VIRTUAL PATHWAYS

# Galileo and the Celestial Phenomena

Pre-visit

(Middle school, age 11-13)

# Introduction

This is the support document for the pre-visit phase of the Educational Pathway "*Galileo and the Celestial Phenomena*" aimed at both teachers and students.

**Short description**
The activity, structured in three phases (pre-visit, visit and post-visit) focuses on the transition from pre-telescopic astronomy to modern astronomy inaugurated by Galileo, with particular attention to his observation of celestial phenomena and in particular sunspots and the Northern Lights.

**Target audience**
Teachers and students of Middle school (age 11-13)

**Estimated time required for the activity**
In school: 5-6 hours (2-3 pre-visit and 3 post-visit)
In the museum (on site or virtually): 1,5 hour

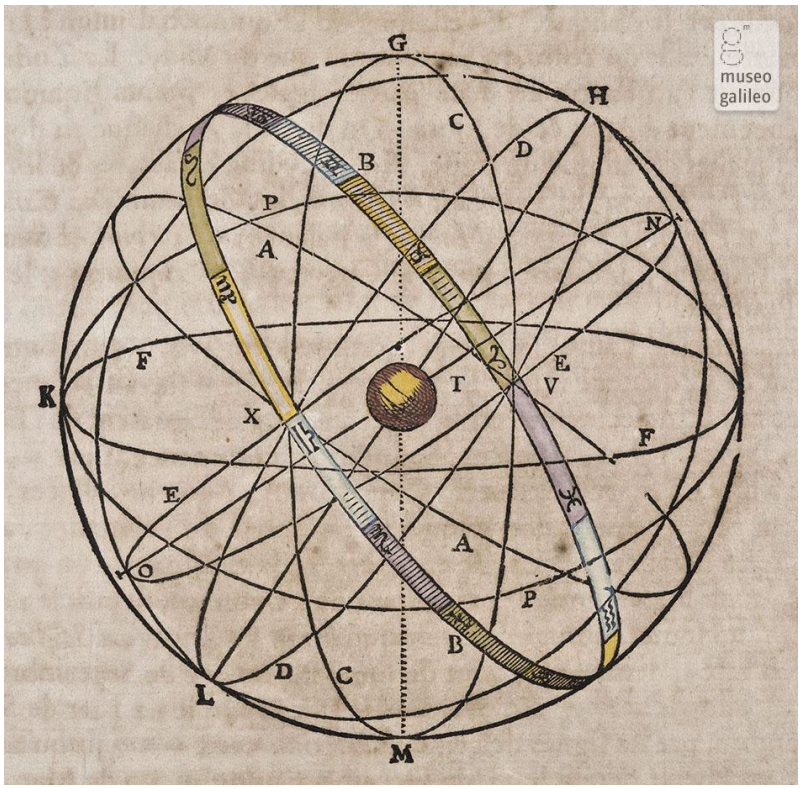
**For more information visit:**
https://www.virtualpathways.eu/

https://www.museogalileo.it/en/library-and-research-institute/projects/european-projects/2134-virtual-pathways.html

## The Celestial Sphere, a Dome Above Us

### *What does the sky look like at night?*

If we observe the sky on a bright starry night we will notice that the stars are moving. They all move together in a uniform and regular way. It feels like a revolving dome, the celestial sphere, with thousands of lights embedded in it.
Of course, this is an illusion: there is no dome above us, the stars are far away from us and very distant from each other. What we see is simply the effect of the rotation of our planet Earth on its axis.
In order to realise this, let us imagine we are on a merry-go-round at the amusement park: looking around we see the surrounding world spinning rapidly around us. While at the amusement park we do not need to remind ourselves that we are on a carousel, on our own planet this effect has deceived people for hundreds of years, giving them the illusion of a celestial vault that revolves around the motionless Earth in the center of the Universe.




Blaeu, Willem Janszoon, *Le grand atlas, ou, Cosmographie Blaviane.*
Representation of the celestial sphere

Raffaello Sanzio, *Prime Mover* (ceiling panel), Stanza della Segnatura, Vatican Museums. The stars on the celestial vault were always represented as they would appear to someone observing the celestial sphere from the outside

*The celestial sphere*
https://catalogue.museogalileo.it/indepth/CelestialSphere.html

## The birth of astronomy and the Geocentric System

*How was the sky imagined in antiquity?*
*Who were the first observers?*
*Why was the sky observed?*

Primitive peoples have always been fascinated by everything related to the sky: stars, planets, and strange celestial phenomena. Sailors orientated themselves at sea by looking at the stars, while farmers used them to decide when to sow. The sky has therefore always represented an important reference point for mankind.

