ASTR 1P01
Brock University
Prof. Barak Shoshany

Lecture 4:
Astrology
(and why it's nonsense)

We will learn about…

- The relationship between astronomy and astrology.
- How to use the scientific method, critical thinking, and skepticism to prove that astrology is incorrect.
- Why billions of people still believe in astrology despite an overwhelming body of evidence against it.

The Crab Nebula
Credits: NASA, ESA, J. Hester and A. Loll (Arizona State University)

Astronomy and religion

- Imagine living in ancient times, thousands of years ago, without the scientific knowledge we have now.
- At that time, people didn't know what caused natural phenomena such as storms, earthquakes, volcanic eruptions, droughts, diseases, and so on.
- In the absence of rational scientific explanations, gods and other hypothetical beings were said to control different aspects of nature.

Astronomy and religion

- Ancient cultures thought that natural disasters happen as punishment, when the gods are displeased with them.
- In fact, some people still think this way today, even though scientists fully understand what causes these natural phenomena.

Astronomy and religion

- The ancients also didn't understand the celestial bodies.
- What they saw in the sky was an intricate pattern of fixed glowing dots.
- Some of these dots formed shapes that resembled animals, people, or objects. So they assumed this must mean something.

Astronomy and religion

- They also saw 7 bodies moving between those stars: the Sun, the Moon, Mercury, Venus, Mars, Jupiter, and Saturn.
- These bodies move in complicated paths, as if they have a will of their own.
- The sky was a huge mystery beyond comprehension!

Astronomy and religion

- Both the gods and the celestial bodies were mysteries, so perhaps they are related to each other?
- Ancient cultures all over the world associated gods with each of the 7 moving celestial bodies known to them.
- This practice dates back to at least 2600 BC with the ancient Sumerians, but existed in many cultures throughout the world.

For example, the Sun was represented by gods such as Ra in ancient Egypt --

Ra, Egyptian God of the Sun
Credits: Jeff Dahl

Shamash (Utu), Mesopotamian God of the Sun
Credits: Katolophyromai (Wikipedia)

Shamash in ancient Mesopotamia --

And Helios in ancient Greece.

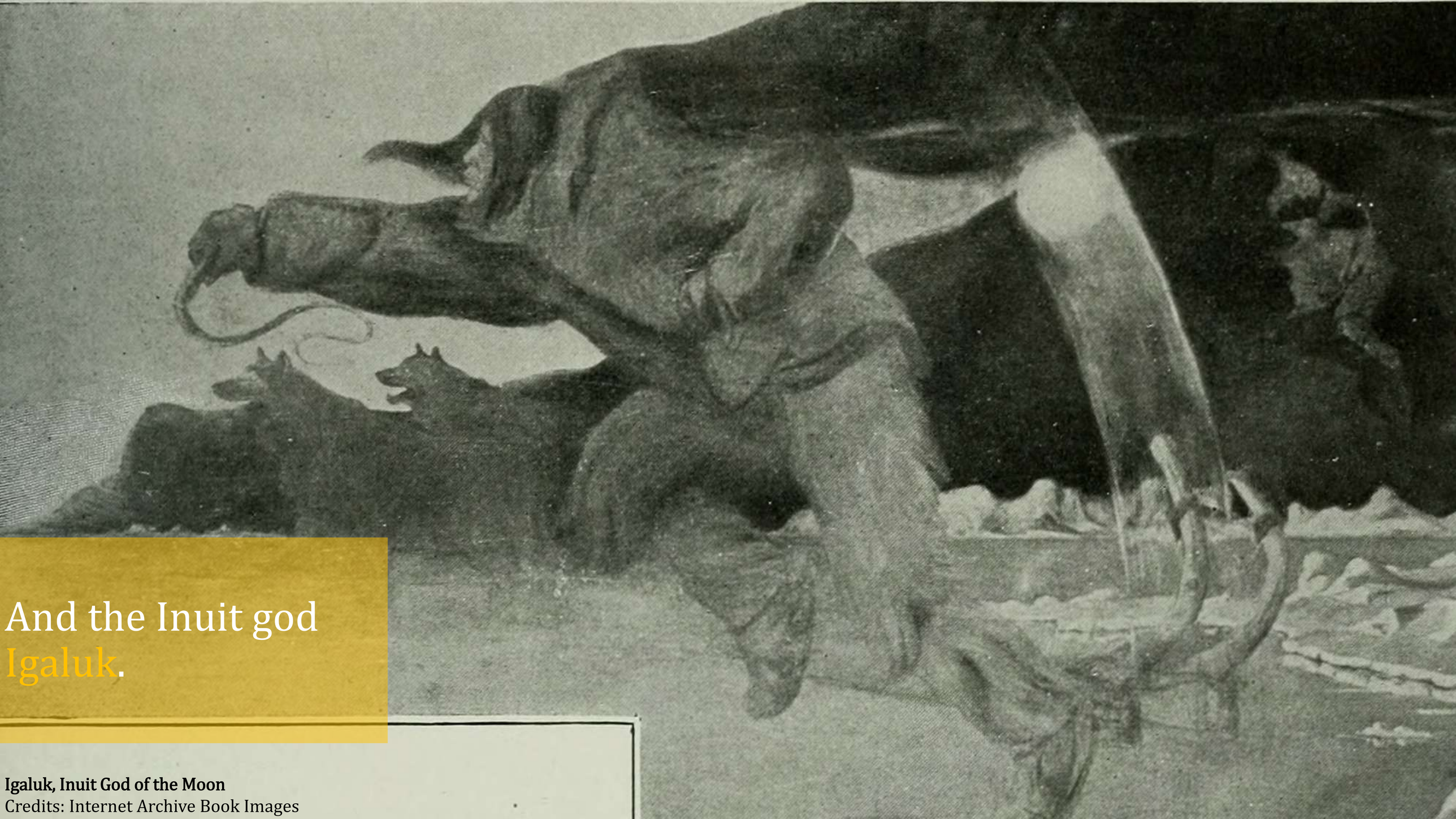
Helios and His Chariot on a Vase, circa 430 BC
Credits: British Museum

