



# ROCK STAR

ENHANCING STEM EDUCATION

## ASTRONOMY VS ASTROLOGY

Task Box: Are we alone?

### Summary

This activity compares astrology and astronomy in order to understand the differences between the scientific method and other alternatives. The students will check the validity of the horoscopes with digital tools.



## Overall learning objective

Using the history of science and digital tools to understand, explore and play with the scientific method, and reflect about the differences between the scientific method and other disciplines.

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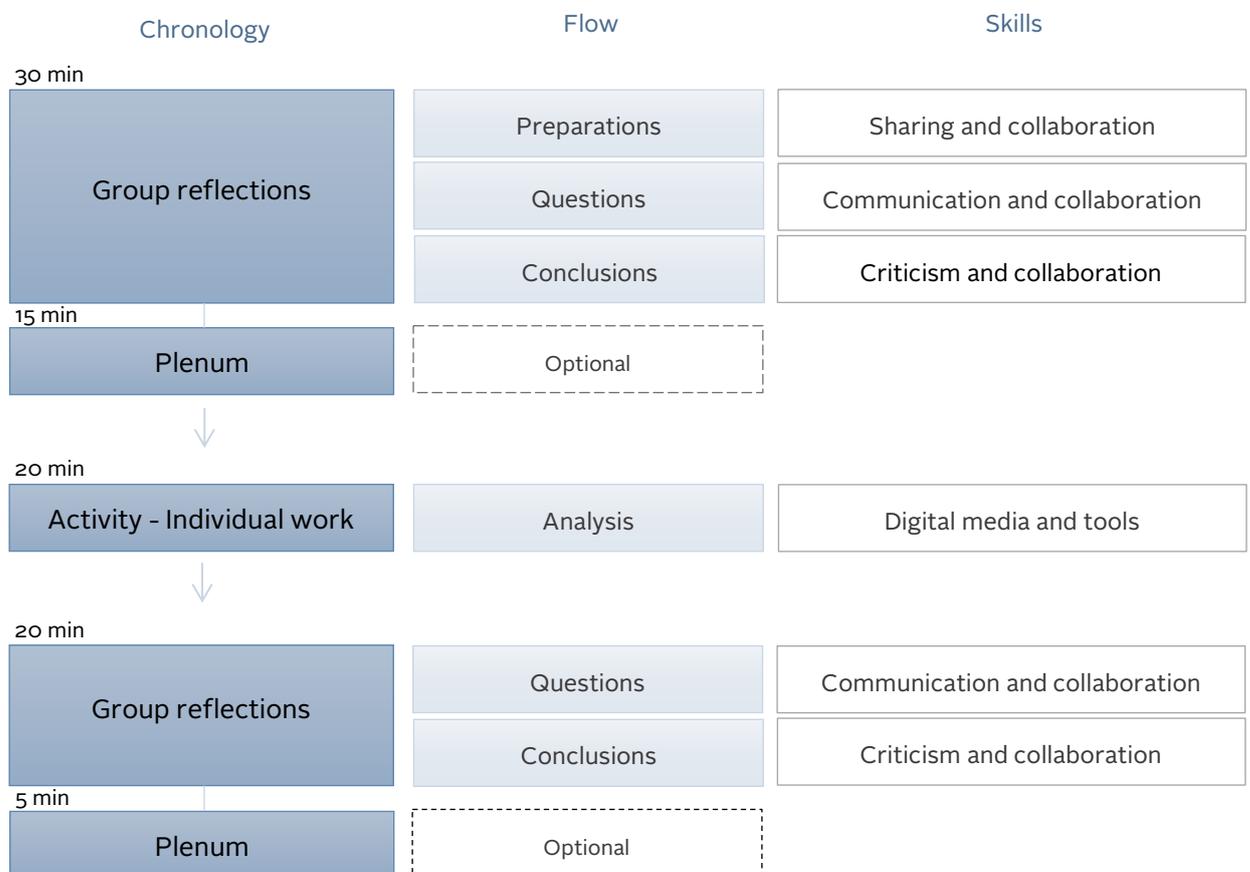
## Note for the teachers:

This task is designed to understand and learn about how the **scientific method** works. This is an important topic in the curriculum in natural science. The topic covered is **popular** among young students and have been proven to be effective to get their attention.

The procedure uses **active-inquire** learning, to strength the learning quality. The task can also play an important role in achieving learning objectives of other disciplines, like English. The activity focuses on a historical approach and makes use of a combination of individual and group work.

