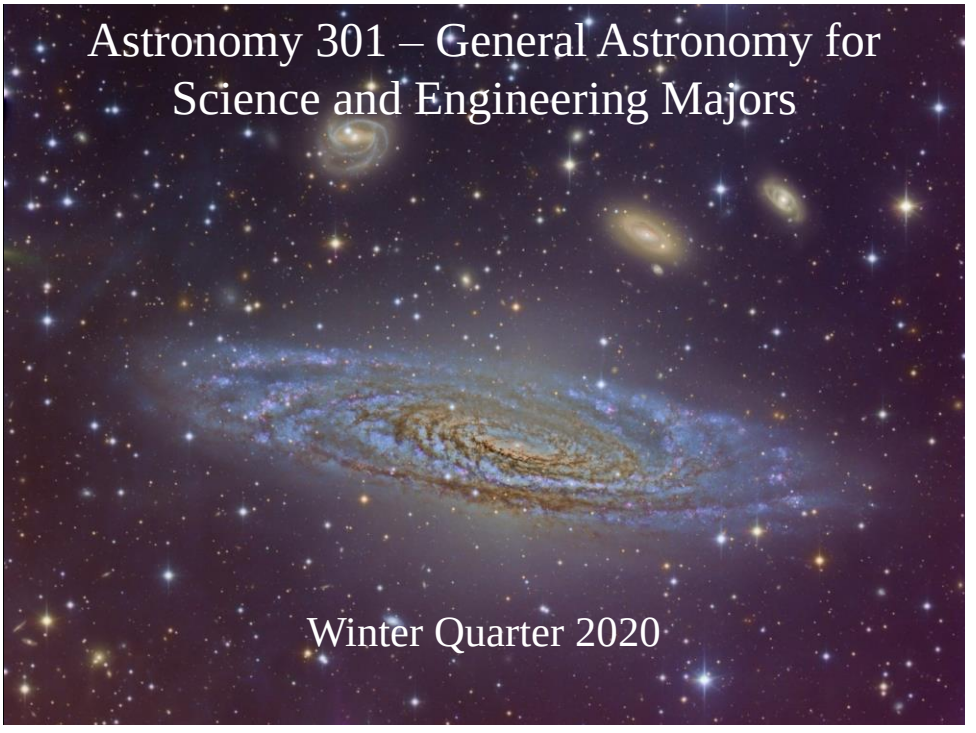


First Day Business

Class Web Page

https://faculty.washington.edu/wampaz/classpages/a301/Home.html

First Day Business

Syllabus highlights:

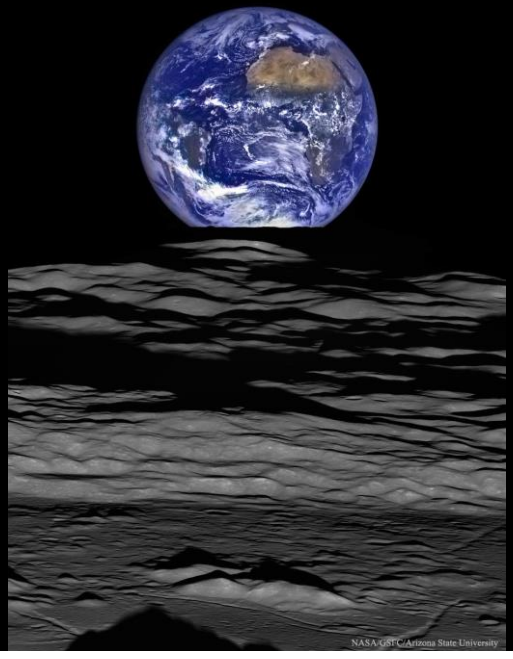
- Lots of material! Read, listen, do the suggested homework and get your questions answered!
- Quizzes in class every Thursday – do not skip class, and contact me if you'll be absent!
- Fully optional Final Exam – do well on all the weekly quizzes and you won't need to take it at all!
- Out-of-class activity– experience astronomy outside of the classroom!