The Moon was associated with the Roman goddess Luna --

Luna, Roman Goddess of the Moon
Credits: Anthony Majanlahti

Chandra, Hindu God of the Moon
Credits: Los Angeles County Museum of Art

The Hindu god
Chandra --



And the Inuit god Igaluk.

Igaluk, Inuit God of the Moon
Credits: Internet Archive Book Images

Astronomy and religion

- Even modern religions today still claim that their gods live "in the heavens", although they don't associate them with specific celestial bodies.
- The seven days of the week were actually named for these 7 moving celestial bodies and their associated gods in many different languages.
- For example, in English, Sunday is the day of the Sun, and Monday is the day of the Moon.

Astronomy and religion

- In many Romance languages, such as French and Italian:
  - Tuesday corresponds to Mars,
  - Wednesday to Mercury,
  - Thursday to Jupiter,
  - Friday to Venus, and
  - Saturday to Saturn.
- All of these are gods associated with the planets.

Astronomy and religion

- In English, Saturday is still named after Saturn, but the other days are named for the Norse counterparts of the Roman gods associated with the planets:
  - Tuesday is named after Tyr,
  - Wednesday after Odin,
  - Thursday after Thor, and
  - Friday after Freya.

Astronomy and religion

- It was natural to associate celestial objects with gods, because they do influence our lives.
- The Sun brings light and warmth, and dictates our daily activities. Without it, life cannot exist.
- The position of the Sun in the sky correlates with the time of day and the change of seasons.
- The Moon also influences things on Earth by affecting the tides.
- All this was already known to ancient astronomers tens of thousands of years ago.

Astronomy and religion

- Ancient cultures noticed that different stars and constellations mark certain periodic events.
- For example, in Egypt, the star Sirius appears in the night sky for the first time around mid-July.
- Before that, it's only in the sky during daytime, so it cannot be seen.
- Farmers used this to predict the annual flooding of the Nile.

The birth of astrology

- Associating celestial bodies with gods led to the belief that the will and intentions of these gods can be interpreted by studying the sky and looking for celestial “omens”.
- The movements and timings of the Sun, Moon, and planets, and unusual astronomical events such as eclipses, were seen as communication from the gods.
- This practice started at least 5,000 years ago with the Sumerians, but it is most likely much older than that.

The birth of astrology

- Astrology was originally developed as a way to organize these omens.
- The oldest known system of astrology is Babylonian astrology, which was developed as early as 1800 BC.
- Many examples of Babylonian astrology are documented in a series of 70 clay tablets from around 1600 BC, called Enuma Anu Enlil.
- They survived to this day and contain the interpretations of thousands of celestial omens, and other omens such as weather phenomena and earthquakes.

The birth of astrology

- Babylonian priests attempted to interpret celestial events using two methods.
- The first method was an abstract association of ideas between celestial phenomena and certain events.
- For example, if the new moon appeared earlier than expected, then this was associated with the idea of something happening prematurely, which was considered a bad omen.

The birth of astrology

- The second method involved using observations and historical records to try to find correlations between celestial phenomena and good or bad events that happened at the same time.
- For example, if the rising of a new moon seemed to be correlated with a good event, such as victory in battle, then it was considered a good omen.