- **Individual section objectives:** this section makes use of the software Stellarium and the analysis of the results. Besides learning how the scientific method work, important abilities covered are the **use of digital media** and **learn to think**.
- **Group sections objectives:** the group section is designed to stimulate **collaboration, communication** and sharing of opinions. This reinforce other important abilities like **criticism**.

These are important abilities recommended to develop and already present in several curricula. Some of them are referred in occasions as **21<sup>st</sup> century skills**. This is a proposed flow example:



## Overview

Purpose	Understand the differences between the scientific method and other disciplines. Become familiar with the software "Stellarium" and use it to test your horoscope.
Duration	2 x 45min
Location	Classroom
Equipment	Computer with internet connection
Safety issues	None
Background	Basic training with "Stellarium"
Literature	Included
Software	Stellarium

## Learning objectives

Gain increasing knowledge about:

- the scientific method and differences with other methodologies
- the Babylonians discoveries about the night sky
- astrology and differences between astrology and modern science
- become familiar with the software "Stellarium" and how to use it to test your horoscope

21<sup>st</sup> Century skills:

- Learn to think
- Critical thinking
- Collaboration
- Communication
- Information and media literacy
- Expanded version: Work in international groups using English as communication language

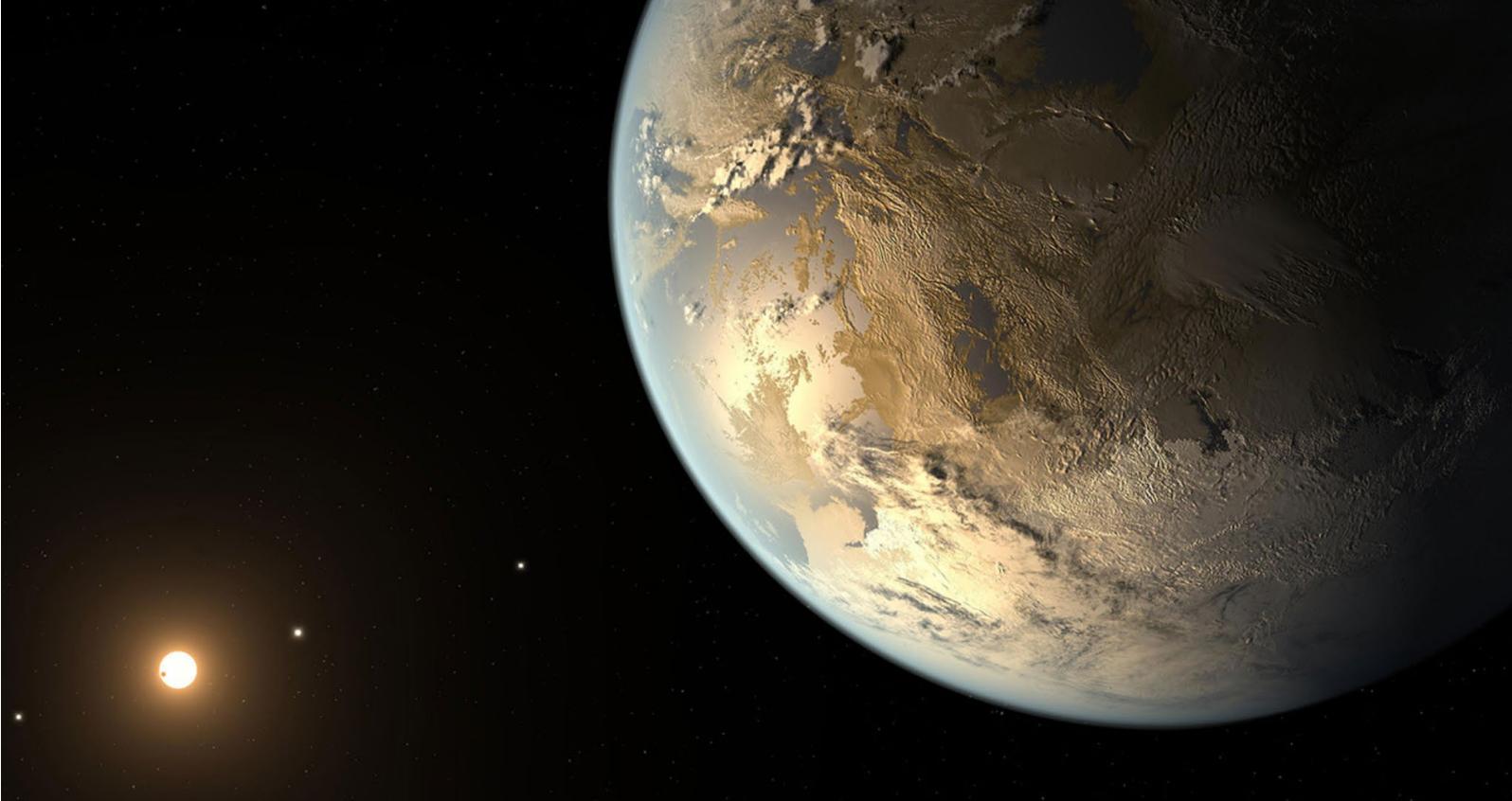


Figure 1: Artist's concept of Kepler-186f. The discovery of Kepler-186f confirms that Earth-size planets exist in the habitable zones of other stars and signals a significant step closer to finding a world like Earth (NASA).

## Introduction

In our search for answers to the question “Are we alone?”, we will explore not only the recent scientific achievements about our understanding of the Universe. Important clues that shed light on this question as, for example, the studies about how the variety of the chemical elements takes place during the stellar evolution, and the increased knowledge of the existence of exoplanets everywhere and their characteristics. We will also travel through cultures and time, and alternative ways to explain the Universe. This first task focuses on analysing how several cultures, using other methodologies not based on science, have reached already an answer: we are NOT alone. Several ancient cultures have believed that the universe is full of divinities, goodness, and semi-divine spirits-living who interact notably with us. This has been a constant understanding of our place in the Universe for thousands of years, before the scientific method started to be used as a quite efficient tool to explain and discover the secrets of Nature.

