I love talking shop because astronomy is great fun and questions keep me on my toes (and doing my homework). Feel free to drop me an email with questions and I'll be happy to answer them.

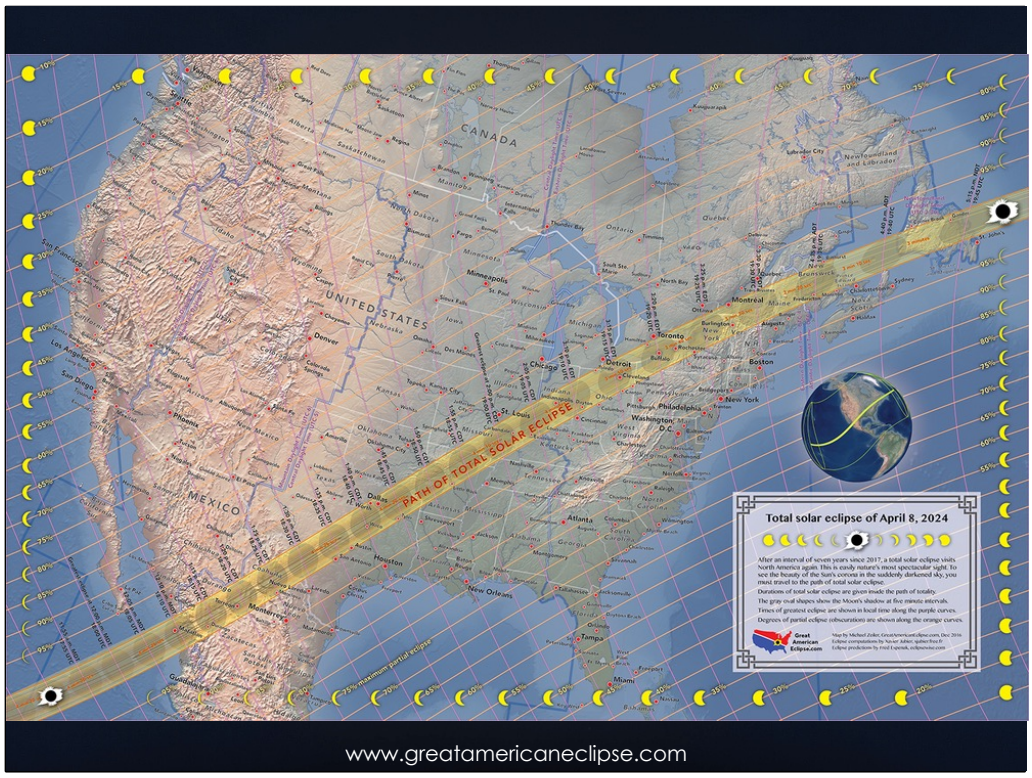
And this presentation gets tailored for the audience, but all of the slides from whatever version you saw are here (and some more you might have not).

Solar eclipses can look quite ominous from space – here taken by a high-altitude balloon sent up from the company Sent Into Space.

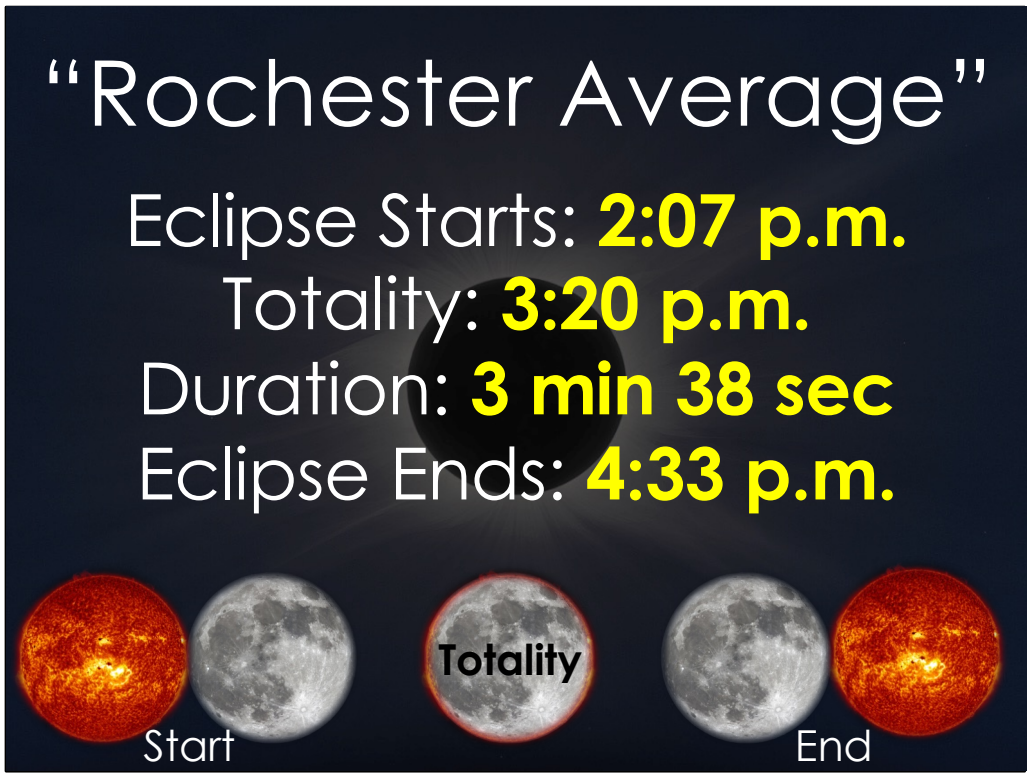
These were the four things I really want to cover, then folks had the option of picking from among a set of other related topics (after the safety talk).

A brief introduction to the Solar System Ambassador program and the three of us currently active in the area who are presenting during the time running up to the solar eclipse. By all means check on other local libraries to see another set of slides describing the eclipse (I suspect we all agree on the technical details).

Onto the technical details.

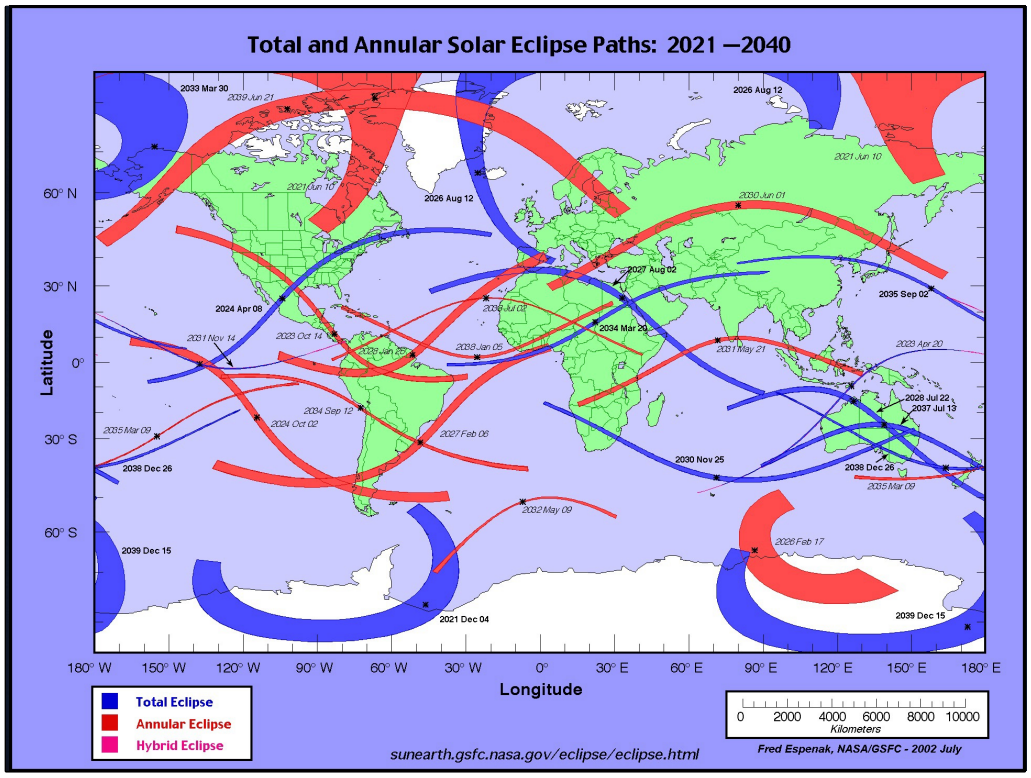


A focused, and fancy, image of the path of the 8 April 2024 total solar eclipse from greatamericaneclipse.com (an excellent resource, as useful for the 2017 partial eclipse in CNY as it is for the 2024 total eclipse).



The numbers here are for the city of Rochester – the timings will be slightly different if you're enough east/west/north/south. Just be sure to be paying attention around the expected time of totality.