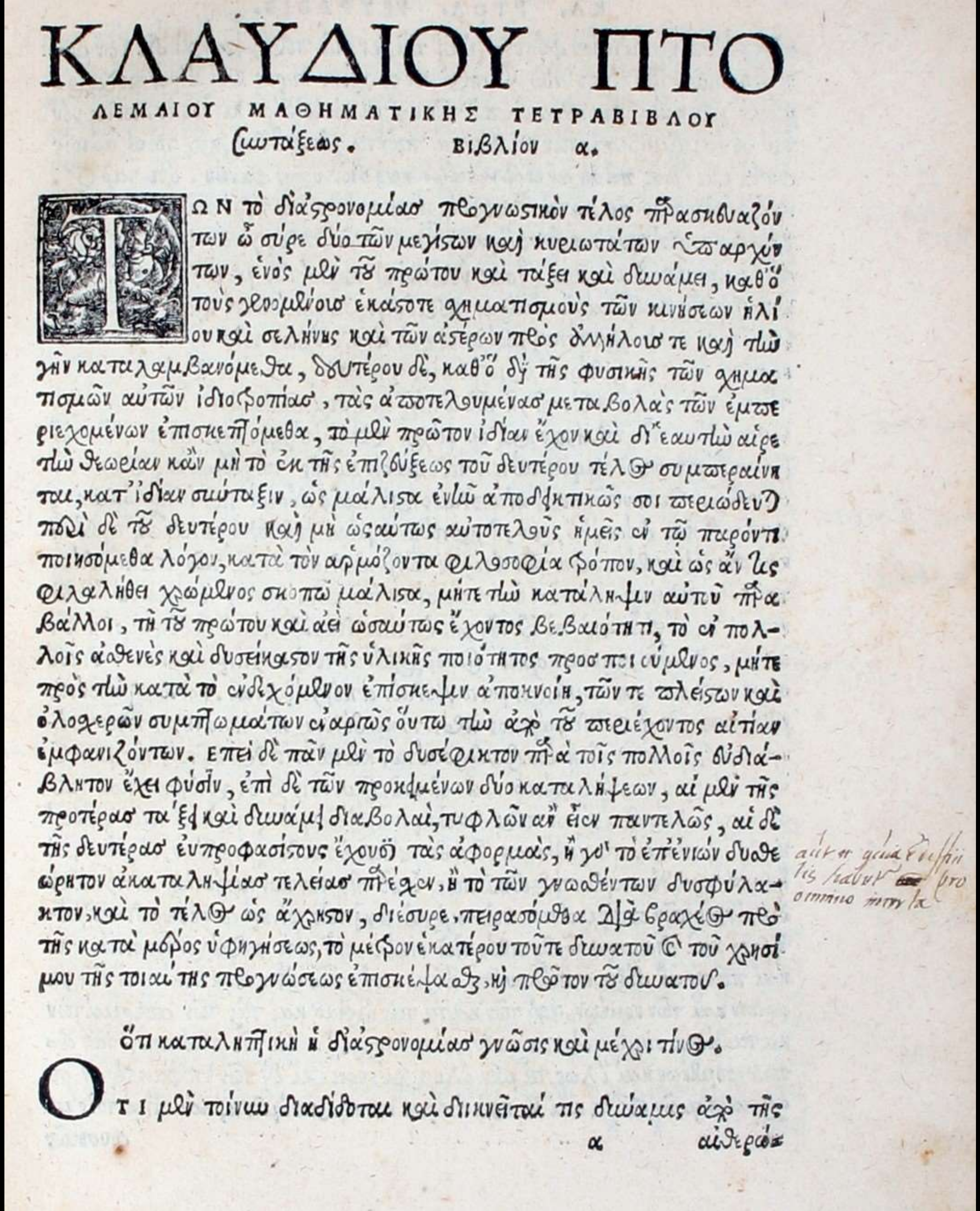
The birth of astrology

- Babylonian astrology gradually spread throughout the world to many different cultures, including Egypt, Greece, Rome, and the Islamic world.
- However, other cultures developed astrology independently, for example the Hindus, Chinese, and indigenous peoples in North America.

The birth of astrology

- Around 200 BC, the Greeks developed astrology further by introducing the idea that celestial objects influence the lives of individual people.
- They believed that the configuration of the Sun, Moon, and planets at the moment of a person's birth dictated their personality and affected their fortune throughout their lives.
- This concept is called natal astrology.

In the 2nd century, Ptolemy wrote the Tetrabiblos ("Four Books“).



ΚΛΑΥΔΙΟΥ ΠΤΟ

ΛΕΜΑΙΟΥ ΜΑΘΗΜΑΤΙΚΗΣ ΤΕΤΡΑΒΙΒΛΟΥ συντάξεως. βιβλίον α.