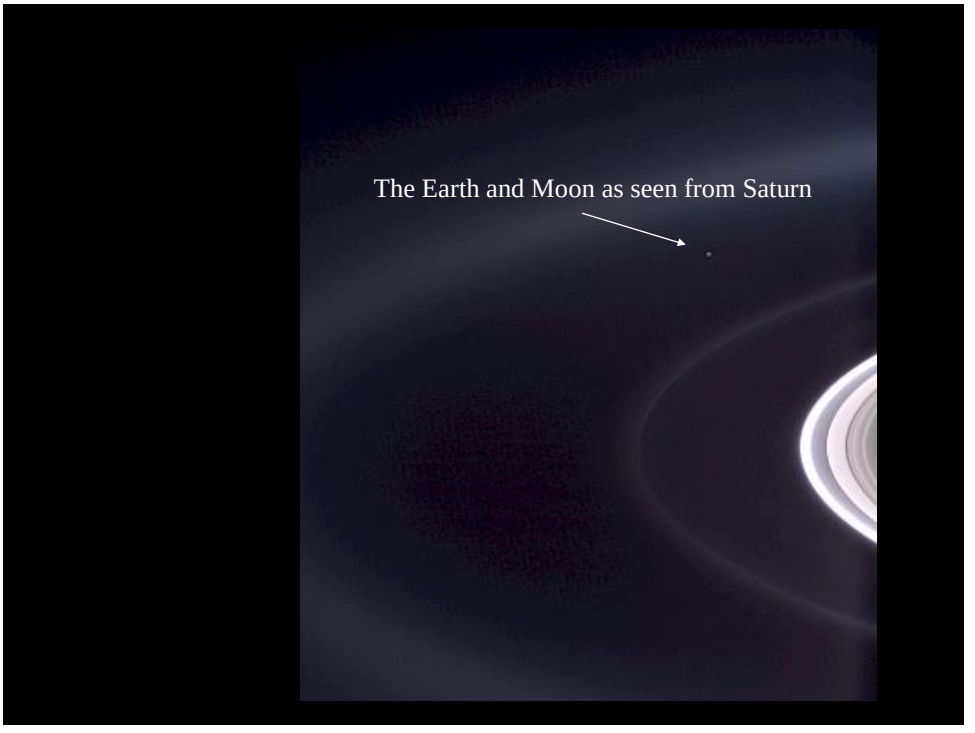
First Day Business

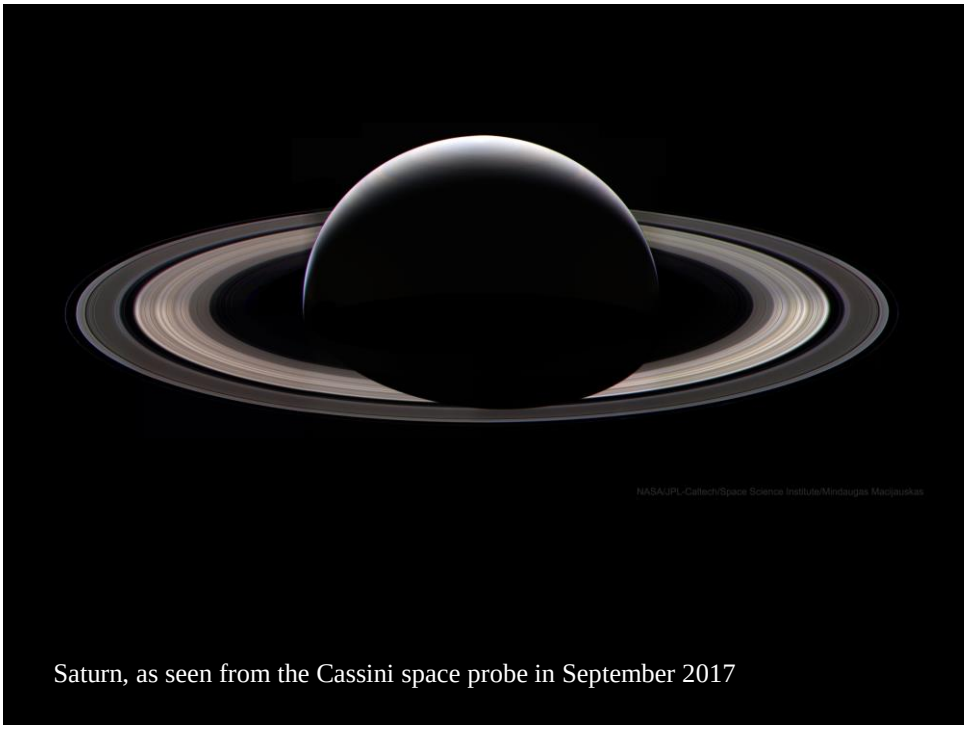
Introductions

We'll begin this class by quickly reviewing

The Big Picture

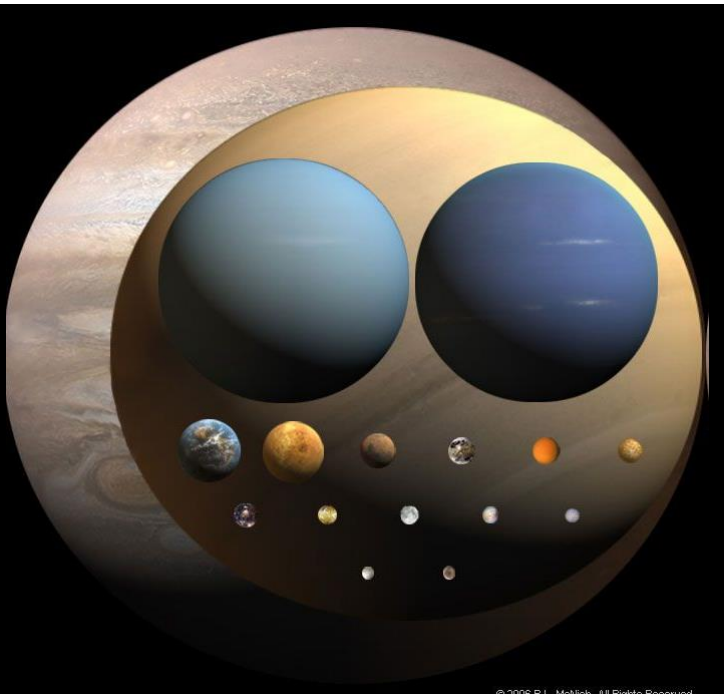




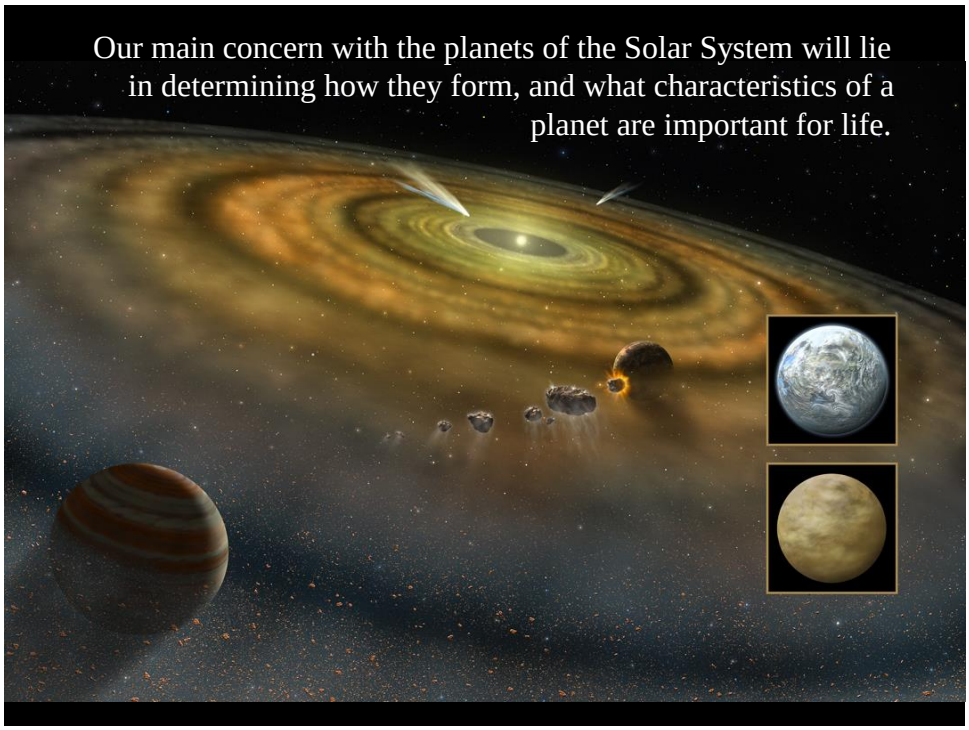


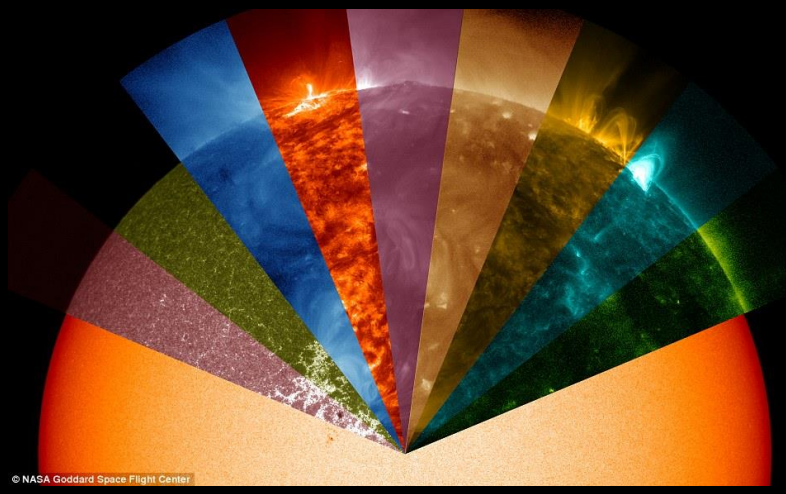
Saturn, as seen from the Cassini space probe in September 2017

We'll spend significant time on the Solar System, but not nearly as much as they do in ASTR150 or 321 – great classes that I highly recommend!