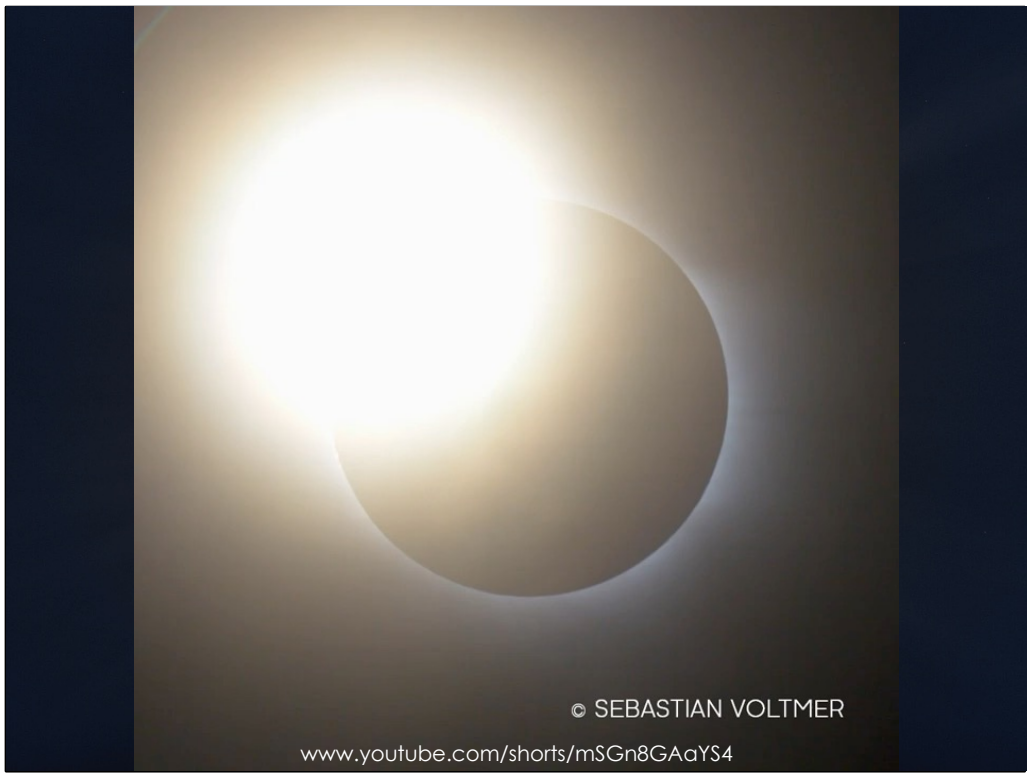
You'll have to wait a while for the next one – and it won't be a total eclipse, only an annular (ring).



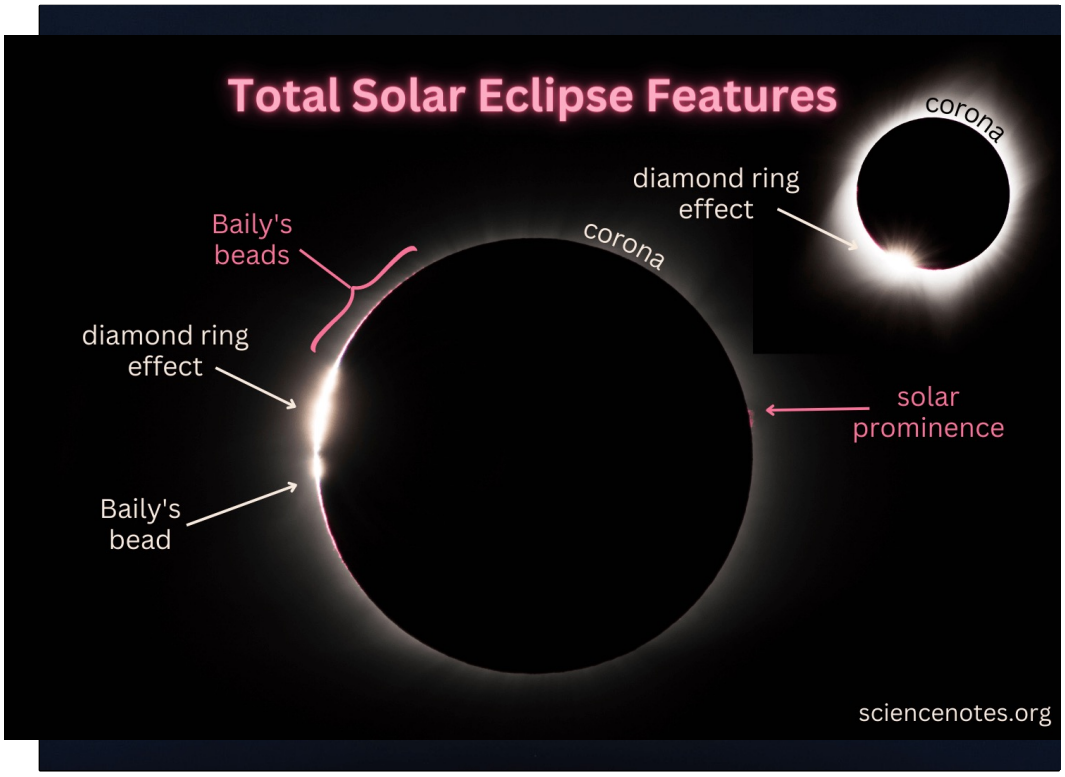
A good, information-rich, limited-color-pallet image of all of the solar eclipses occurring on the face of the Earth, and their locations, from 2021 to 2040. Fred Espenak is also known as “Mr. Eclipse” in various astronomical circles – if he says it, and it’s about an eclipse, you can take it to the bank. Yes, our math is more than good enough to make predictions out hundreds (or more) years for planning hotel reservations.

The section covering, lightly (no pun intended), what the eclipse is going to look like with some visual aids (videos) available online.

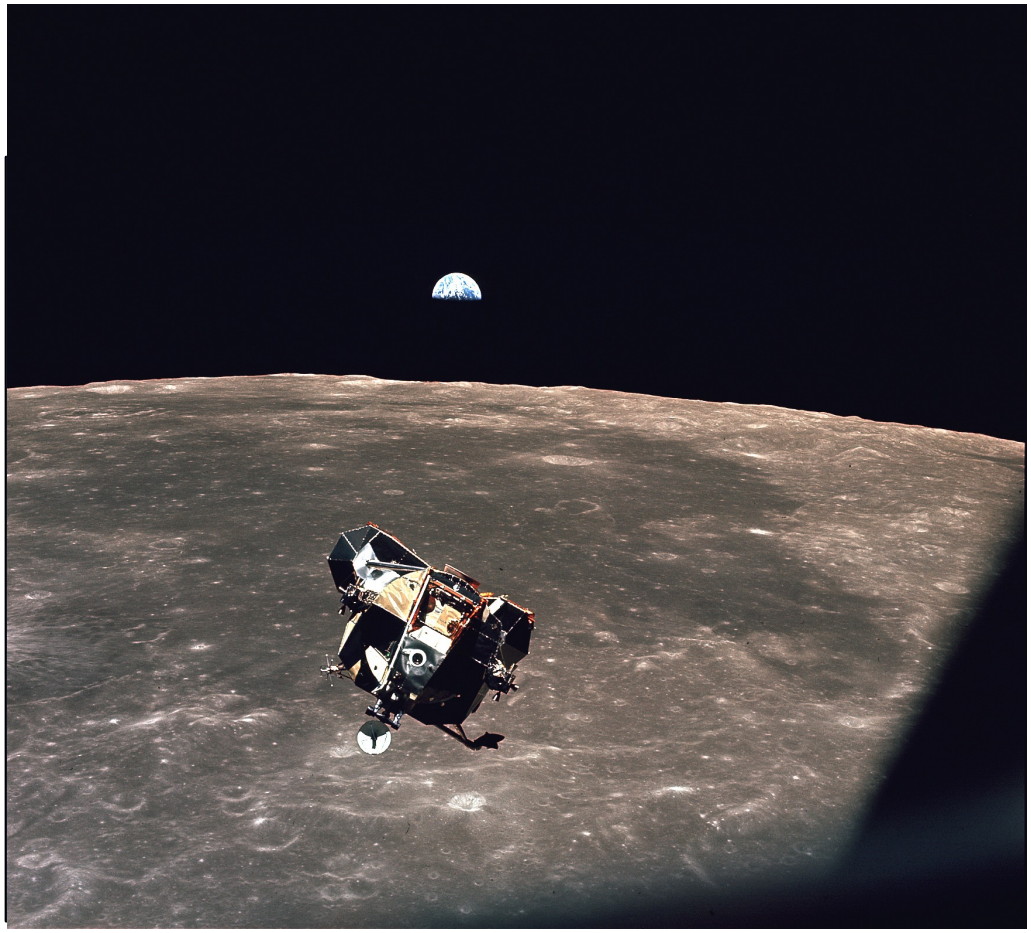
Those of us observing the solar eclipse in 2017 saw the above (much more slowly, of course) – the moon covered only a part of the sun. Given the partially cloudy conditions, most people wouldn't have known there was a partial eclipse going on at all if not for the news stories leading up to it. There is a big, big difference between a partial and total solar eclipse.