The modern scientific method is a relatively new way to try to understand Nature and its phenomena compared to other approaches. Throughout history, the predominant way to give answers has been the religions. Other non-scientific approaches are mythology, popular beliefs, and several branches in the philosophy. Science is just another methodology, but which has turned out to be an extremely efficient tool to look for the “Truth” behind the phenomena, to understand how the nature works and, based on this, to be able to “dominate” and use the laws hidden behind the real world. We build planes, bridges, robots, medical treatments based on science. We reached the moon, have sent robots to planets in the solar system, have discovered the existence of millions of extrasolar planets with the possibility to host life by using this method. We live on average 40 years more than some centuries ago based on science. And these are just a very small amount of areas where our knowledge and understanding of how the Universe works have increased by using this approach. The scientific method's great efficiency in discovering the truth behind the Cosmos, understanding it, and developing technology based on this newly acquired knowledge, has been impossible to reach with other approaches.



## Activity: Checking your horoscope with Stellarium

### Preparations

This task makes use of the program “Stellarium”. Complete the tutorial you can find as part of the Module 3 to be familiar with the basic functionalities.

This task combines individual work with group work, preferable of 3 students. Group work focuses on reflections and discussions about the subject and the individual work results. After the group reflection, the discussions can be extended to the whole classroom (plenum) lead by the teacher.

#### Group reflections during the first session, before proceeding with the individual activity:

Discuss in groups the following questions. Take note of your group conclusions. One of the members of each group can be responsible of taking notes, but everybody is encourage to participate.

- Discuss in the group: Is astrology a science? Why or why not?
- Take note individually: do you like to read your horoscope? Why or why not? Write a number between 1 and 5 that you think indicates how accurate are the horoscopes (1 no accurate at all, 5 complete accurate). Write a couple of sentences to explain about the number selected. Discuss with your group colleagues about the number selected and reasons behind.
- Why do you think astrology (reading horoscopes) is so popular, especially among young people?

After working in groups, we will proceed to share the thoughts with the others.

## Activity

Let's work individually. The objective is to check your horoscope using Stellarium. Follow the next steps:

- Read the Annex to become familiar with the main topics of the task.
- Open Stellarium. Choose your place and current time as it was explained in the task "Stellarium, introduction".
- Select «Sky and Viewing Options [F4]» in the vertical toolbar. Click «Markings». Select «Azimuthal grid». You can also enable it from the horizontal menu that appears when you place the mouse in the down-left area of the window program.



Select also «Constellations lines» and «Constellations labels».



Zoom in/out and rotate the image in the viewer window so that you observe towards the south with FOV about 70°. FOV means "Field of view". This information is displayed down in the Stellarium window, towards the left of the date/time info.

Select again «Sky and Viewing Options [F4] » in the vertical toolbar. Click "Markings" and select «Ecliptic (J2000)» and «Ecliptic (of date)».