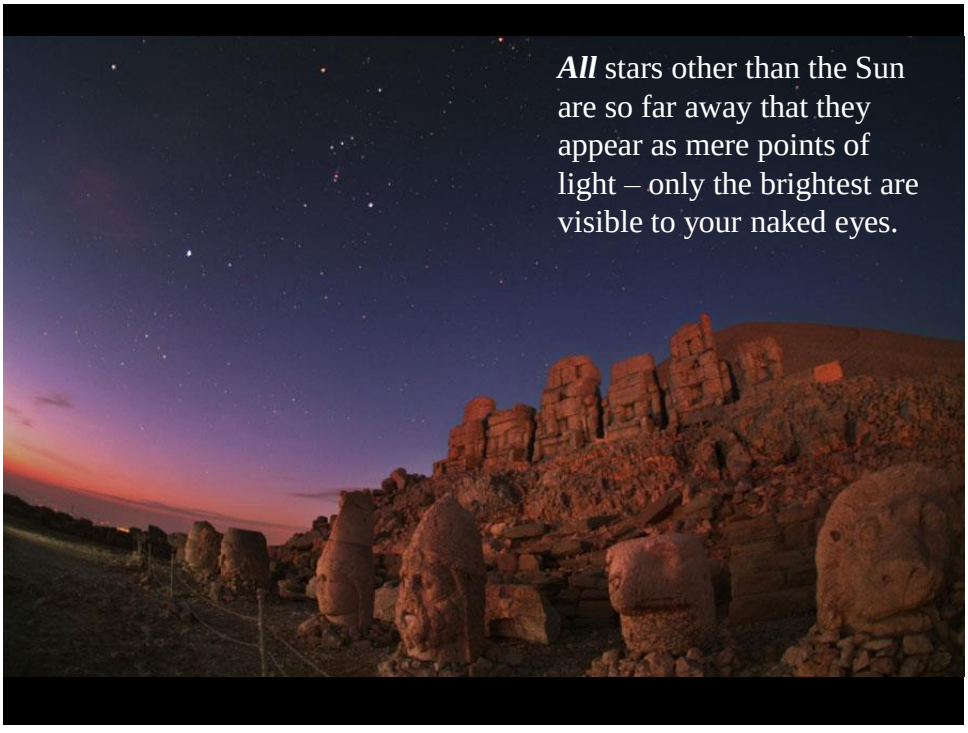


Our main concern with the planets of the Solar System will lie in determining how they form, and what characteristics of a planet are important for life.





We'll also study our Sun, and place it in its proper context amongst the other stars, using what we can learn about its inner workings as a guide to all other stars.



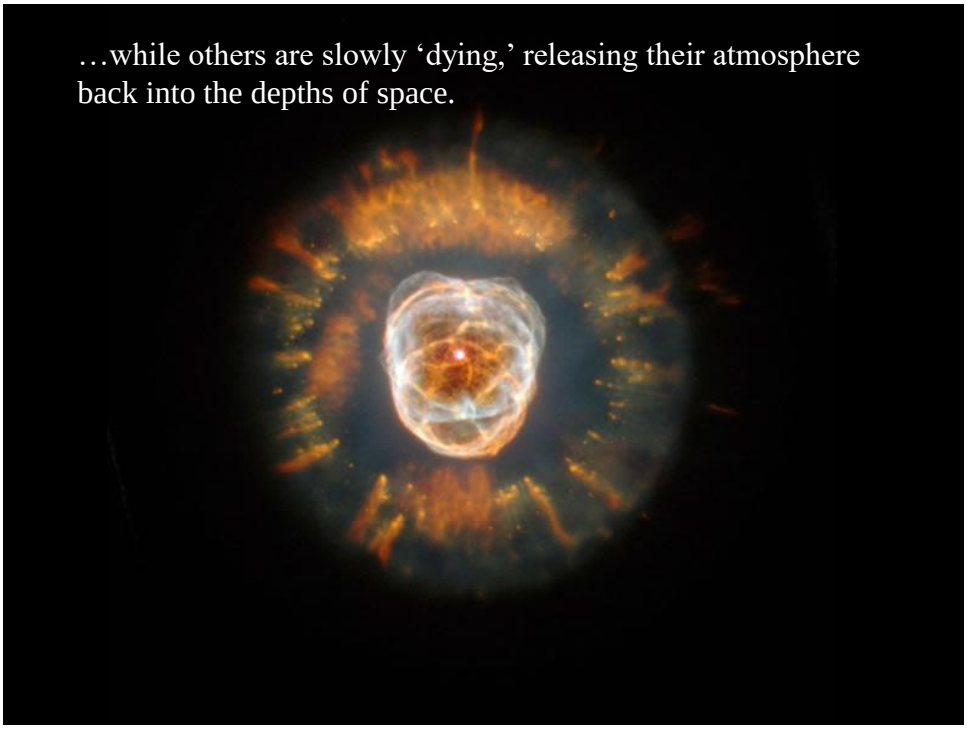
All stars other than the Sun are so far away that they appear as mere points of light – only the brightest are visible to your naked eyes.

In modern times, and with the help of important technology – cameras, telescopes, and computers – many more stars can be revealed, and their diverse characters made apparent. We see that many are yellow-white like our Sun, but others are very red…

…while others are extremely blue.

We see stars in the process
of being ‘born’, deep inside clouds of gas and dust...

…while others are slowly ‘dying,’ releasing their atmosphere
back into the depths of space.