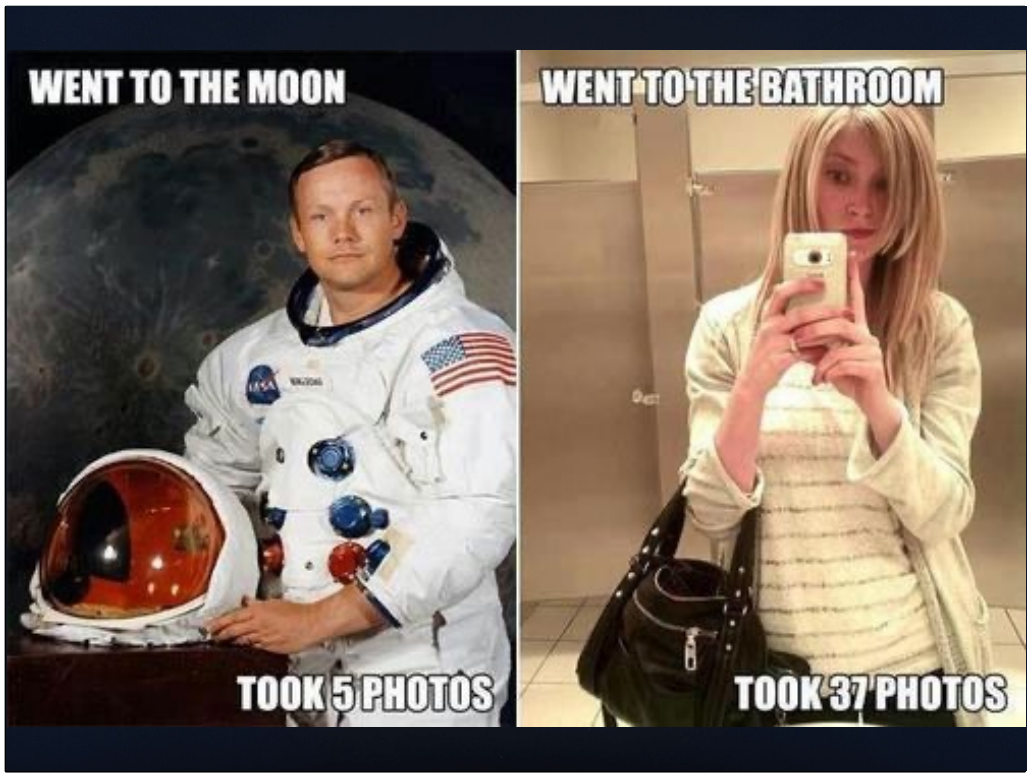
This is what we will be witnessing, weather-permitting, on the 8th of April. Complete coverage, the “diamond ring” at the edge of totality, Baily’s Beads, then +3 minutes of corona above and very different conditions on the ground below.



And things to look for! Many people miss them because they still have their solar glasses on, but the “diamond ring” will occur when the moon is almost completely covering the sun. Baily’s Beads are harder to catch without magnification, but you might be able to see tiny bright patches very, very close to totality with your glasses on. When totality ends and the sun starts to come out again, you’ll see the diamond ring and Baily’s Beads – put those eclipse glasses back on!



Baily's Beads – occur because of the varied lunar topography (also a chance to show one of my favorite pictures of all time).


WENT TO THE MOON
TOOK 5 PHOTOS
WENT TO THE BATHROOM
TOOK 37 PHOTOS

Aside.

Visible Planets!

Easy:

- Jupiter
- Venus

Tough:

- Saturn
- Mars

No binos, please!

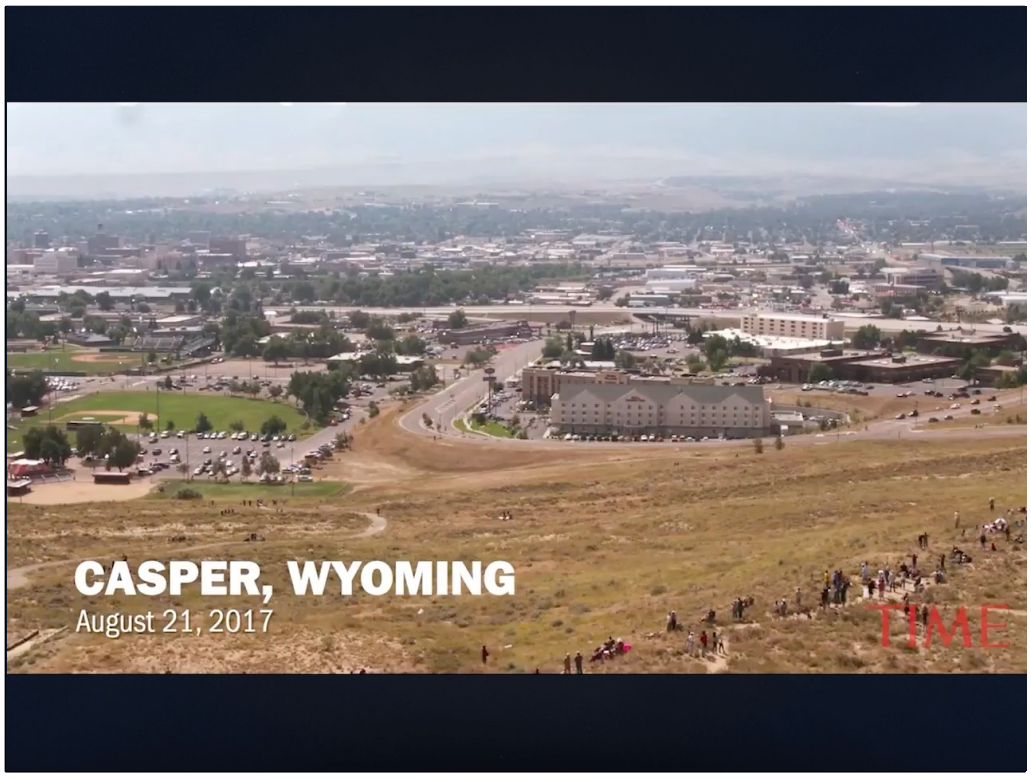
During totality, you should have no problem seeing Venus. Jupiter might stand out quite well. Saturn and Mars are there, but may be a struggle. I STRONGLY urge you to keep yourself to visual observing without optics in your search to not risk your binos crossing the path of the incoming sunlight post-totality while you're flailing around to find stuff.

Visible Stars! **No binos, please!**

During totality, you'll even be able to see some of the brightest stars depending on the conditions and your eyesight. Sirius, is the brightest star in the nighttime sky, will be visible to your southeast. You may see part of the outline of Orion the Hunter and can confirm your suspicions after sunset when Orion is high in the sky.

And note the stars visible in this image as well!

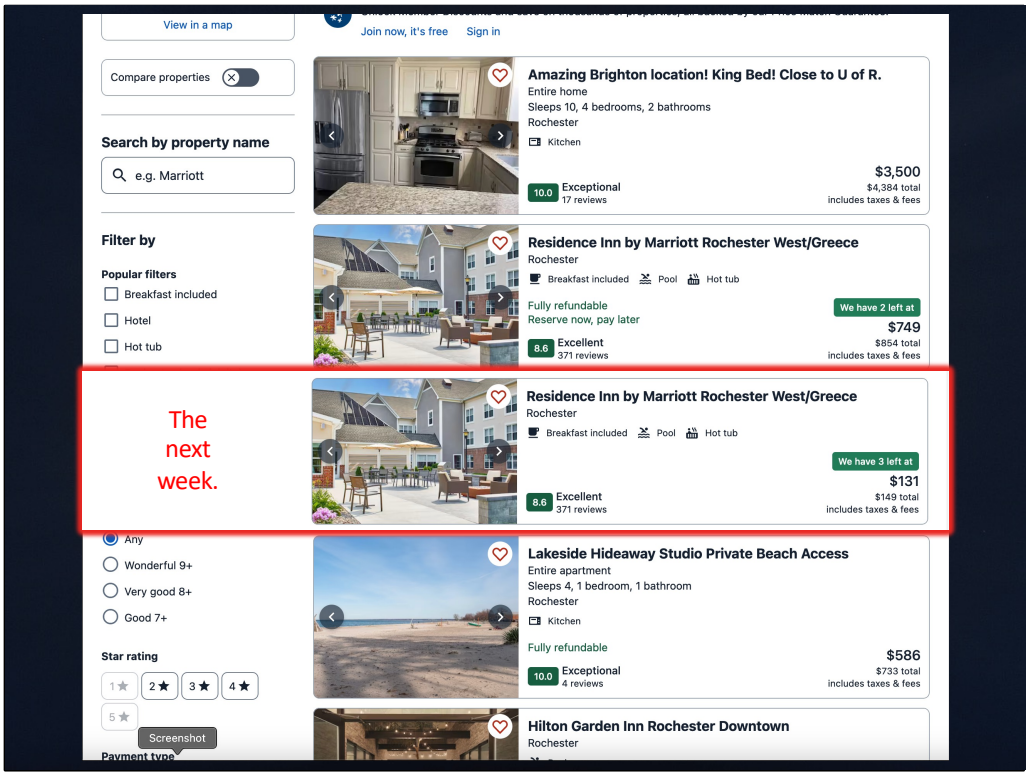
The birds (chickens!) return to their nests (roosts!). Animals will go quiet. Some people around you may get a little freaked out. People may start crying. It is a magical, and very different, experience from anything you might know. Take it all in as much as you can or, depending, just wait it out. Whatever your reaction, you will not forget totality.



When we say that it's going to be dark during totality, the above video shows what we mean. If you took a nap at 2:30 and woke up mid-totality, you'd think you slept well past sunset.