**Why the ecliptic is important. Can you describe the difference between these two ecliptics?**

- Click over «Atmosphere [A]» and «Ground [G] » in the horizontal toolbar to remove them. Open the «Date/Time» window [F5]. The definition of the horoscope is based on the sun's position when you were born. For example, we see in the magazines and books that Capricorn are people born between December 22nd and January 19th. Therefore, the Sun must be in this constellation at that time.

Set your birthdate in the «Date/Time» window [F5] and check if the sun is in your horoscope.

**Describe what you have found. What is the zodiac sign showed in Stellarium? Is this what you expected?**

- e. Read below. This is the horoscope for Capricorn that was published in the on-line version of ELLE magazine on February 18th, 2017. It indicates that the sun enters Pisces on that day. Now we can check it with Stellarium.

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**WEEKEND OF February 18 - 19, 2017**

Downshift, Capricorn! You've been on a tear for the past month, with the Sun powering up your industrious second house, pushing you beyond the call of duty. You've done good work and learned a lot, but as a result you're running on fumes. Now it's time to ease off the throttle and recharge your batteries. **You get a chance to kick back and rejuvenate starting Saturday**, when el Sol shifts into Pisces and your third house of socializing, bringing a much-deserved lightheartedness to your life. Reach out to friends you haven't seen in a while. See what's new in your neighborhood. By hanging out with interesting people, you'll remember why we don't work 16 hours a day! Of course, some of these alliances could be good for business. With this part of your chart lit up, opportunities to partner up may pop up at every turn. On Sunday be selective about the company you keep. The moon in your sleepy twelfth house is connected with motivated Mars in your domestic zone, so projects around the house may be more compelling than any group get-together!

Note: "el Sol" means "the sun" in Spanish.

**Is this right? Describe where the sun was that day.**

- f. Repeat the point "c" but select in the «Date/Time» window [F5] the year -2000 (2000 BC). **Describe what you have found.**
- g. Have you heard about the Earth's precession. Search for it in internet and explain what it is and how it can explain these differences, taking into account that the horoscope was defined around the year 2000 BC.

**Group reflection after the activity:**

The previous activity with Stellarium indicates that, following the right astrological definition, we have been reading a wrong horoscope!

- Discuss and reflect with your group colleagues about your findings and implications.
- Discuss together if this affect your position about astrology. Why or why not?
- Discuss why even reading the wrong horoscope, it seems to work for many people.

## Annex

### The Scientific Method

But what is science? Science, as mentioned above, is a method. It concerns the description, understanding, and prediction of natural phenomena based on empirical evidence from observation and experimentation. Science needs a beautiful combination: imagination and skepticism. Attempts for explaining a natural phenomenon starts with an idea, called a hypothesis. It can be simple or complex, even in several cases risky or “out of sense”, but it must be validated by performing and predicting measurements, experiments, that is, empirical evidence. If the results of the experiments do not correspond with the hypothesis, then the latest must be discarded. Concepts like personal wishes and beliefs have not much room in science if they are not also validated by the facts. Therefore, the most important pillar in science is empirical evidence. This is completely different from other ways to understand phenomena, like religion, where important pillars are beliefs and/or holy books, which are independent and even contradictory to empirical evidence. The next chart shows how the scientific method works:

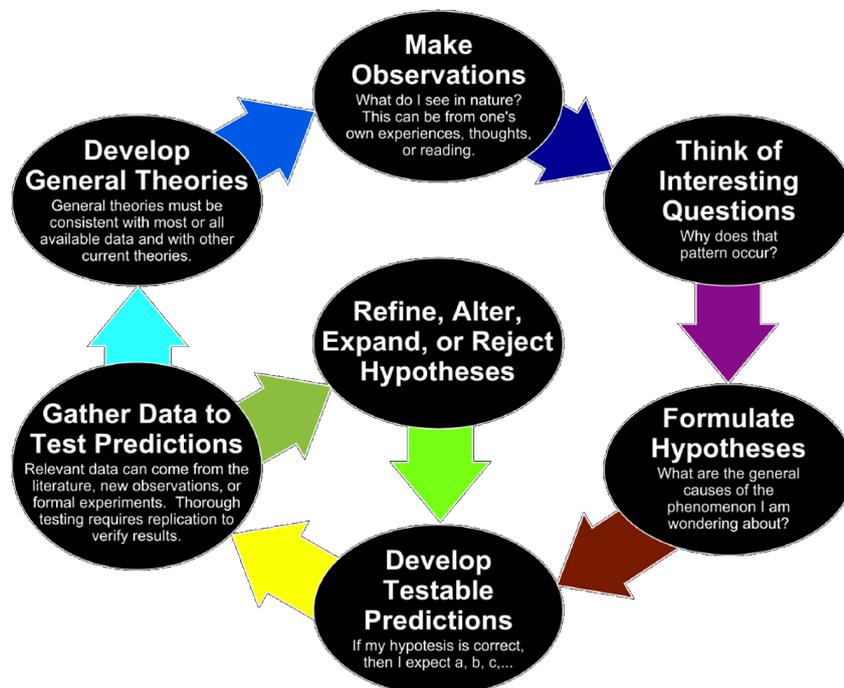


Figure 2: The scientific method.

### Ancient cultures and the night sky

Until very recently we have been observing the night sky only with our eyes. Aside from the Moon, all the known celestial bodies were basically grouped in 2 different kinds of objects: stars and planets. The stars shine like points of lights being always in their same relative positions. There were recognised by ancient cultures by grouping them together, drawing in the sky different

patterns: from warriors to animals, from daily tools to gods. These are the constellations. Different ancient cultures have produced their own associations, based on their own culture, daily experience, mythology and gods.

One popular constellation is Ursa Major. The ancient Greeks named it Kallisto. Under the Greek mythology, Kallisto was a daughter of the Arkadian King Lykaon and a hunting companion of the goddess Artemis. She was seduced by the god Zeus, transformed into a bear, and was hunted down as a beast and placed amongst the stars as the constellation Ursa Major. In general, the constellations, as described in Greek mythology, were mostly god-favored heroes and beasts who received a place amongst the stars as a memorial of their achievements. They were regarded as semi-divine spirits—living, conscious entities that strode across the heavens. Far away, the Vikings called Ursa Major as the Great Wagon or “Karlswagen”. An old Swedish chronicle connects Karlswagen with the god Thórr, “who stepping into his chariot holds the seven stars in his hand”<sup>1</sup>

These are two concrete examples of how the same constellation was interpreted by two different cultures. There are so many and rich interpretations. Several gods related to complete different cultures, disperse in space and time, have been placed in the night sky. The starry night emerges as a powerful experience awakening wonders, shaping religions, mythologies and philosophy everywhere. Besides the diversity of interpretations, an important and common aspect to all the ancient cultures is that they have deeply observed the night sky, creating questions and answers to understand our place in the universe.

Planets are moving through the background of stars, walking across some constellations. This “strange” movement going out to the relatively fixed path the stars were following, awoke in several ancient cultures the idea that planets must be related to something powerful. If the constellations were already full of divinities and gods, the planets were interpreted as the most important and powerful Gods. A good example is given by Roman Mythology. The names we used for the planets came from the Roman deities. The planets and deities have been related to each other. In this context, Jupiter is not only the second brightest planet, the most important in the night sky since the most brilliant, Venus, can only be observed during few hours after the sunset or before sunrise. In addition, Jupiter is the Leader of the Olympian Gods; mentor and teacher of gods, always helping gods in war against demons<sup>2</sup>.

One important characteristic in the erratic movement of the planets is that they do not cross the constellations randomly. Planets are observed crossing a selected group of constellations, all of them, following almost a well-defined path in the sky. This is known as the zodiacal belt. Several cultures have noticed it. However, one ancient culture stands out over the other because of being the first in achieving and registering meticulous observations not only of the movement of the planets but, in general, about several important astronomical phenomena: the Babylonians.

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<sup>1</sup> <http://www.vikinganswerlady.com/stars.shtml>

<sup>2</sup> [https://en.wikipedia.org/wiki/Planets\\_in\\_astrology](https://en.wikipedia.org/wiki/Planets_in_astrology)



Figure 3: The Babylonians.

### The Babylonians

This great culture lasts long time, from around 2000 BC to 60 BC. They were the first to monitor in a systematic way the movement of some planets, and to register astronomical phenomena. They inhabited the region called Mesopotamia between the Tigris and Euphrates rivers (present-day Iraq). Babylonian astronomers surveyed the skies carefully, keeping detailed records of the movements of the stars and planets. They recognized five planets (Mercury, Venus, Mars, Jupiter and Saturn), along with the sun and moon, and called them “wild sheep” because of their wandering paths over the fixed backdrop of the stars.