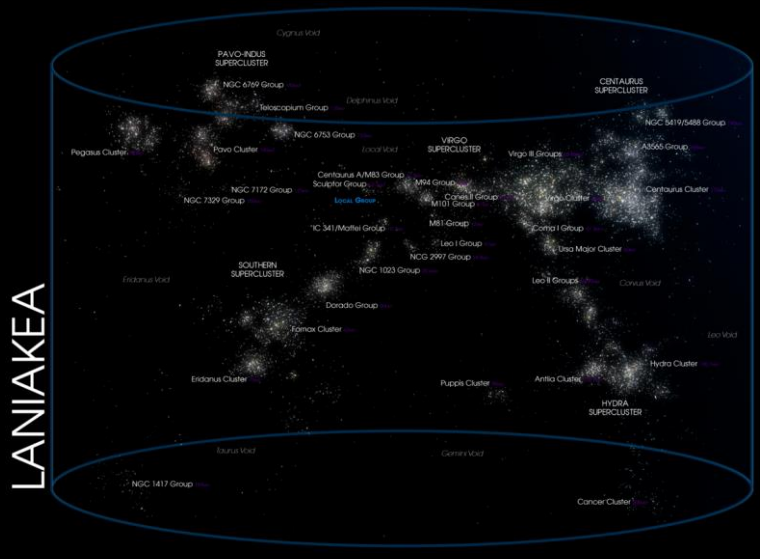


Though some stars end in a much more dramatic fashion!

Before…

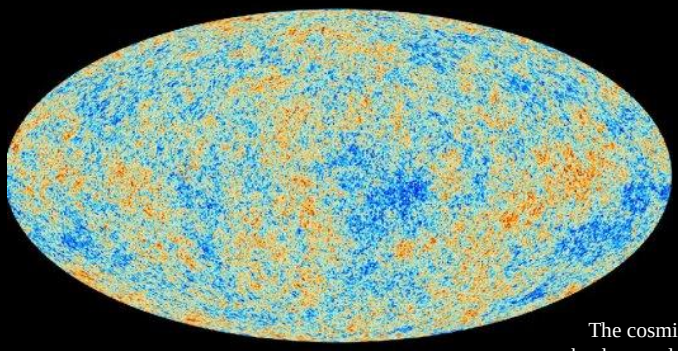
All of the stars we can see with our naked eyes, and many more – over 200 billion in all – lie in our home ***galaxy***, the Milky Way

Galaxies like the Milky Way, or its very close and very similar neighbor, the Andromeda Galaxy (seen on the left), contain many hundreds of billions of stars and planets. They are vast, star-making factories, over a billion times larger than our Solar System!

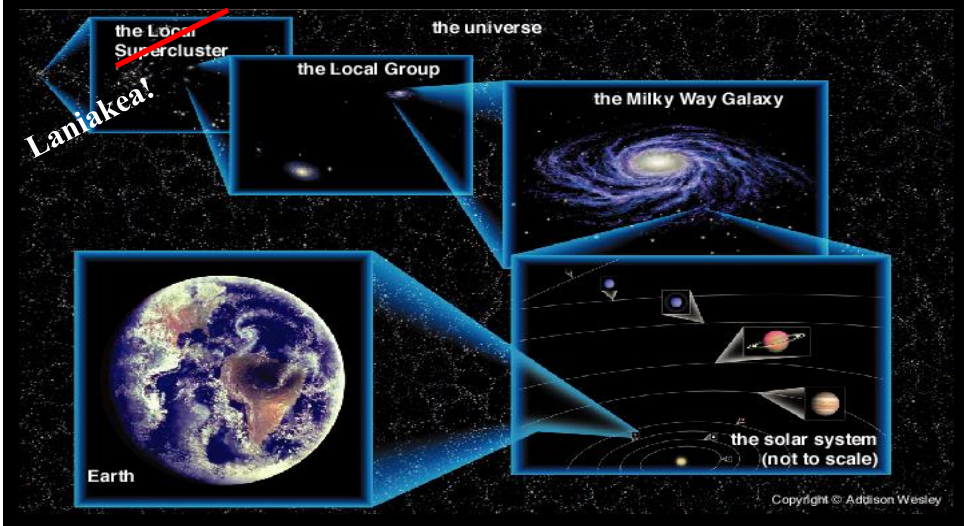


These galaxies congregate in *groups*, *clusters*, and *superclusters* – some with dozens of members, others with hundreds or thousands.

These superclusters are the largest coherent structures in the universe – we see no larger objects, or even any galaxies or stars at distances greater than about 13 billion l.y. from Earth. Beyond this realm, we see only the smooth radiation from a time before stars and planets existed, when the universe was indeed a very different place!



The cosmic microwave background, formed over 13 billion years ago

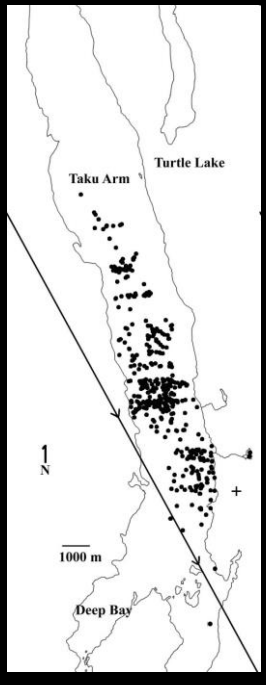


That means we now have a relatively complete "Cosmic Address" – and a sense of objects in space we'll be dealing with and their spatial relationships to each other!

But so far we haven't touched upon their relationships in *time*…

…and time is in many ways an important thing to think about in astronomy. If nothing else, just as the 'spatial' scales we've seen are large compared to human scales, astronomical 'time' scales are generally much, much longer than human lifetimes.

This graduate student is holding one of the oldest rocks known to mankind – over 4.6 billion years old. Believed to be a fragment of asteroid 773 Irmintraud, it fell to Earth on January 18, 2000, just over Tagish Lake in British Columbia.