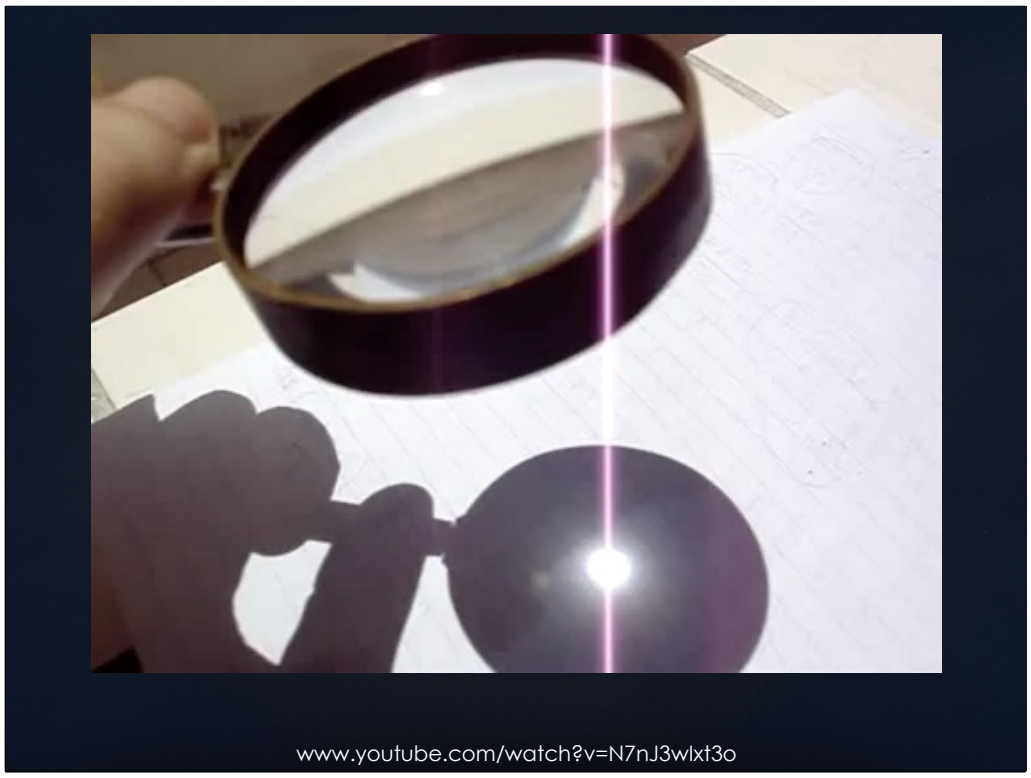
And look at that person driving during totality! Didn't someone tell'em?!

And, of course, the 100,000 to 500,000 (or more) people they expect might arrive in the Rochester area and camp out in your backyard (above) won't forget it either. Traffic will (likely) be significant!



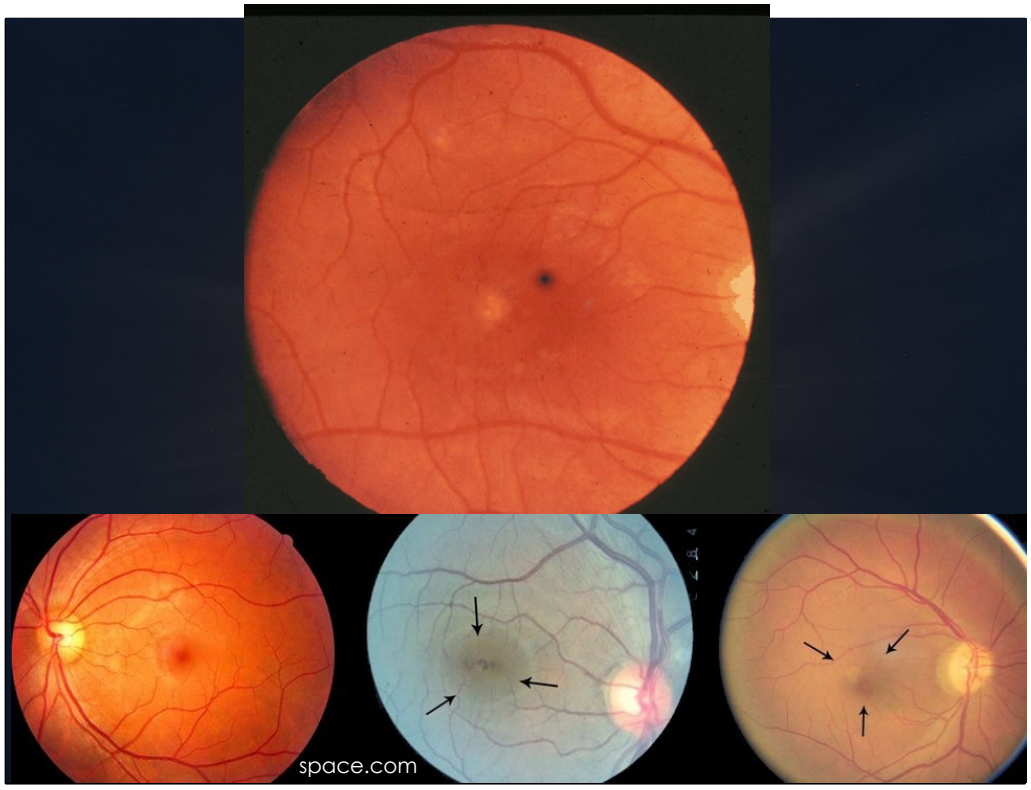
And, of course, the market economy.

If you ignore the rest of the lecture, go back to your phone, take a nap, whatever, great. This is the only section I REALLY want you to pay attention to.



This is a cheap magnifying glass and a clean piece of college-ruled paper on a sunny day. It does not take long to start smoking that piece of paper even at low magnification.

Having this slide on the screen is not my invitation to you to try this at home without an adult present!



After whatever this person did while observing, I can report that this person was fortunate to have only a pinhole burn to their retina. I say fortunate because they could have done serious damage to a much larger region. Unfortunately, this burn mark will not correct itself and this person will, permanently, have no vision at that spot.

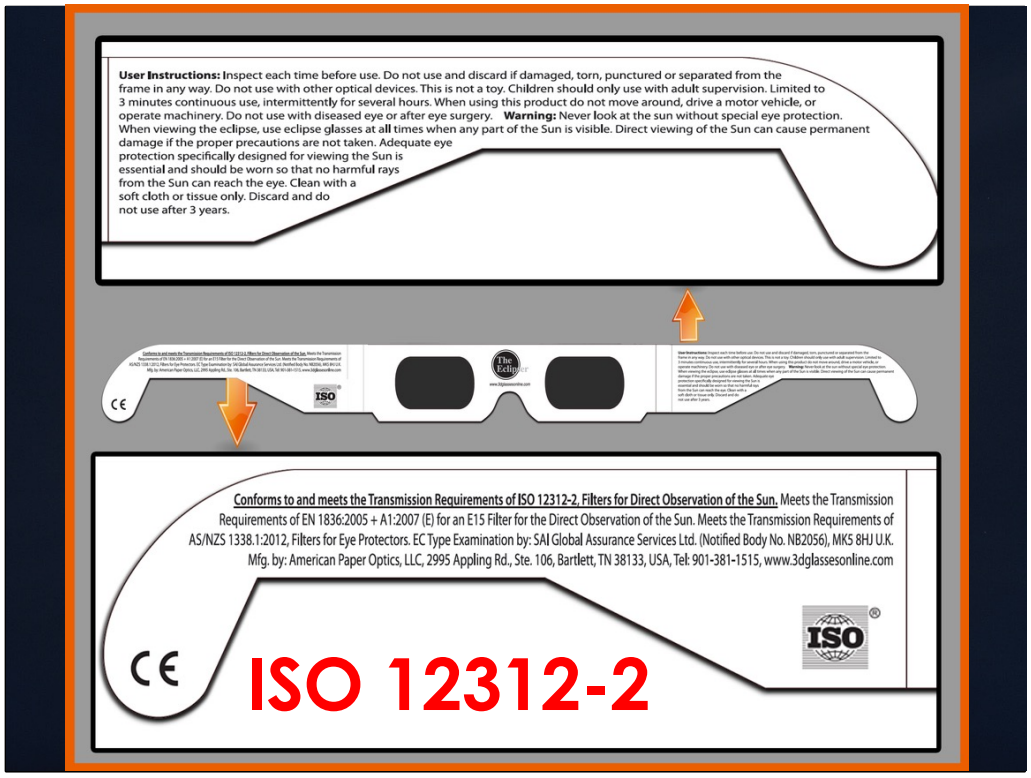
DO NOT LOOK DIRECTLY AT THE SUN WITH ANY PIECE OF OBSERVING EQUIPMENT WITHOUT A PREVIOUSLY INSPECTED SOLAR FILTER SAFELY ATTACHED! BINO OR TELESCOPE? TAPE IT OR SCREW IT DOWN!

There are all kinds of cheap and expensive ways to observe the sun safely. Pinhole cameras, colanders, projection onto paper, etc. Recent news stories even report the use of disco balls for projecting the eclipse on the ground (if you have one handy, of course).

You ll
amount of very specific wavelengths.

And you'll see this.

