpton 322⁵³ contains sophisticated Pythagorean triples⁵⁴ from around 1800 BC.

One especially impressive computation is their approximation of $\sqrt{2}$ on the tablet YBC 7289⁵⁵, accurate to about six decimal places, which is extraordinary for nearly 4,000 years ago. The result was 1;24,51,10 in sexagesimal, which equals about 1.41421296.

The Babylonians also used fractions⁵⁶ and very small quantities, but they did not have a symbol for zero at first, and they did not think in terms of “the smallest possible number” the way modern mathematics does.

"At first" means that Early Babylonian numerals had no true zero⁵⁷ symbol at all. This created ambiguities in their positional system, but they initially relied on context instead. However, around the late 1st millennium BC, scribes began using a special placeholder symbol made from two small angled wedges to mark an empty position inside a number. So instead of a blank space, they could indicate “there is nothing in this place value”. The important point is that this was not yet a full mathematical zero, but they did think of zero as an abstract quantity⁵⁸.

As already mentioned, their number system was sexagesimal (base-60)⁵⁹, so the smallest commonly written fractions were powers of 60, e.g. $1/60^3$, and because their notation was positional⁶⁰, they

⁵³ https://en.wikipedia.org/wiki/Plimpton_322

⁵⁴ https://en.wikipedia.org/wiki/Pythagorean_triple

⁵⁵ https://en.wikipedia.org/wiki/YBC_7289

⁵⁶ <https://en.wikipedia.org/wiki/Fraction>

⁵⁷ <https://en.wikipedia.org/wiki/0>

⁵⁸ In one Egyptian papyrus written around 1770 BC, a scribe recorded daily incomes and expenditures for the pharaoh's court, using a specific hieroglyph to indicate cases where the amount of a foodstuff received was exactly equal to the amount disbursed

⁵⁹ <https://en.wikipedia.org/wiki/Sexagesimal>

⁶⁰ https://en.wikipedia.org/wiki/Positional_notation

could in principle keep extending fractional places indefinitely. However, they usually did not use a separate fraction notation like $\frac{1}{2}$ or $\frac{3}{4}$. Instead they wrote numbers in sexagesimal place value, so 30 could mean 30, or $30/60 = 1/2$, depending on context.

The smallest attested fractions in surviving tablets are extremely tiny astronomical quantities, especially in Late Babylonian astronomy, where they subdivided degrees and time very finely. For example, 1 degree = 60 arcminutes⁶¹, and 1 arcminute = 60 arcseconds. This division ultimately comes from the Babylonian system and is why we still divide hours and circles into 60s today.

Final comment, both Babylonian omen systems and modern LLMs⁶² are, at their core, large-scale statistical engines for pattern association⁶³ built from accumulated corpora⁶⁴. The differences are enormous in mechanism and epistemology⁶⁵, but a Babylonian diviner would say “If X sign appears, Y consequence tends to follow”, whereas an LLM says “If token/context pattern X appears, token/response Y is statistically likely”. Both were/are subject to hallucinations⁶⁶ and overgeneralisations⁶⁷.

⁶¹ https://en.wikipedia.org/wiki/Minute_and_second_of_arc

⁶² https://en.wikipedia.org/wiki/Large_language_model

⁶³ https://en.wikipedia.org/wiki/Pattern_recognition

⁶⁴ https://en.wikipedia.org/wiki/Text_corpus

⁶⁵ <https://en.wikipedia.org/wiki/Epistemology>

⁶⁶ [https://en.wikipedia.org/wiki/Hallucination_\(artificial_intelligence\)](https://en.wikipedia.org/wiki/Hallucination_(artificial_intelligence))

⁶⁷ https://en.wikipedia.org/wiki/Faulty_generalization