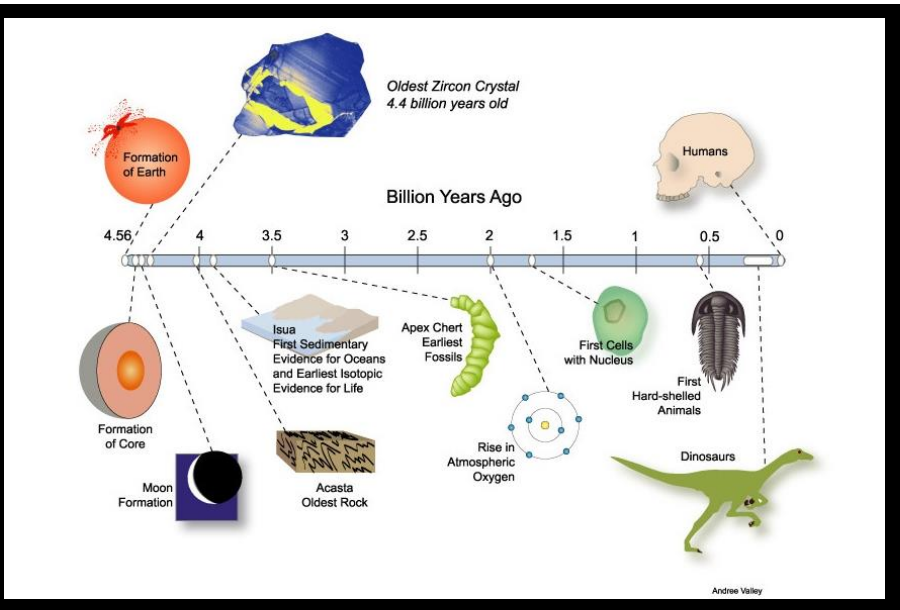


This image features the oldest known star in our galaxy – and arguably the oldest well-dated ***thing*** ever! HD140283 is an evolved, bluish star, soon to become a red giant. Studies of the elements in its atmosphere have led us to conclude that it has led a **LONG** life – over 13.2 billion years so far! That takes us back to the earliest times we can directly observe, some 13.75 billion years ago…

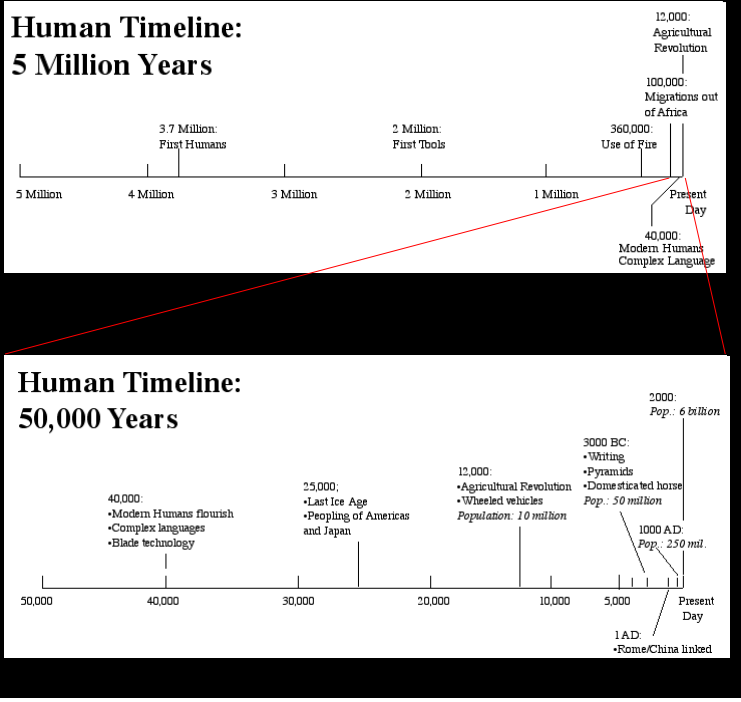
January	February	March	April	May	June	July	August	September	October	November
Big Bang occurs.				Milky Way Galaxy forms.				Our solar system forms. Life on Earth begins.	Earth's atmosphere becomes oxygenated.	First complex life forms appear.

December						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19 Vertebrates appear.	20 Land plants appear.	21
22	23	24	25 Dinosaurs appear.	26 Mammals appear.	27	28
29	30 Dinosaurs become extinct.	31 Humans appear.				

In Chapter 1, your book also presented a quick overview of the history of the universe – the *temporal* "Big Picture", if you will.

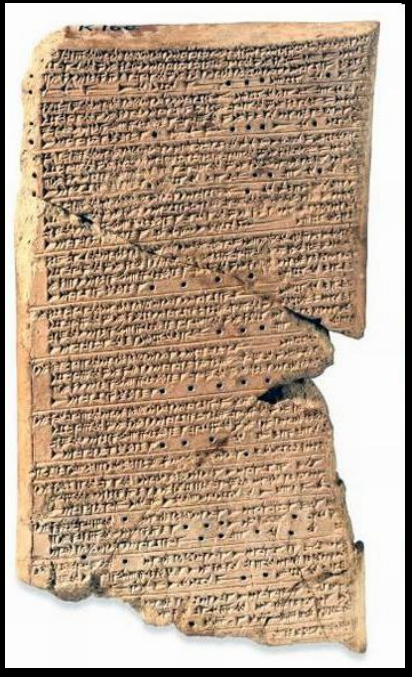


Those last few "months" – over 4.6 billion years of real time – have been quite busy here on Earth!

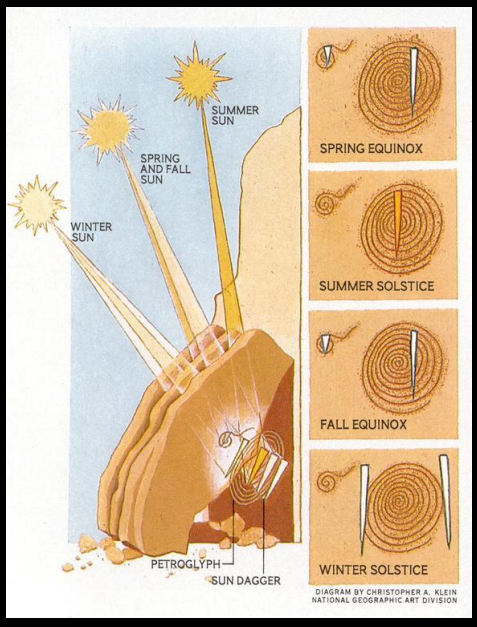


We now arrive at an important point in our study of the history of astronomy – the first indication of humans *paying careful attention* to the worlds whirling around them in the heavens.

The Babylonian "Venus tablet of Ammisaduqa", carved ~ 1700 BC, clearly describes the motions of Venus in the sky, and makes it apparent that these ancient astronomers were aware of the periodic motion of the brightest and nearest planet to Earth.



Constructs such as this Anasazi "Sun Dagger", for example – a petroglyph carved behind a series of standing rocks in New Mexico (ca. A.D. 1000) – reveal the skills of ancient astronomers – and the power of simple observations.

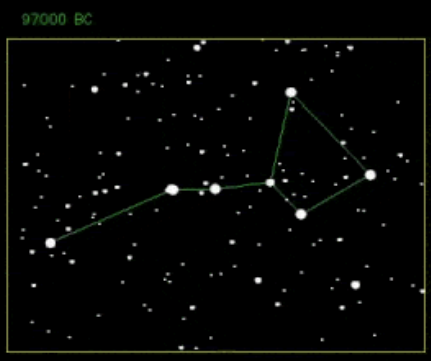


Sunlight falling through the rocks splits the spiral petroglyph with shafts of light in very particular ways on particular days of the year, allowing Anasazi priests to reliably predict seasonal changes and mark important agricultural and ceremonial times.