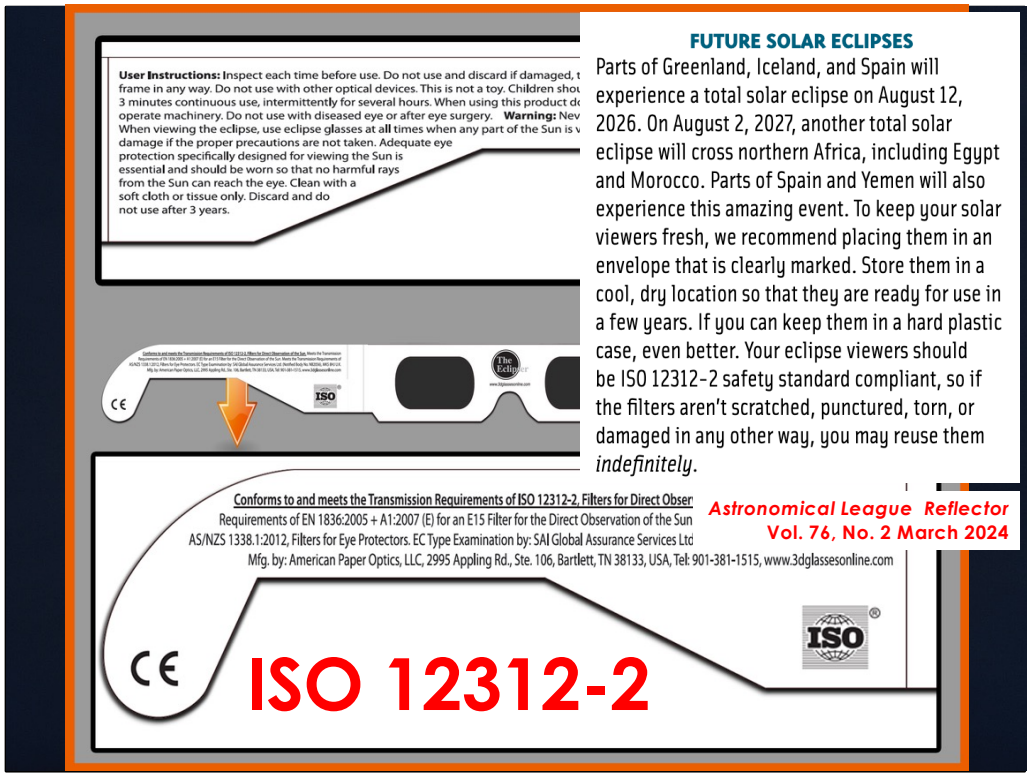
The Sun – just looking at Halpha light. Prominences, surface undulations, sunspots, all in a beautiful – and safe - view.



Everyone around here will have at least one pair of these glasses by the morning of the 8th. If you see ISO 12312-2, the Astronomical League reports that these glasses can, if you treat them nicely and always inspect for problems before use, be used *indefinitely*.

THAT SAID – it is up to you to treat them WITH RESPECT. Keep in a dry, dark location when not in use. They're not expensive and easily purchased online. Any concern? Just buy more.

The sun is out every other day, too. Take some looks and enjoy our nearest star!



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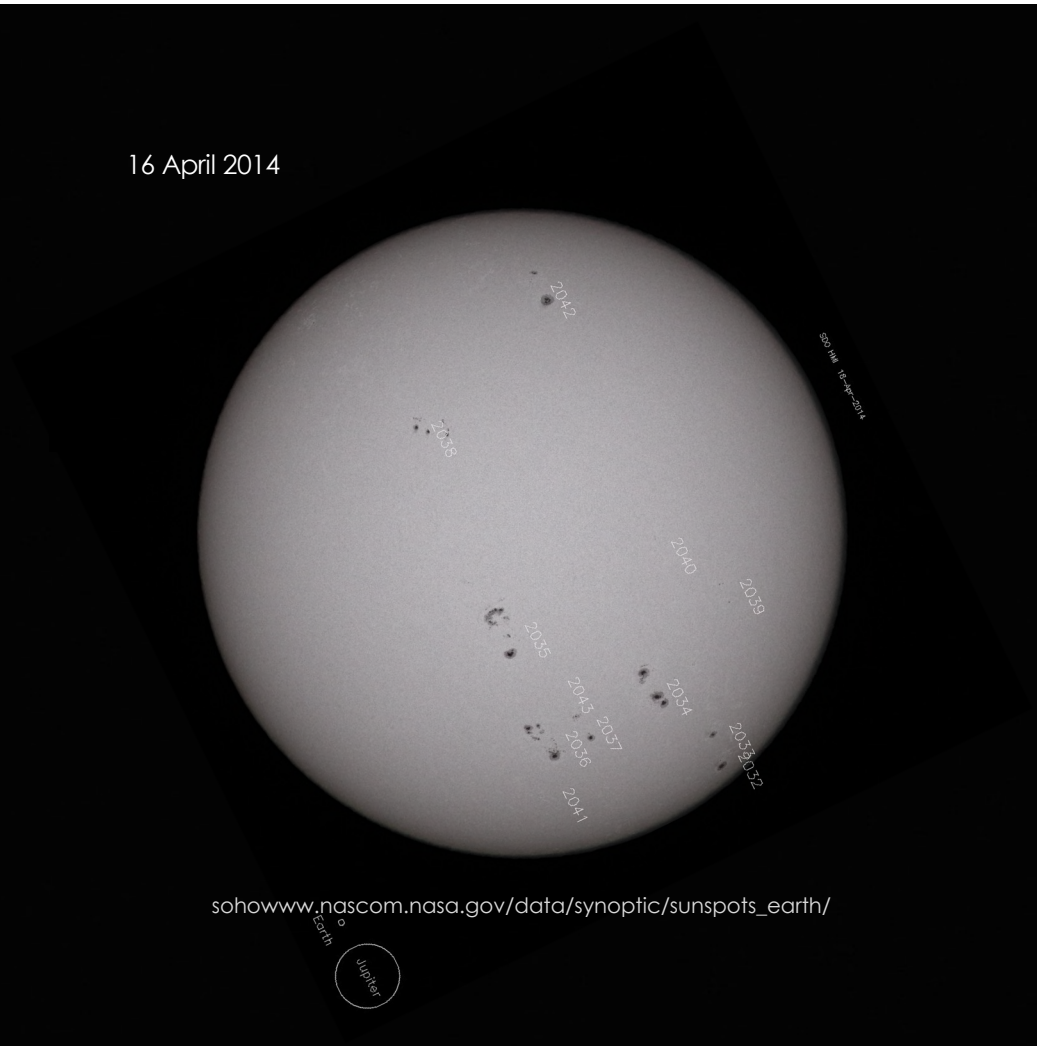
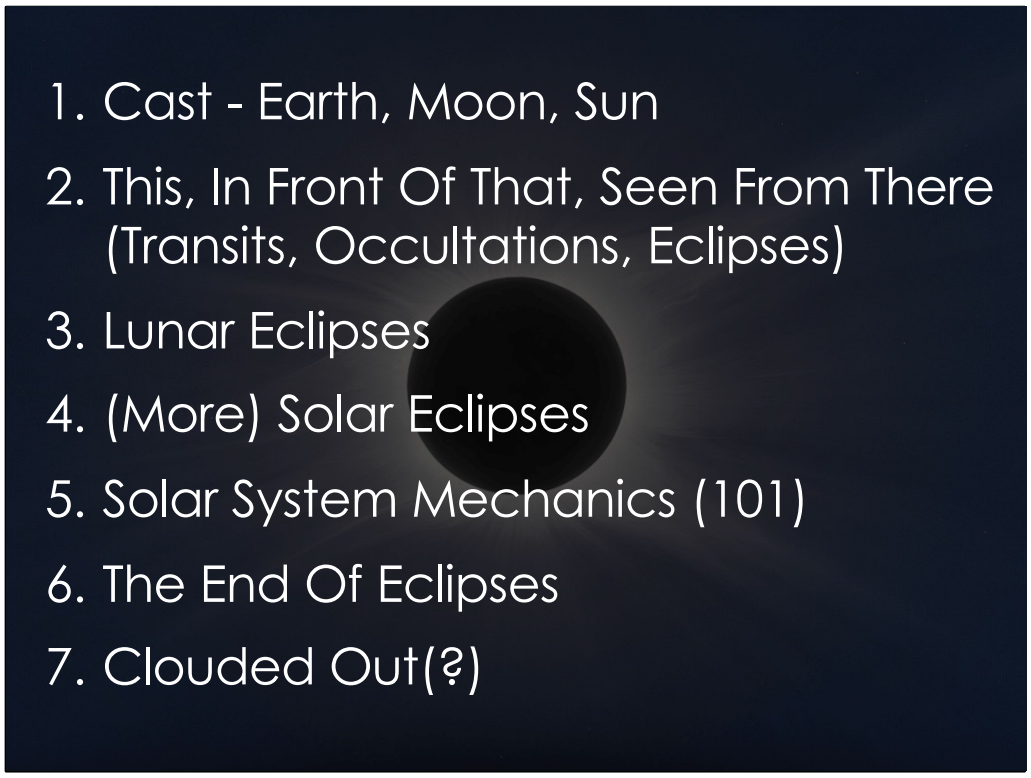
16 April 2014