Their motivation was not very scientific, they were not seeking the understanding of the Universe through these observations, but to read their deities advice. The Babylonians believed that their gods transmitted messages about the future through the appearance of the celestial bodies: when planets rose over the horizon, what colour they were, when they stood in certain arrangements or conjunctions, when eclipses happened, and so on. It was the task of scholarly diviners to interpret these messages so that they could deliver sound advice to the king.<sup>3</sup>

On the other hand, during the 8th and 7th centuries BC, Babylonian astronomers developed a new empirical approach to astronomy. They began studying philosophy dealing with the ideal nature of the universe and began employing an internal logic within their predictive planetary systems. This was an important contribution to astronomy and the philosophy of science. This new approach has been referred to as the first scientific revolution and was adopted and further developed in Greek and Hellenistic astronomy. Some of their most relevant achievements are the following: they compiled stars catalogues, divided the circle into 360 degrees, performed calculations of day-lengths changes, planets motions and lunar eclipses, registered comets observations (164 BC Halley), divided the sky sphere into 12 (30 degrees) defining the ecliptic and zodiacal constellations, regions where the planets move.

<sup>3</sup> <https://www.theatlantic.com/science/archive/2016/02/babylonians-scientists/462150/>



Figure 4: Stellarium screenshot taken on 16<sup>th</sup> February 2020, showing the ecliptic (red line), and the position of the Sun in Aquarius; Saturn, Jupiter and Mars in Sagittarius; and the Moon in Scorpius.

## Zodiac

An important outcome from the Babylonians that has survived until nowadays is the zodiac. The zodiac is an area of the sky that extends approximately 8° north or south (as measured in celestial latitude) of the ecliptic. The Babylonians defined the ecliptic as the apparent path of the Sun across the celestial sphere over the course of the year. All the important celestial bodies for the ancient cultures, Sun, Moon and planets, were observed to follow almost the same path across the constellations. The zodiac area was defined to cover these movements. Therefore, the paths of the Moon and visible planets are also within the belt of the zodiac. The division of the ecliptic into the zodiacal signs was done in Babylonian astronomy during the first half of the 1st millennium BC. Around the end of the 5th century BC, Babylonian astronomers divided the ecliptic into twelve equal "signs", by analogy to twelve schematic months of thirty days each. Each sign contained thirty degrees of celestial longitude, thus creating the first known celestial coordinate system. Because the division was made into equal arcs, 30° each, they constituted an ideal system of reference for making predictions about a planet's longitude. In Babylonian astronomical diaries, a planet position was generally given with respect to a zodiacal sign alone, less often in specific degrees within a sign. For daily ephemerides, the daily positions of a planet were not as important as the astrologically significant dates when the planet crossed from one zodiacal sign to the next.<sup>4</sup>

The zodiac has been used since then by several cultures for developing their astrology. The relative position of planets, Sun and Moon in relation to the 12 zodiacal signs are believed to predict future events, to define what are the strong and weak points of our personalities, to define the close future and personal expectations. These beliefs have survived to our days as the Modern zodiac or horoscopic astrology. The modern horoscope signs follow the same original

<sup>4</sup> <https://en.wikipedia.org/wiki/Zodiac>

definition of the Babylonians: the position of the Sun in the ecliptic at the time of birth. For example, we are Gemini if the Sun was crossing this constellation when we were born. Therefore, and following astrology, the Sun is the main celestial object defining our fate and personality. Its position at the time of our birth defines our horoscope sign.

Astrology knowledge has been historically a source of power. Astrologers read the signs written in the sky to take decisions, to advise kings. There were not many other alternatives to understand and predict events. Now we have further possibilities, but even in our current time, full of technology and scientific solutions, astrology is much present in our daily life: All the newspaper dedicates a section for horoscopes. There are several web sites about the subject that are among the most popular in internet. There are by far more publications and books about astrology than about another scientific discipline. Astrology is an important business nowadays.

As indicated, modern astrology is much based on the horoscope sign and, therefore, in the birth date. In addition, astrologers predict possible expectations for our close future based on the combination of the horoscope sign and the actual relative position in the zodiac of the Sun, Moon, and planets. This gives the opportunity to have at least once per week the possibility to read about expectations for ourselves.

Through cultures and time, many questions and predictions have been attempted using astrology. Several of them may have been right, others maybe not. Now, as curious people, we have a great opportunity to wonder: How effective is astrology? How much can we trust it? Is it a solid methodology? For several thousands of years there was no other alternative, and the vision of the universe did not allow many cultures to make these questions. Astrology was intrinsically considered as a true, so formulating these questions has "no sense". However, now we have further tools, methodologies, a better historical perspective, to try to reflect about astrology.