ΤΩΝ τὸ δι' ἀστρονομίας προγνωστικὸν τέλος παρασκευαζόντων ὦ Σύρε δύο τῶν μεγίστων καὶ κυριωτάτων ὑπαρχόντων, ἑνὸς μὲν τοῦ πρώτου καὶ τάξει καὶ δυνάμει, καθ' ὃ τοὺς γινομένους ἑκάστοτε σχηματισμοὺς τῶν κινήσεων ἡλίου καὶ σελήνης καὶ τῶν ἀστέρων πρὸς ἀλλήλους τε καὶ τὴν γῆν καταλαμβανόμεθα, δευτέρου δὲ, καθ' ὃ δι' αὐτῆς φυσικῆς τῶν σχηματισμῶν αὐτῶν ἰδιοτροπίας, τὰς ἀποτελουμένας μεταβολὰς τῶν ἐμπεριεχομένων ἐπισκεπτόμεθα, τὸ μὲν πρῶτον ἰδίαν ἔχον καὶ δι' ἑαυτὴν αἱρετὴν θεωρίαν κἂν μὴ τὸ ἐκ τῆς ἐπιζεύξεως τοῦ δευτέρου τέλος συμπεραίνηται, κατ' ἰδίαν σύνταξιν, ὡς μάλιστα ἐνῆν ἀποδεικτικῶς σοι περιώδευται. περὶ δὲ τοῦ δευτέρου καὶ μὴ ὡσαύτως αὐτοτελοῦς ἡμεῖς ἐν τῷ παρόντι ποιησόμεθα λόγον, κατὰ τὸν ἁρμόζοντα φιλοσοφίᾳ τρόπον, καὶ ὡς ἄν τις φιλαλήθει χρώμενος σκοπῷ μάλιστα, μήτε τὴν κατάληψιν αὐτοῦ παραβάλλοι τῇ τοῦ πρώτου καὶ ἀεὶ ὡσαύτως ἔχοντος βεβαιότητι, τὸ ἐν πολλοῖς ἀσθενὲς καὶ δυσείκαστον τῆς ὑλικῆς ποιότητος προσποιούμενος, μήτε πρὸς τὴν κατὰ τὸ ἐνδεχόμενον ἐπίσκεψιν ἀποκνοίη, τῶν τε πλείστων καὶ ὁλοσχερῶν συμπτωμάτων ἐναργῶς οὕτω τὴν ἀπὸ τοῦ περιέχοντος αἰτίαν ἐμφανιζόντων. Ἐπεὶ δὲ πᾶν μὲν τὸ δυσέφικτον παρὰ τοῖς πολλοῖς εὐδιάβλητον ἔχει φύσιν, ἐπὶ δὲ τῶν προκειμένων δύο καταλήψεων, αἱ μὲν τῆς προτέρας ταξ' καὶ δυνάμ' διαβολαὶ, τυφλῶν ἂν εἶεν παντελῶς, αἱ δὲ τῆς δευτέρας εὐπροφασίστους ἔχουσι τὰς ἀφορμὰς, ἢ γὰρ τὸ ἐπ' ἐνίων δυσθεώρητον ἀκαταληψίας τελείας παρέχει, ἢ τὸ τῶν γνωσθέντων δυσφύλακτον, καὶ τὸ τέλος ὡς ἄχρηστον, διασύρει, πειρασόμεθα διὰ βραχέων πρὸ τῆς κατὰ μέρος ὑφηγήσεως, τὸ μέτρον ἑκατέρου τοῦ τε δυνατοῦ καὶ τοῦ χρησίμου τῆς τοιαύτης προγνώσεως ἐπισκέψασθαι, καὶ πρότερον τοῦ δυνατοῦ.

Ὅτι καταληπτικὴ ἡ δι' ἀστρονομίας γνῶσις καὶ μέχρι τίνος.

ΟΤΙ μὲν τοίνυν διαδίδοταί καὶ διικνεῖταί τις δύναμις ἀπὸ τῆς

They summarized the techniques and philosophy of astrology at the time.

Ptolemy's Tetrabiblos
Credits: Joachim Camerarius

Astrology vs. science

- Ptolemy’s other work, Almagest, was considered the definitive text on astronomy for more than a thousand years.
- Today, astronomers know that Almagest is incorrect, since it describes a geocentric model and contains many other errors.
- Therefore, we don't consider it an authoritative source of information about astronomy anymore.

Astrology vs. science

- Just like Almagest, the Tetrabiblos is widely known to be incorrect.
- The claims it makes that can be tested scientifically have been proven false.
- Despite that, the Tetrabiblos still forms the basis of modern Western astrology.

Astrology vs. science

- This provides a great illustration of the difference between astronomy and astrology.
- Astronomy is a science, so it changes and evolves over time. Old theories are discarded if their predictions don't match experimental or observational data.
- Astrology is not a science, so astrologers never bother to check if astrology is actually correct, they just accept it as a fact - despite overwhelming evidence against it.
- We call astrology a pseudo-science: it often claims to be a science, but it doesn’t actually employ the scientific method.

Astrology vs. science

- Let's go back to the second method used by the Babylonian priests to determine the meaning of celestial omens.
- They collected data about celestial phenomena and tried to find correlations with historical events.
- This method actually resembles science, in that it involves analyzing observational data!
- However, that's where the resemblance ends.

Astrology vs. science

- The Babylonian priests assumed that correlation implies causation.
- Today we know that the fact that two events seem to correlate doesn't necessarily imply there is any causal relationship between them.
- A good scientific hypothesis must explain the mechanism of action by which one event causes the other.
- The Babylonians never attempted to suggest any mechanism by which the celestial objects could cause or influence events.

Astrology vs. science

- Another important aspect of modern science is experimental testing and falsification of hypotheses.
- It's not enough to just find correlations in existing data. A hypothesis must make predictions that are not already in the data.
- Scientists must perform experiments to test these predictions before they can accept the hypothesis as a valid theory.

Astrology vs. science

- If the predictions do not match the experimental results, then this means the hypothesis is incorrect, and it must be thrown away!
- The hypothesis is only considered to be valid, and promoted to a scientific theory, if experiments have successfully verified enough of its predictions.
- The more predictions verified, the more confidence scientists can have that the hypothesis is indeed correct.
- Scientists never have 100% confidence in a theory. They are always ready to replace it with a better one with better predictions.

Astrology vs. science

- Babylonian astrology did not involve any form of hypothesis testing.
- Today we know that the correlations the priests noticed were just pure coincidences. So many of the predictions must not have come to pass.
- If those predictions were part of a modern scientific hypothesis, then that hypothesis would have been discarded.
- So why didn't the Babylonian astrologers realize their hypothesis was wrong after its predictions didn't turn out to be correct?

Astrology vs. science

- This was thousands of years before the scientific method was invented, so people were not yet used to thinking rationally.
- They had no method of determining what's true and what's not, and beliefs were indistinguishable from facts.
- It's likely that it never even occurred to them that a hypothesis needs to be discarded if it makes incorrect predictions.