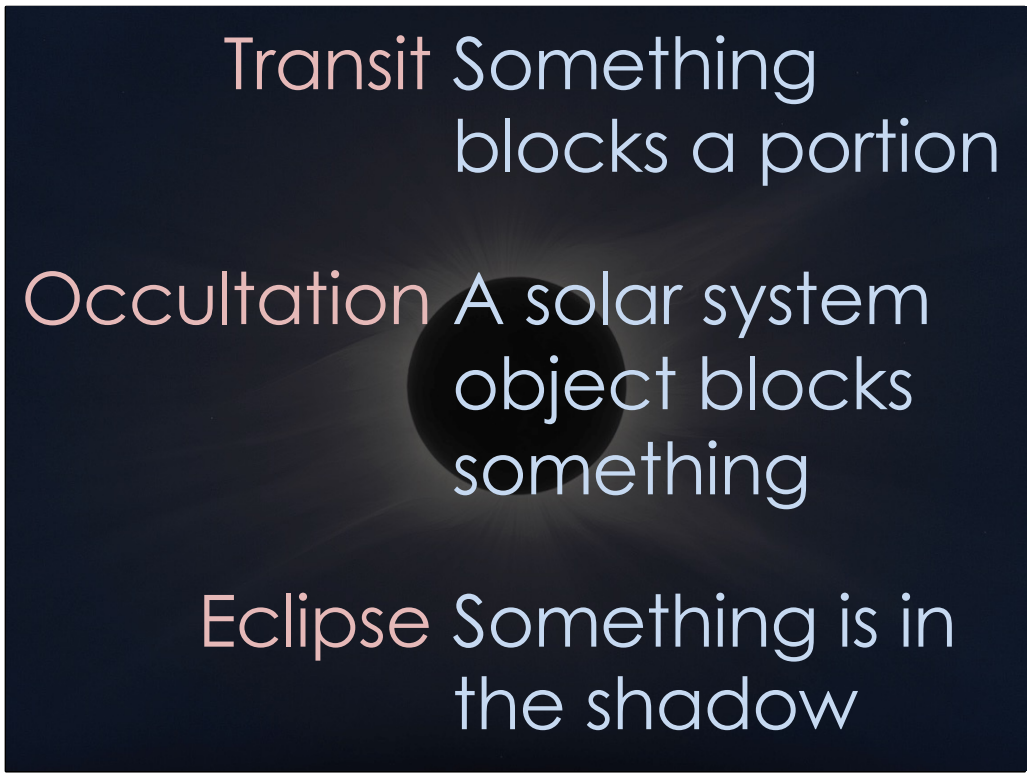
sohowww.nascom.nasa.gov/data/synoptic/sunspots_earth/

I did a quick demo with a ridiculously bright light bulb and/pr a super-bright flashlight. If in doubt, do the same at home before use. And do so before use generally.



Having covered the really, really important items for the eclipse, I then opened up the option of covering a few other topics (time-depending. Some got them all, albeit quickly).

Eclipses are an extra special subset of all those astronomical cases where “something goes in front of something else.”

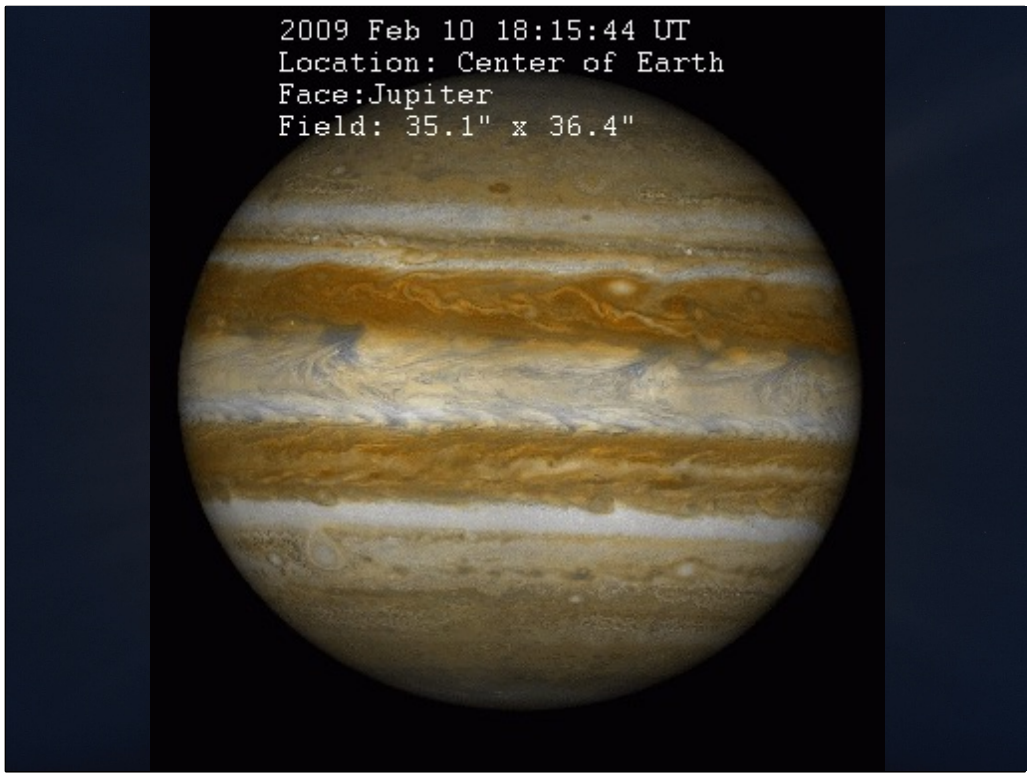


As defined above.


Transits, Eclipses,
Occultations

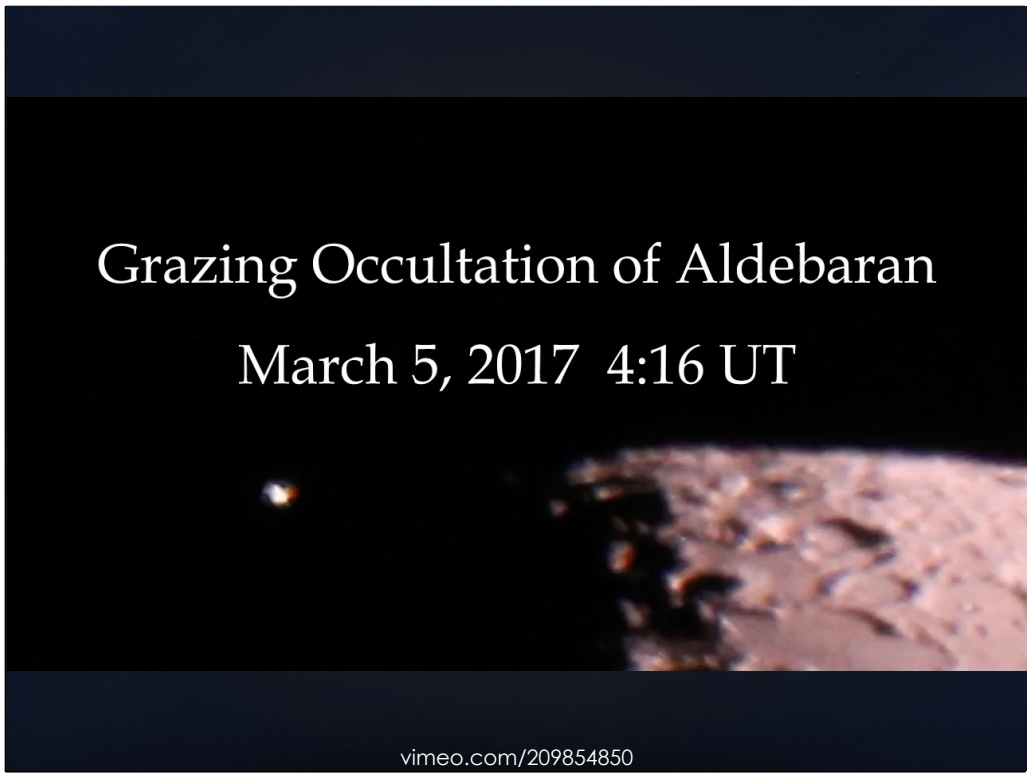
A transit - something, like the moon, going in front of the Sun but not covering much of it.

Or the Moon transiting the Earth – clearly, it depends on where you're observing the event from.