On a broader level, astronomy provided a clear way to organize time itself, and to schedule complex agricultural, social, and religious events. Further, discovering and recording ***patterns*** in the locations and movements of objects in the heavens reinforced the ‘rationality’ and ‘repeatability’ of the natural world – concepts key to the development of science itself!

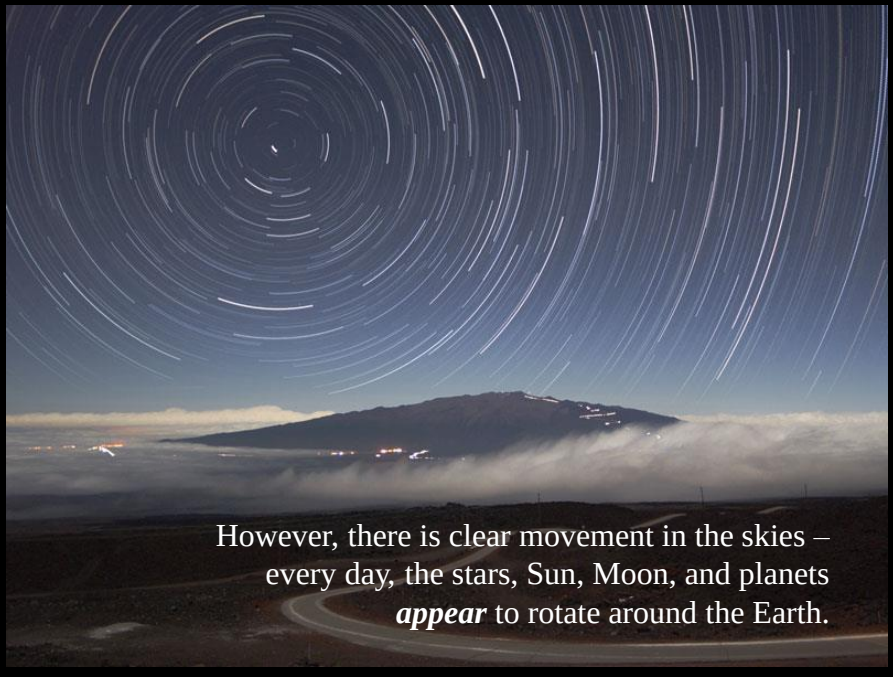
These were very, ***very*** powerful tools for early cultures – and thanks to astronomy's 'obviousness' (you can't 'hide' the Sun, Moon, and stars!) they spread quickly and widely across the globe.

Relics of the deep history of astronomy and its ties to ancient cultures persist in the names of our ***constellations*** – patterns of the apparent position and arrangement of bright stars, representing human elements in the sky such as mythical beasts and hero figures like Orion, the Hunter.



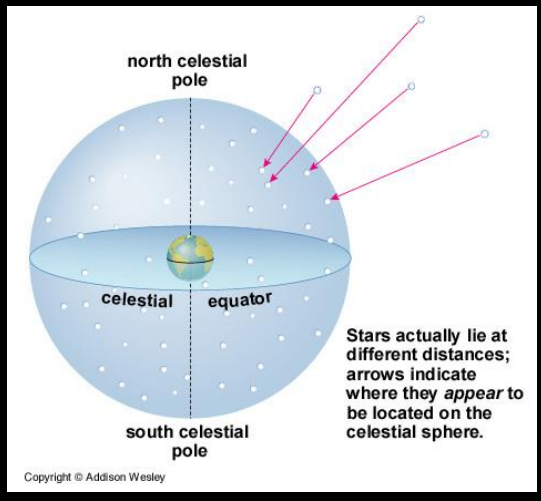
Artist's impression of the changing view of the Big Dipper over a few thousand years!

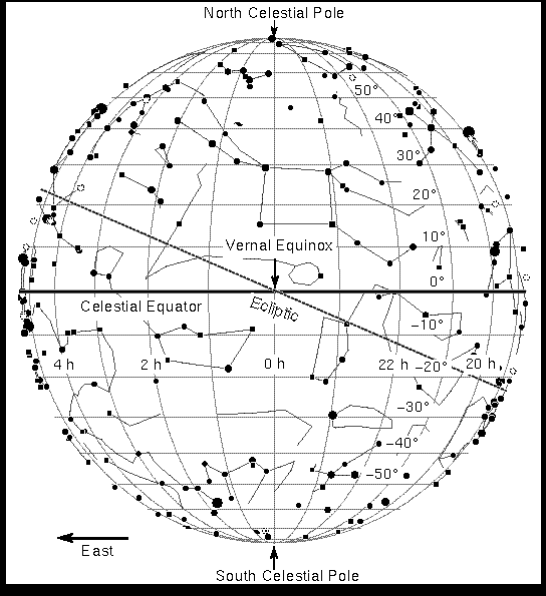
These patterns of location don't seem to change from night to night – though later in the class we'll discuss the fact that stars really are moving at very high speeds around us through our galaxy. It's only because stars are so far away that their movements are hard to detect, and in fact almost unnoticeable, even over centuries of time.



However, there is clear movement in the skies – every day, the stars, Sun, Moon, and planets ***appear*** to rotate around the Earth.

Because astronomical objects are ***so*** far away, our eyes cannot tell how far apart they are from each other. This apparent ‘sameness’ in their distances combines with their apparent daily ‘motions’ to create a compelling illusion that the Earth is in the center of a great ‘celestial’ sphere that rotates around us.



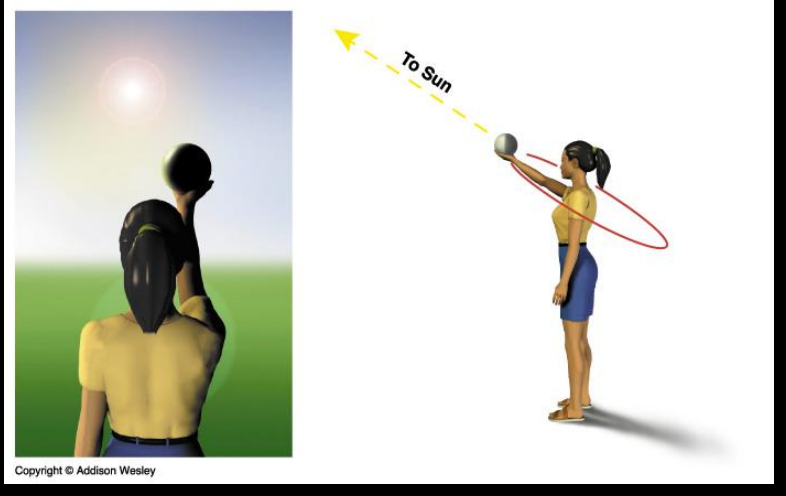


We still use this concept in modern astronomy, in the form of various spherical coordinate systems for mapping the position of objects on the sky – though as we’ll see, for most of human history we have believed the ‘celestial sphere’ to be a real object!