Astrology vs. science

- After all, even today many people still believe in astrology even though its predictions can easily be shown to be incorrect.
- The scientific method and rational thinking are skills that need to be learned, people are not born with them. And it took humanity thousands of years to figure them out!

Astrology vs. science

- Another possible reason that the hypothesis was not discarded is called confirmation bias.
- People are naturally biased towards confirming their existing beliefs.
- They tend to remember predictions that were fulfilled, and forget about predictions that were not fulfilled.
- An important part in the training of any scientist is to become aware of this bias and know how to correct for it.

Astrology vs. science

- A third reason is that Babylonian priests used astrology to guide their rulers.
- It is almost certain that in many cases they simply made up omens, to make those rulers do what the priests wanted them to do.
- Using religion or other supernatural beliefs to manipulate and control people has been common practice since prehistoric times, and it is still very common today, so it's safe to assume it existed in Babylonia too.

Astrology vs. science

- Exploring astrology gives us excellent insight not only into the scientific method, but also into the psychological and even political factors that cause people to ignore the scientific evidence.
- This is very important knowledge to have. Even if you do not want to be a scientist, you may still want to be able to tell fact from fiction. This can sometimes be a matter of life and death!
- So let's dive deeper and discuss some of the evidence against astrology.

Astrology vs. science

- We will prove that astrology is wrong in 4 different ways:

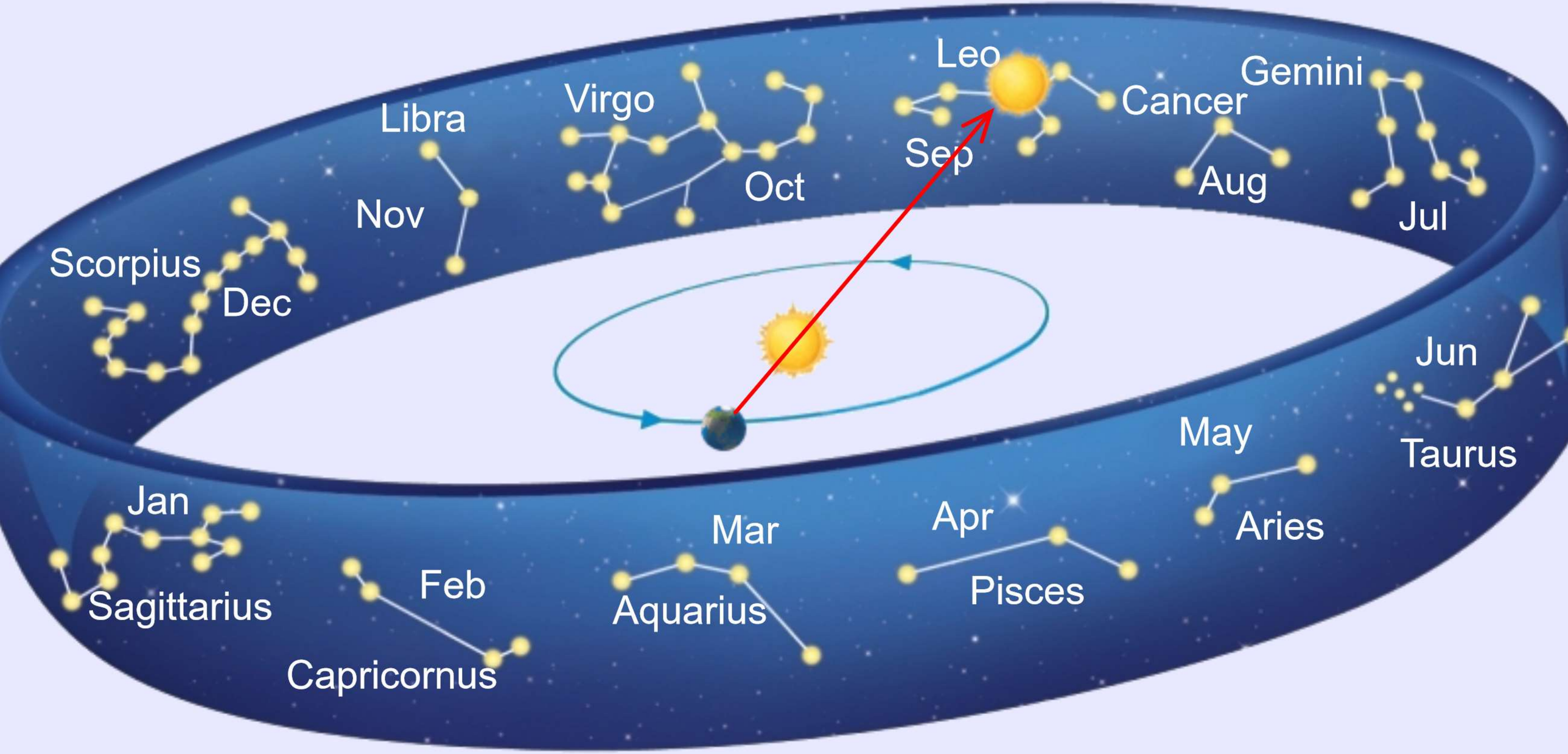
1. It is based on incorrect assumptions.
2. It provides no mechanism of action.
3. There is indirect evidence against it from unrelated studies.
4. There is direct evidence against it from experiments specifically designed to test it.