Observing the celestial vault, thanks to a little imagination and creativity, the constellations took shape: groups of easily recognisable nearby stars whose shape and characteristics recalled animals or objects of daily life such as, for example, the constellation Ursa Major or the so-called Orion Belt. Observing them in the sky, people guessed their movements and sought explanations.

Starting from the Mesopotamians and the ancient Egyptians, people began to scrutinise the sky more and more and were able to determine the movements of the planets* visible to the naked eye: Mercury, Venus, Mars, Jupiter and Saturn. When they observed the movement of the Moon, they noticed that it had phases** that were repeated in well-defined times. Moreover, thanks to their great ability in performing mathematical calculations, they were able to determine the duration of the day, which they divided into 24 hours, and of the solar year.

Their representation of the Universe was, however, strongly linked to mythological elements. For example, for the Assyro-Babylonians, the Earth rested on the Kingdom of the Dead, submerged by the ocean waters, and dominated by the celestial vault, while for the Indian culture the universe was initially enclosed in a gigantic egg from which, once hatched, the sky emerged from the upper half of the shell, and the earth from the lower half of the shell.

The predominant model throughout antiquity was the geocentric one which saw the Earth immobile at the center of the Universe and all the other celestial bodies revolving around it with circular and uniform motions.

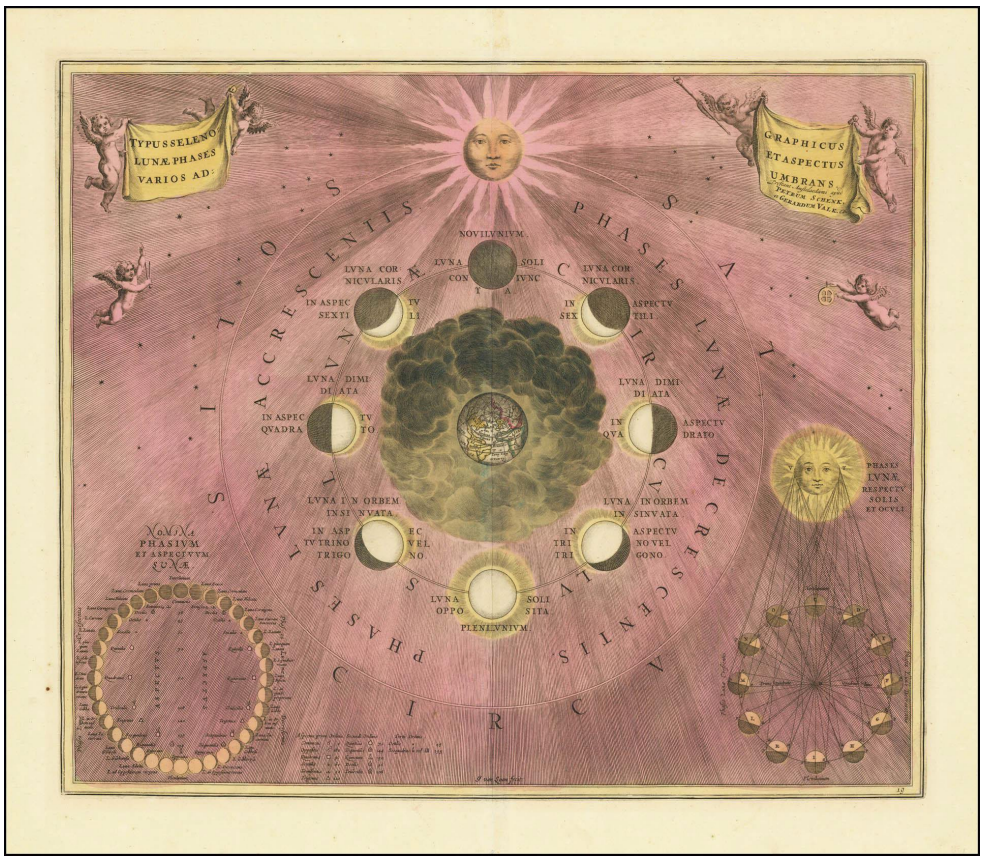
In the geocentric system all celestial bodies orbit Earth following this order: Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn, and the fixed stars located on the celestial sphere.
Museo Galileo, Florence

***Planets**

The world Planet derives from the ancient Greek 'planetes', which means 'wandering'; in ancient times, planets were called precisely those celestial bodies that moved in relation to stars that remained fixed, that is those stars that form constellations and do not change their appearance.