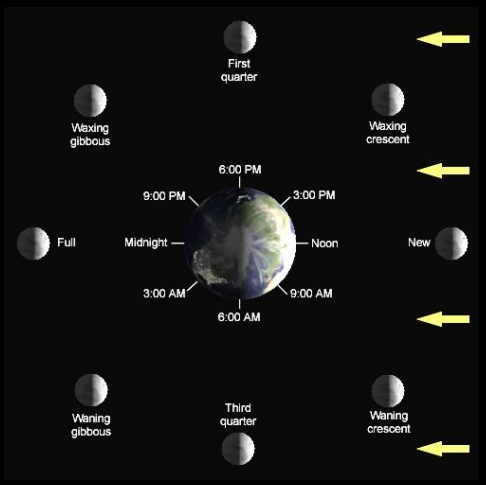
Other Motions in the Sky – the Phases of the Moon

Every night, the amount of illuminated area on the Moon that one can see changes. These changes repeat in a cycle about every 28 days, and are the historical source of the month as a unit of time.

These phases are ***not*** caused by the shadow of the Earth, but instead by the changing angle between the Sun, Earth, and Moon, and how those changes affect our ***view*** of the Moon.

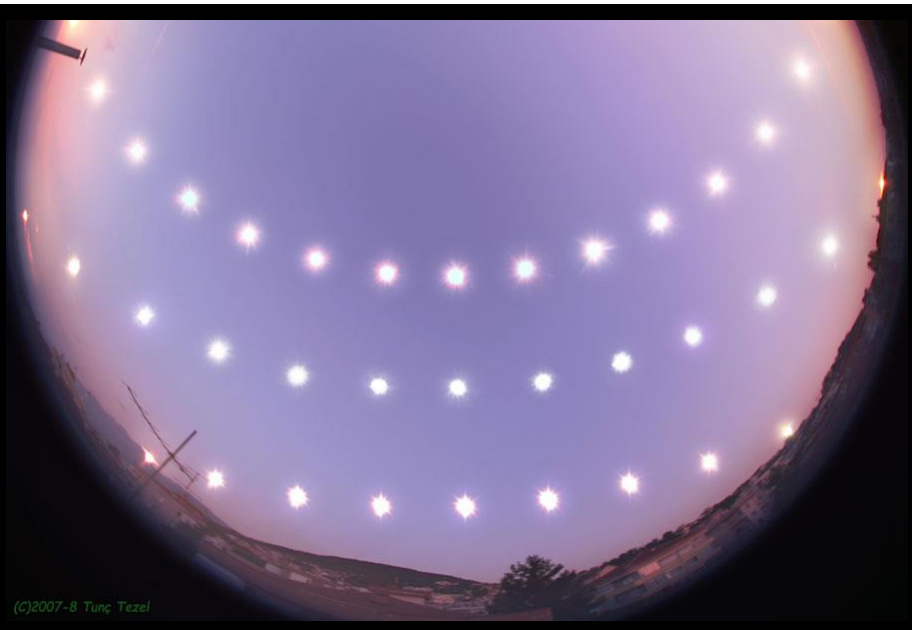


As the Moon slowly orbits around us, half of its surface is always "lit up" – but how much of that illuminated half is visible from Earth steadily changes. Further, because of the Earth's daily rotation, you can only see a given phase of the Moon at certain times of the day or night.



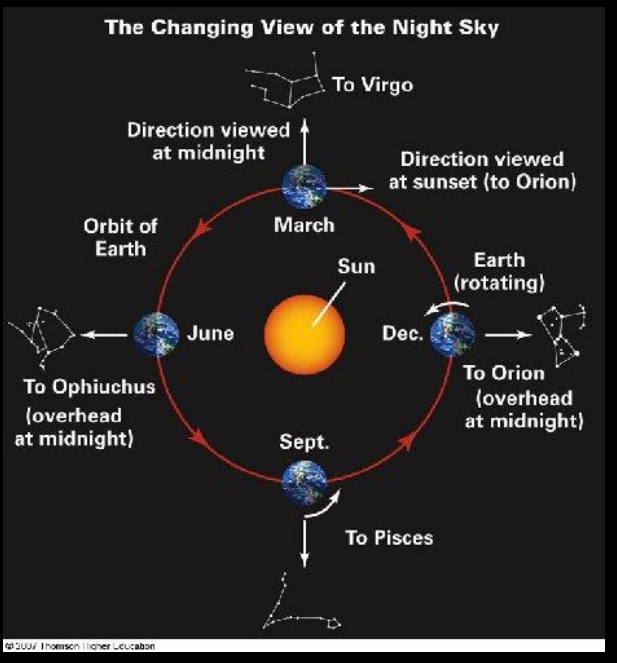
Looking for Annual Patterns – the Seasonal Movements

For example, the changing location of the Sun at sunrise and sunset, as seen from the hills of Greece…

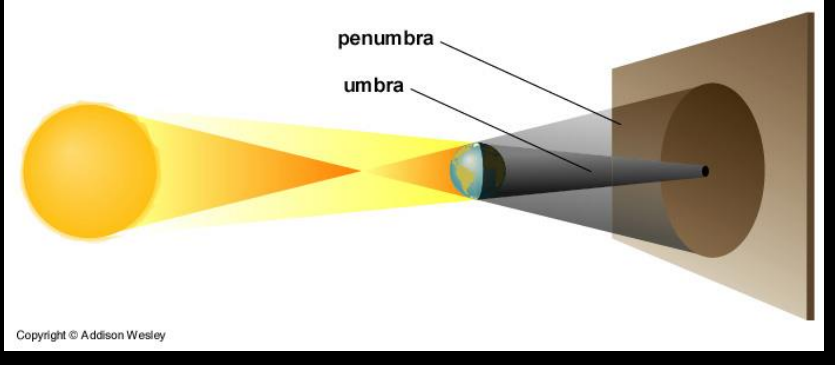


…or the changing altitude of the Sun in the sky over Turkey.

The Sun also appears to move with respect to background stars, so that at different times of the year you will see different constellations in the nighttime sky. Orion, for example, is easily visible in winter skies, but is lost in the glare of the Sun for most of the summer.