Incorrect assumptions

- Recall that the ecliptic marks the apparent path of the Sun in the sky throughout the year.
- The paths of the Moon and the planets are all within the zodiac, a belt centered around the ecliptic.
- Natal astrology relies on horoscopes, which are charts showing the positions of the 7 celestial bodies in the sky at the moment of birth.

Incorrect assumptions

- The zodiac is divided into 12 sectors called signs.
- The signs are named for the constellations that are located at the corresponding part of the zodiac.
- The Sun sign indicates the zodiac sign where the Sun was located at the moment of birth. It is the most commonly used sign.
- Similarly, the Moon sign is the sign where the Moon was located, and the rising sign (or ascendant) is the sign that was rising on the eastern horizon.



Determining the Sun Sign
Credits: JavaLab

Incorrect assumptions

- The zodiac was first divided into signs by the Babylonians around 400 BC.
- But due to axial precession, the Earth's axis slowly rotates, completing a full circle every 25,700 years.
- This means that the stars and constellations change their positions with time.
- In 2,400 years, the zodiac rotated by a bit more than one full sign.
- But astrologers today still use the same signs used by the ancient Babylonians.

Incorrect assumptions

- So your "actual" Sun sign is the one before the one astrologers use.
- For example, if you were born between November 23rd and December 21st, your Sun sign is considered to be Sagittarius, even though the Sun was actually at the constellation Scorpio that day.
- Even if we accept the hypothesis that the position of the Sun at birth affects us, the actual predictions of astrology aren't even based on the real position of the Sun.
- Of course, this doesn't bother astrologers, since astrology still "works" whether you use the correct sign or not (as we'll see).

There is actually a 13th constellation on the zodiac: Ophiuchus (off-ee-YOO-kus).

13 Constellations of the Zodiac
Credits: Found online, autho unknown

Incorrect assumptions

- If you were born between November 29 and December 18, your Sun sign is “actually” Ophiuchus.
- Every year, articles appear in the media claiming that “astronomers discovered a new zodiac sign”.
- This is not the case. Obviously, the constellation was always there, it’s not a new discovery.

Incorrect assumptions

- The Babylonians chose to divide the zodiac into 12 equal parts because there are 12 months in a year.
- This was an arbitrary choice. They could also have divided it into any other number of parts, including 13.
- The modern division of the sky into 88 constellations (i.e. regions), including Ophiuchus, is also arbitrary.
- There is an infinite number of other ways we could have divided the sky into constellations.
- This doesn’t disprove astrology, it just shows that astrology is based on arbitrary choices, not on anything physically meaningful.

Incorrect assumptions

- Some movements in the sky, such as a planet in retrograde, are proclaimed in astrology to have a special meaning.
- A planet “in retrograde” is still moving forward in its orbit, but since we are passing next to it, it looks like it’s moving backwards.
- So retrograde motion is just an illusion. Nothing unusual is actually happening, so this apparent motion cannot have any significance.

Incorrect assumptions

- Astrology is based on the positions of the Sun, Moon, and planets as seen from Earth.
- So what happens if you are born on another planet, e.g. Mars?
- The constellations will still be the same.
- But it has two moons, and the positions of the Sun and planets in the sky are very different, not to mention that now Earth is one of those planets!

Incorrect assumptions

- Taking it even further, what happens if you're born on a different solar system?
- Remember that the constellations in the sky depend on your position in the galaxy.
- So in another solar system the constellations will be completely different from the ones we see on Earth.
- There might even be, for example, two different Suns.

Incorrect assumptions

- Today we know a lot more about how pregnancy works than the ancient Babylonians and Greeks did.
- We know there's nothing special about the moment of birth itself.
- We understand very well the process by which a fetus develops into a baby, and we know it is gradual and continuous.
- It's even possible to medically change the moment of birth. So it's illogical to think that the moment of birth itself can have any significance on a person's personality.

Incorrect assumptions

- So in conclusion, astrology assumes:
  - A geocentric model – everything rotates around the Earth.
  - The sky doesn't change over time.
  - The division of the zodiac into 12 signs is physically meaningful.
  - Retrograde motion is not just an illusion.
  - The Earth is the only place humans can inhabit.
  - The moment of birth has some special significance.
- Now we know that all these assumptions are wrong.
- If a hypothesis is formulated based on wrong assumptions, then it is probably incorrect.

No mechanism of action

- Today we know that a person's personality strongly depends on their genes and family environment.
- This can be seen from studies of identical twins that were raised either together in the same house by the same parents, or in different houses by different parents.
- For some personality traits, both twins end up the same no matter where they were raised, due to genetics.
- For other traits, there can be significant differences as a result of their environments.

No mechanism of action

- So we have two factors, genetic and environmental, that we understand reasonably well, and provide concrete mechanisms of action to explain their effects on personality.
- Meanwhile, astrology doesn't provide, or even attempt to provide, any such mechanism.
- Proper scientific hypotheses must include mechanisms of action, because they help us understand why things work the way they do.
- Without a mechanism of action, we cannot generate different predictions that can be tested experimentally to prove or disprove the hypotheses.