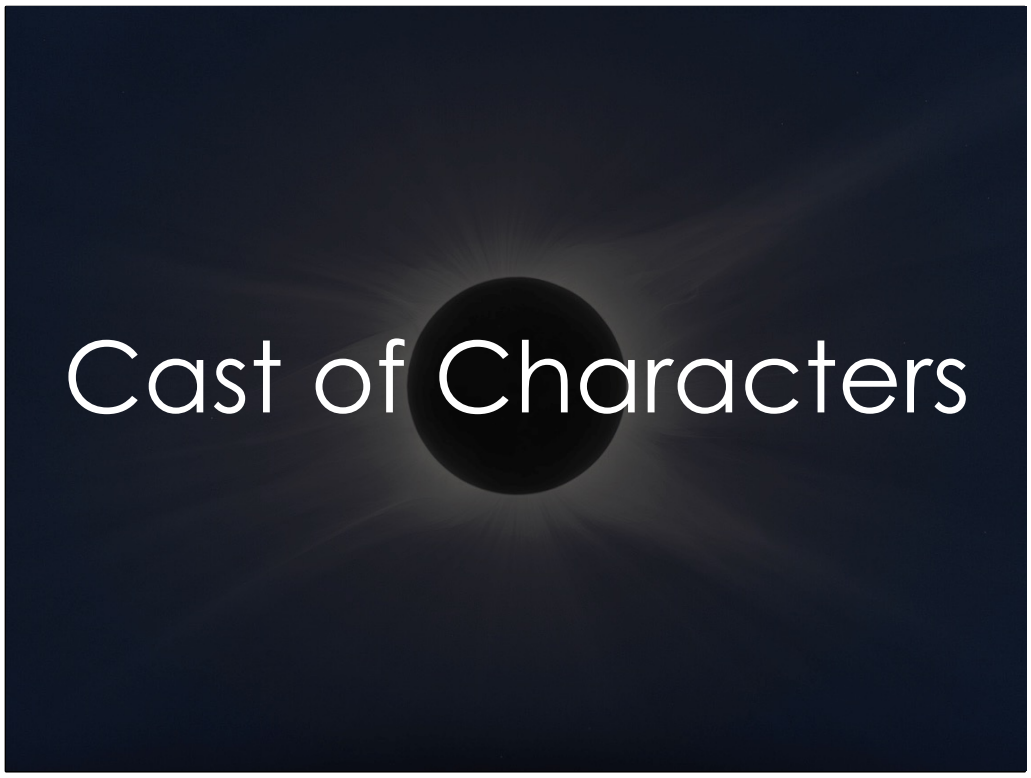


And moons transiting Jupiter are a treat even in small telescopes (the shadow is usually obvious).

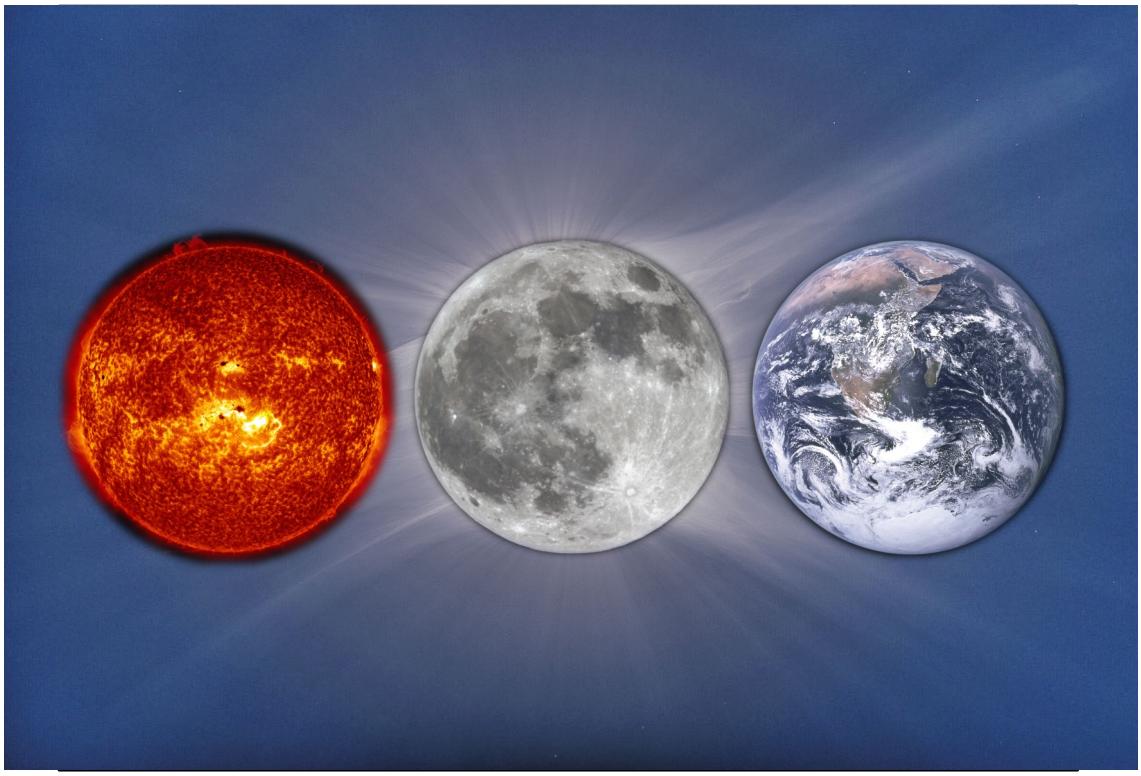

Transits, Eclipses,
Occultations



The moon is our most famous occultate-or, which people can use to even map surface details (with enough people, far enough apart, contributing).



For us, eclipses are a combination of the Sun, Moon, and Earth.



For us, eclipses are a combination of the Sun, Moon, and Earth.

We begin with the easy one.

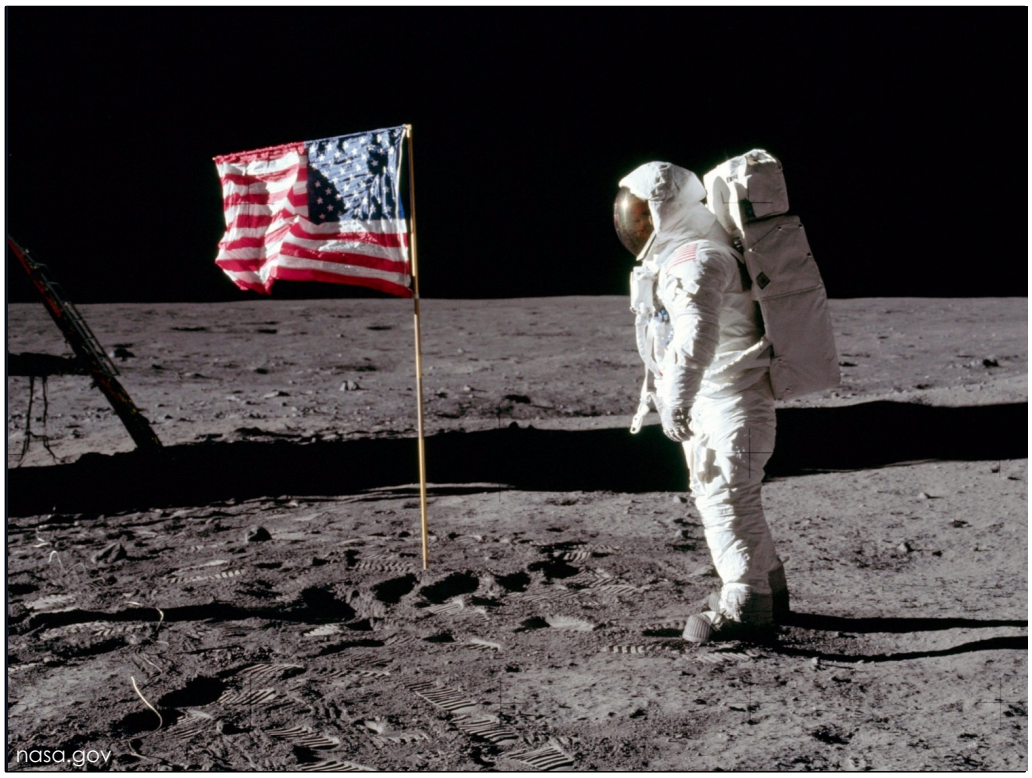
You are here.

We move on to our closest celestial neighbor.

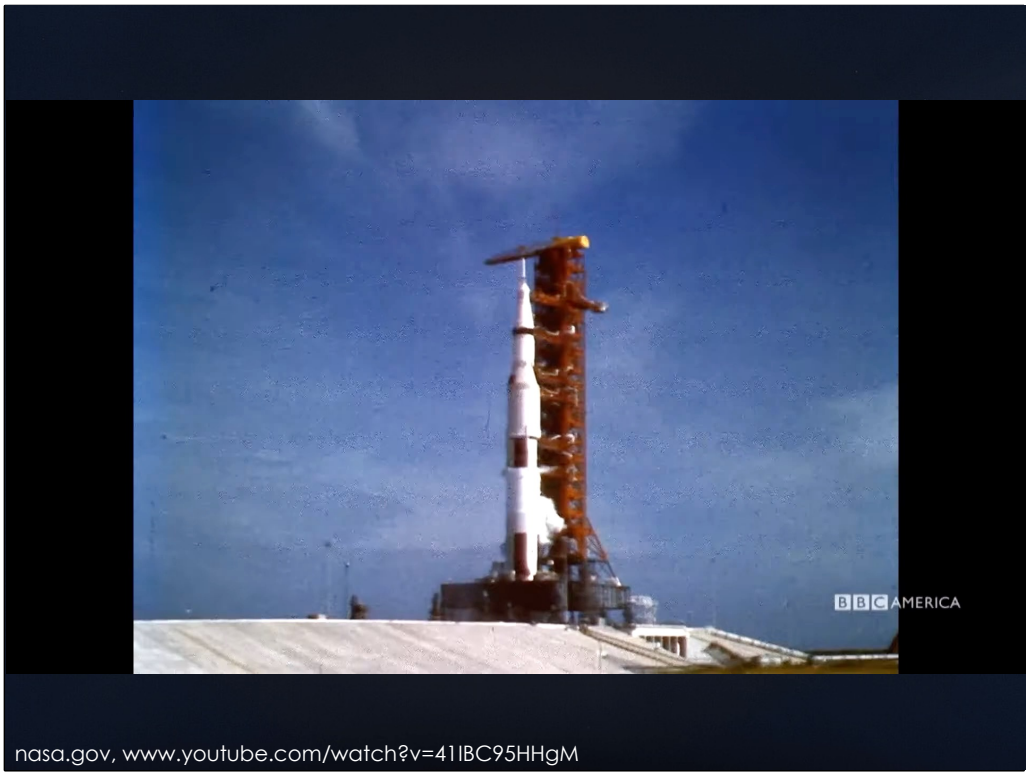
The moon.