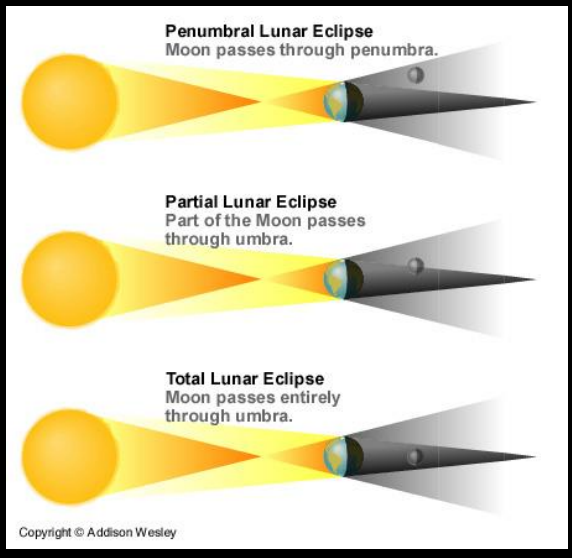


Even longer patterns – Eclipses

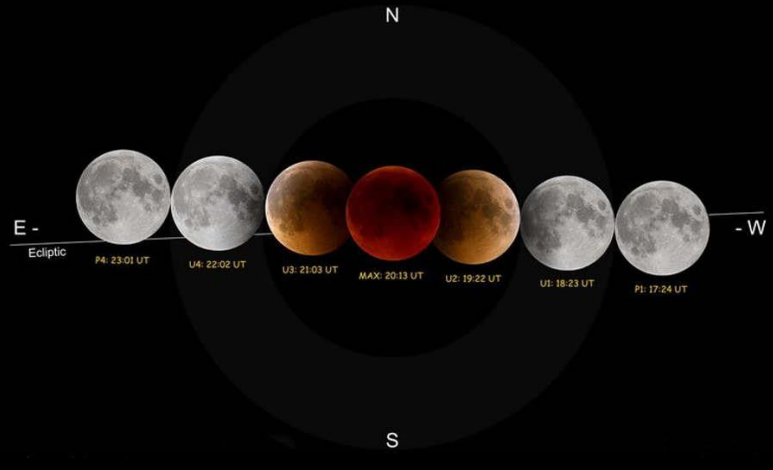


As they move, planets and moons cast shadows into space…

…which can ‘eclipse’ objects passing through the shadow.

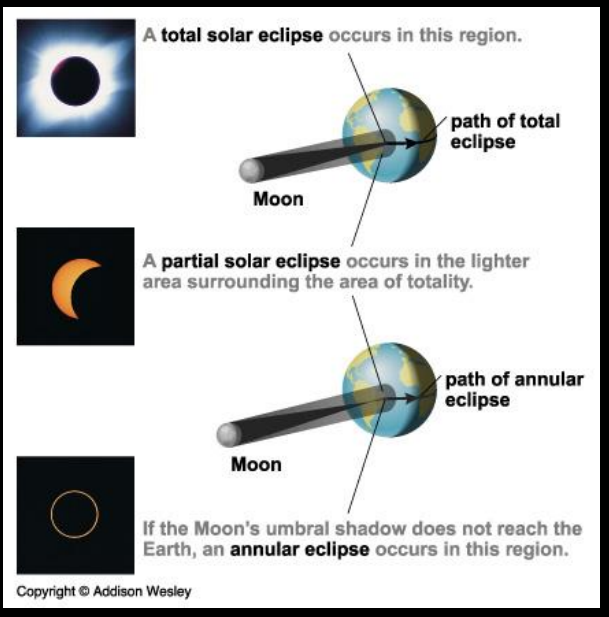


Different types of Lunar Eclipses

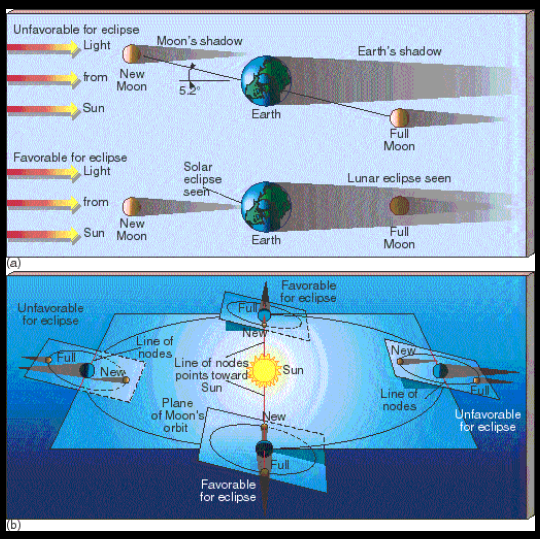


Images from a total lunar eclipse in June 2011

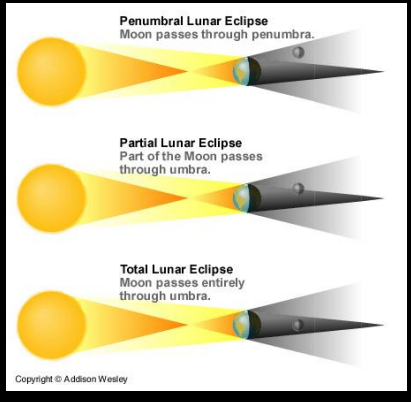
Different Types of Solar Eclipses

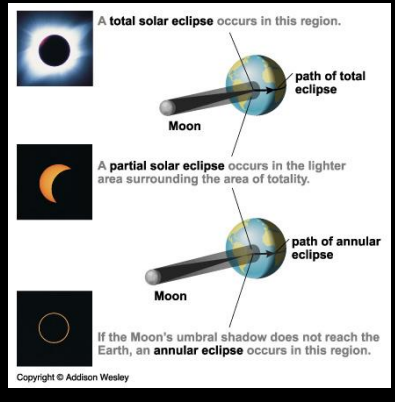


A sequence of images from the 2017 eclipse over the United States



We don't have eclipses every Full and New Moon because the plane of the Moon's orbit around the Earth is not the same as that of the Earth (and Moon) around the Sun. During most Full and/or New Moons, the Moon is either slightly above or slightly below the direct line between the Earth and the Sun.





Finally, let me note something else that these illustrations suggest (correctly, even if not drawn to scale) – the Earth's shadow is much, much larger than the Moon's shadow. Only a very small fraction of the Earth 'sees' a given solar eclipse.

A map of recent and near future total solar eclipses

To review, there are several key patterns of 'celestial motion', visible to the naked eye, that you need to be familiar with:

- The daily rotation of the Earth
- The annual motion of the Earth around the Sun
- Phases of the Moon
- Eclipses of the Sun and Moon

If you understand how the night sky appears to change based on these phenomena, you'll be as up to date as an 18th century astronomer, and in good shape for this week's quiz!