Indirect evidence against astrology

- The results of the twin studies also provide evidence against astrology.
- Twins who were born minutes apart can end up having very different personalities.
- If astrology was correct, we would expect twins to always have the same personality, because the positions of the celestial bodies at the time of birth were the same for both twins.

Indirect evidence against astrology

- Identical twins have more personality traits in common than non-identical twins, who share less genes, even though in both cases the twins were born only minutes apart.
- This supports the hypothesis that genes influence an individual's personality, and contradicts the hypothesis that the celestial bodies influence it.

Direct evidence against astrology

- Since the 1950s, hundreds of studies have been performed that were explicitly designed by scientists to test the predictions of astrology using the scientific method.
- For example, in 1985, Shawn Carlson, an undergraduate student at the University of California, Berkeley, performed a famous experiment involving 28 leading astrologers.

Direct evidence against astrology

- This experiment was designed together with the astrologers, to ensure that there was no bias.
- 116 people provided information about their time and place of birth, and completed a personality test.
- The astrologers received the time and place of birth for each person, and 3 different personality test results, only 1 of which was the true test result for that person.

Direct evidence against astrology

- If astrology was correct, the astrologers should have been able to identify which of the 3 personality test results was the right one.
- In reality, they only identified the correct test a third of the time.
- Since there are 3 options, getting a third of the tests right is exactly what we would expect to get by just choosing answers at random.
- The results of the experiment showed that the predictions of astrology were completely random, and had no correlation with the person's actual personality.

Direct evidence against astrology

- More than 40 similar studies were carefully analyzed by Geoffrey Dean and Ivan Kelly in 2003.
- Their conclusion was that astrology has the same level of accuracy as a random guess at determining an individual's personality traits.
- In other words, there is a very large and consistent body of evidence proving that astrology simply doesn't work.

Why do people believe in astrology?

- So why do millions of people believe in astrology, if it has been conclusively disproven in so many different scientific studies?
- There are two extremely important skills we are not born with: critical thinking and skepticism.
- Critical thinking is the ability to analyze evidence and arguments rationally and in an unbiased way.
- Skepticism means not accepting any claims unless they are supported by satisfactory evidence.

Why do people believe in astrology?

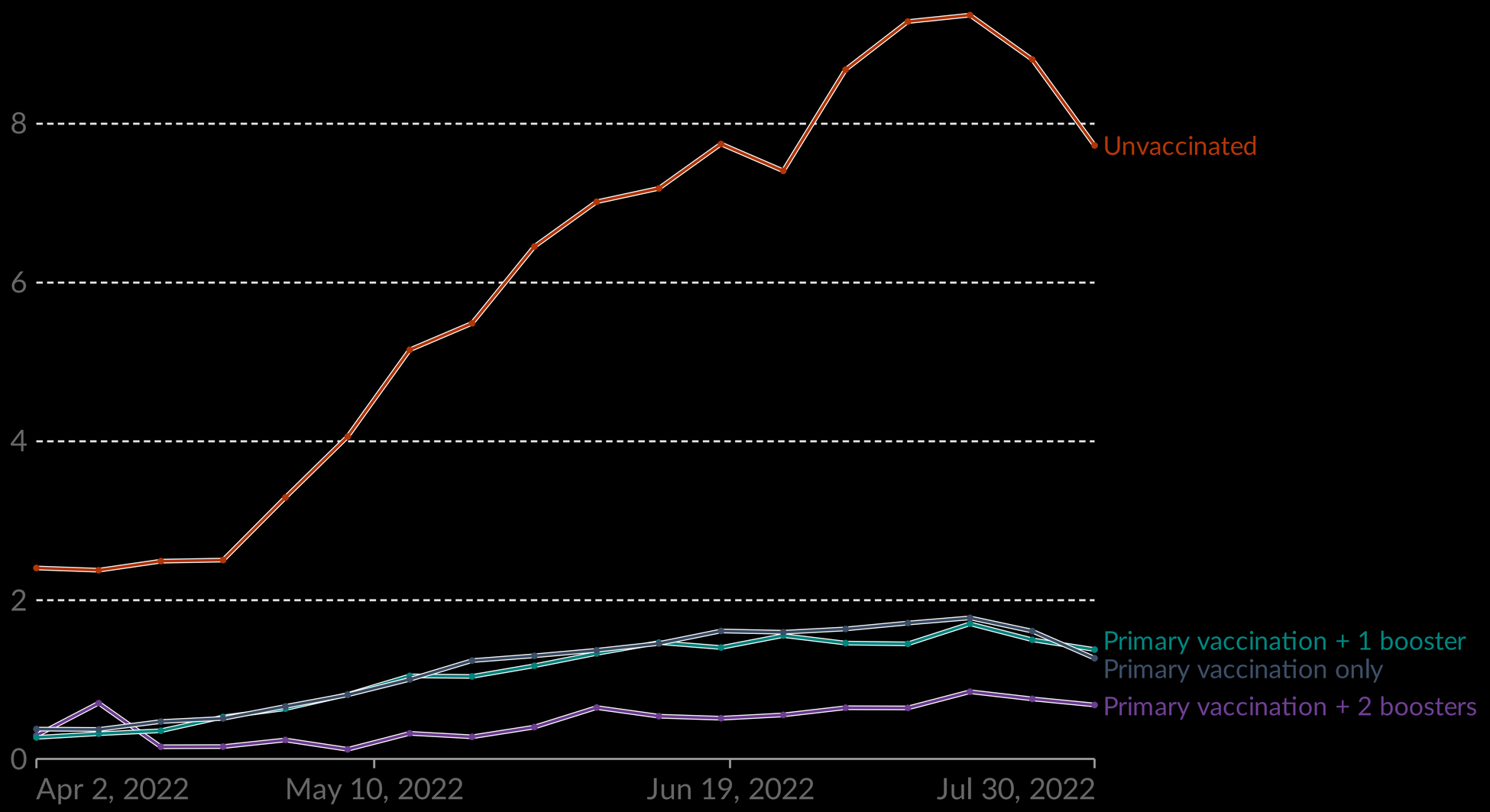
- These skills need to be learned, but most people are never taught them in school.
- Without skepticism, people are inclined to accept certain claims without evidence and never attempt to question them.
- Without critical thinking, even if people do question the claims, they don’t have the right tools to figure out if they are correct.