## **Moon phases

The Moon is the Earth's satellite, that is, it orbits our planet. It does not emit light of its own, but reflects the light of the Sun that reaches its surface. As it moves around the Earth, its position relative to the Sun is constantly changing, which is why, during a lunar month, an observer on Earth sees different parts of the Moon's surface illuminated. The Moon therefore has phases: New Moon, first quarter, full Moon and last quarter.




Andreas Cellarius, *Atlas coelestis seu Harmonia Macrocosmica*. Lunar phases

*Pretelescopic astronomy*
https://catalogue.museogalileo.it/multimedia/PretelescopicAstronomy.html

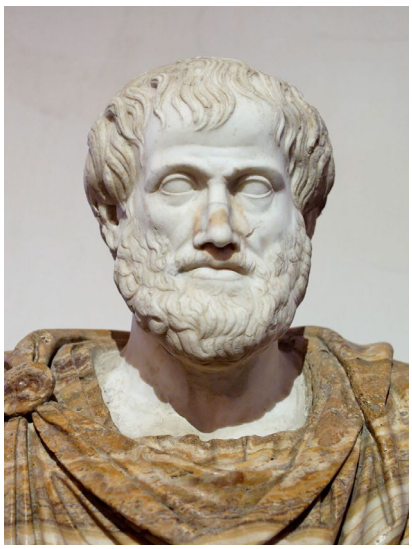
*Arab astronomy*
https://catalogue.museogalileo.it/multimedia/ArabAstronomy.html

## Aristotle

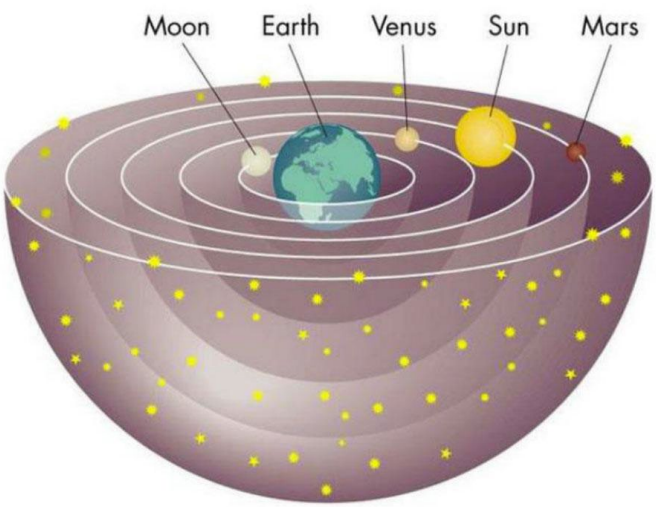
Aristotle, who lived in Greece in the 4th century BC, taking a cue from the ideas of his predecessors, claimed the existence of a clear separation between the terrestrial world, known as the sublunar world, and the celestial world: the former was the realm of instability and imperfection, and was therefore characterised by rectilinear movements, i.e. movements with a beginning and an end, while the latter was the realm of eternity and perfection, and was characterised by circular movements since the circle was the perfect geometric figure by definition.

The Earth was conceived to be motionless at the centre of the Universe, with a series of concentric spheres around it, on which the other visible planets were fixed in succession, that is, in order: Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn. Finally, there was a last sphere, the Firmament, also known as the sphere of the “fixed” stars, so called because, unlike the planets, they seemed anchored to the celestial vault since they never changed their position. This last sky of the fixed stars was also called the "*Primum mobile*" because it was the first to give the initial movement to all the others.

The stars around the Earth were placed on a particular sky, a sphere made of ether, a transparent, perfect and immutable material, which moved with uniform circular motion. The model thus described was the so-called 'geocentric system'.



Bust of Aristotle. Palazzo Altemps, Rome




Model of the Universe according to Aristotle

## Astrolabe

### *What tools were used in the past for orientation?*

This is an ancient astronomical instrument, apparently known as early as the 2nd century BC. It was used to solve astronomical problems without the need to resort to complex calculations: for example, it was possible to determine the position of the stars and to understand which ones were rising and which ones were setting. It was also important for solving more practical problems such as determining the time of day and calculating the height and distance of objects.


Christoph Schissler, Plane astrolabe (1560).
Museo Galileo, Florence