Why do people believe in astrology?

- This applies not only to astrology but also to other claims, such as religion, alternative medicine, and conspiracy theories.
- Sometimes these skills can literally save your life. A great example is given by COVID-19 vaccine misinformation.
- Online there is a huge amount of misinformation, and people can't tell which sources are reliable.
  - Some people know to trust peer-reviewed scientific publications.
  - But other people might trust a charismatic celebrity, politician, or conspiracy theorist instead.
- This resulted in a huge number of deaths that could have been prevented by vaccination.

United States: COVID-19 weekly death rate by vaccination status, All ages

Death rates are calculated as the number of deaths in each group, divided by the total number of people in this group. This is given per 100,000 people.



United States COVID-19 weekly death rate by vaccination status

Credits: Our World in Data, https://ourworldindata.org/grapher/united-states-rates-of-covid-19-deaths-by-vaccination-status

Fallacies and biases

- A crucial part of developing critical thinking skills is learning to recognize logical fallacies and cognitive biases.
- An example of a cognitive bias is the Barnum effect.
- The predictions of astrology are purposefully made to be as vague and general as possible.
- People believe that the predictions apply specifically to them, when in reality they can apply to anyone.
- This technique is used not only by astrologers but also by psychics, fortune tellers, and others.

Fallacies and biases

- The Barnum effect has been demonstrated in many experiments.
- For example, in an experiment conducted in 1948 by Forer, 39 psychology students took a personality test.
- Instead of receiving the results of their individual tests, all students received the same results.
- These results were taken from horoscopes and contained generic statements such as "you have a tendency to be critical of yourself".

Fallacies and biases

- On average, the students rated the accuracy of these results very highly, at 4.3 out of 5, even though everyone got the same results.
- This can explain the success of horoscopes.
- Horoscopes always contain vague and generic statements, so any one of them will apply to you, no matter what your sign is.

Fallacies and biases

- This is also an example of confirmation bias.
- People remember information that confirms their beliefs: the horoscope was right, a person of the “matching” sign was a good match, and so on.
- They subconsciously ignore information that conflicts with their beliefs.

Fallacies and biases

- Here are some examples of logical fallacies relevant to astrology.
- Correlation implies causation: “This event correlated with that astronomical event, so it must have been caused by it.”
- Post hoc: “This event happened after that astronomical event, so it must have been caused by it.”
- Anecdotal evidence: “It helped me find a compatible romantic partner that one time, so it must be true all the time.”

Fallacies and biases

- Appeal to tradition: “It has existed for thousands of years, so it must be true.”
- Appeal to popularity: “Many people believe in it, so it must be true.”
- Appeal to false authority: “That famous person believes in it, so it must be true.”
- Appeal to faith: “Sure, the ‘evidence’ says it’s wrong, but you just need to have faith.”

Fallacies and biases

- If you want to learn to recognize fallacies and biases, here are some resources to get you started.
- Logical fallacies:
  - https://en.wikipedia.org/wiki/List_of_fallacies
  - https://rationalwiki.org/wiki/Logical_fallacy
  - https://yourlogicalfallacyis.com/
- Cognitive biases:
  - https://en.wikipedia.org/wiki/List_of_cognitive_biases
  - https://rationalwiki.org/wiki/List_of_cognitive_biases
  - https://yourbias.is/

What are reliable sources for astronomy?

- Wikipedia - but watch out for [citation needed].
- Encyclopedia Britannica.
- Space agencies of democratic countries (NASA, CSA, ESA, etc.)
- Experiments or observatories (JWST, Hubble, LIGO, EHT, etc.)
- Astronomy textbooks.
- Some popular science books.
- University websites for non-profit, non-religious universities.
- A very small number of YouTube channels - but beware! 99% of YouTube is 100% bullshit.

Conclusions

- In this lecture, we illustrated the difference between:
  - Astronomy, which is a science supported by evidence, and
  - Astrology, which is pseudo-science disproven by evidence.
- I hope that it helped you understand better how science works, and encouraged you to develop some useful critical thinking skills.

- Reading: OpenStax astronomy, section 2.3.
- Exercises: Practice questions are available in the textbook and on the course website.