To scale (size, not distance).

Also to scale (size, not distance).

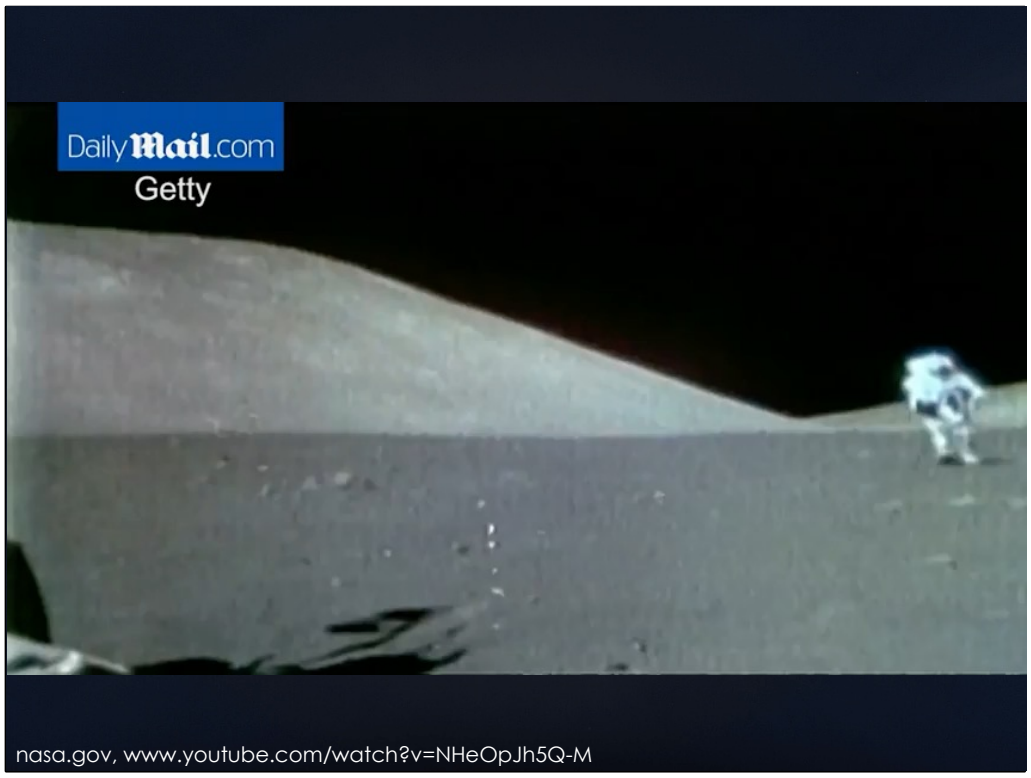


And we have been there, done some things, then took a long, long break before finally returning in the next few years, both through government entities (soon in person, we hope) and private industries (looking to demonstrate capabilities cheaply and efficiently as part of future plans to explore for resources and financially lucrative endeavors).



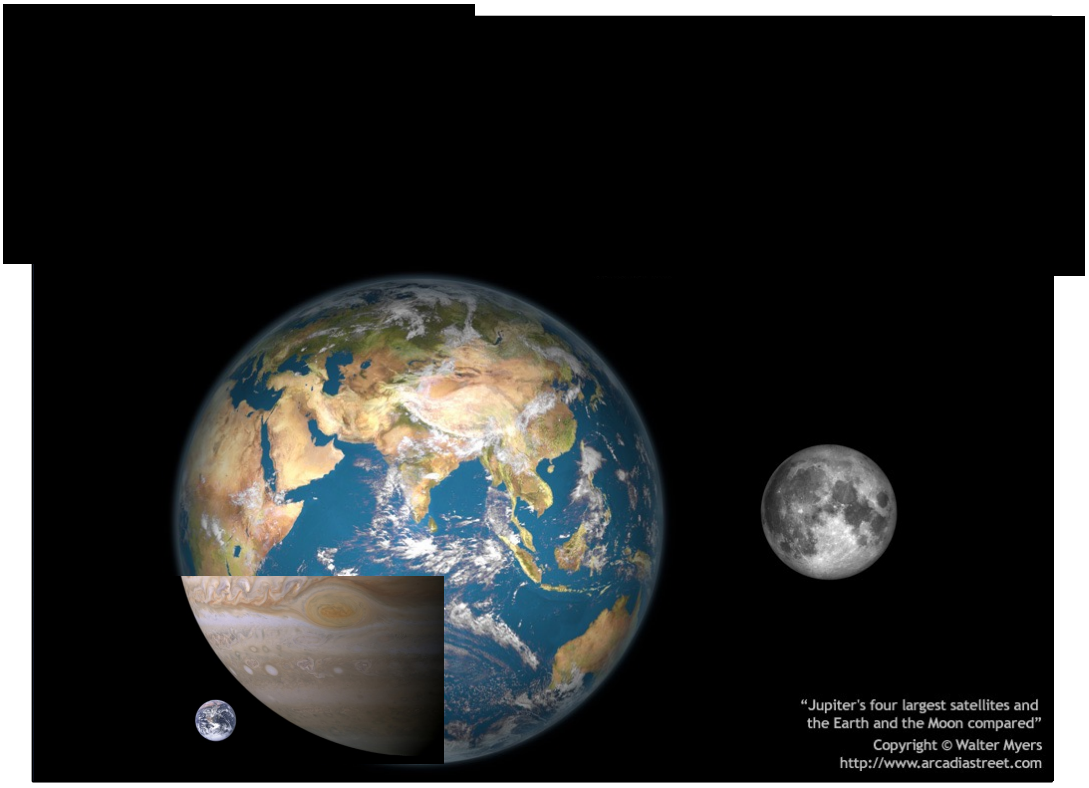
nasa.gov, www.youtube.com/watch?v=41IBC95HHgM

And how we got there.



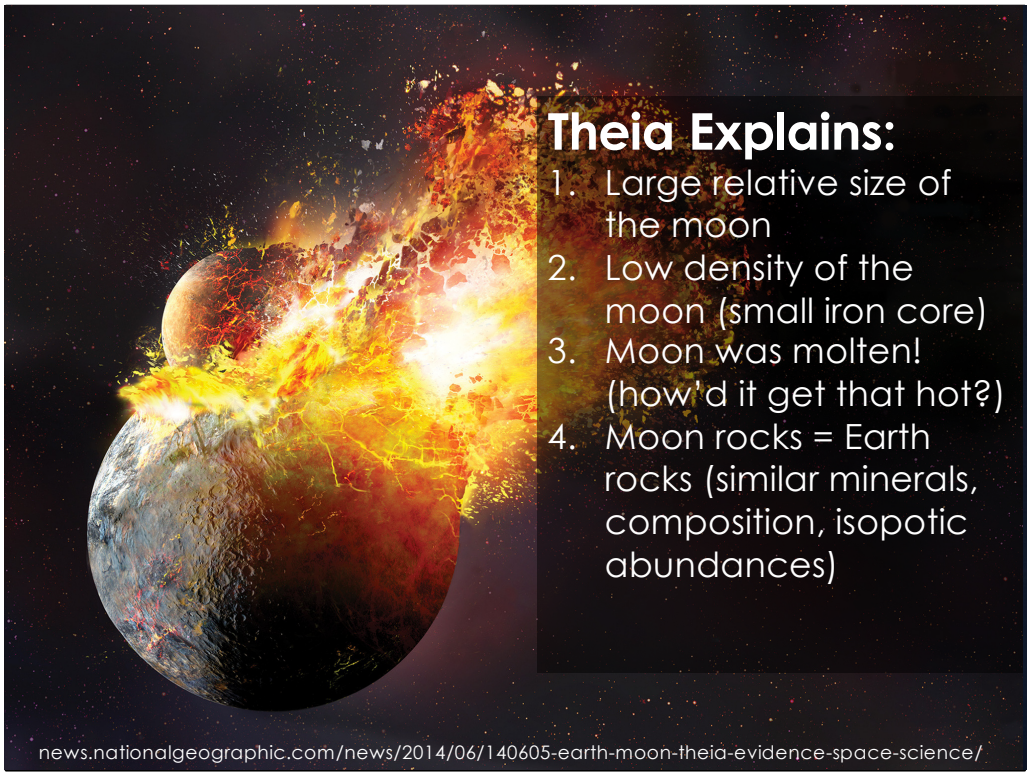
Briefly showing what a difference in gravity means. These suits are 180-ish lbs on Earth (30 lbs on the moon) and Eugene Cernan is leaping like a rabbit tied to helium balloons.

And, having not spent a lot of time walking on the moon before, some folks had an easier time than others.



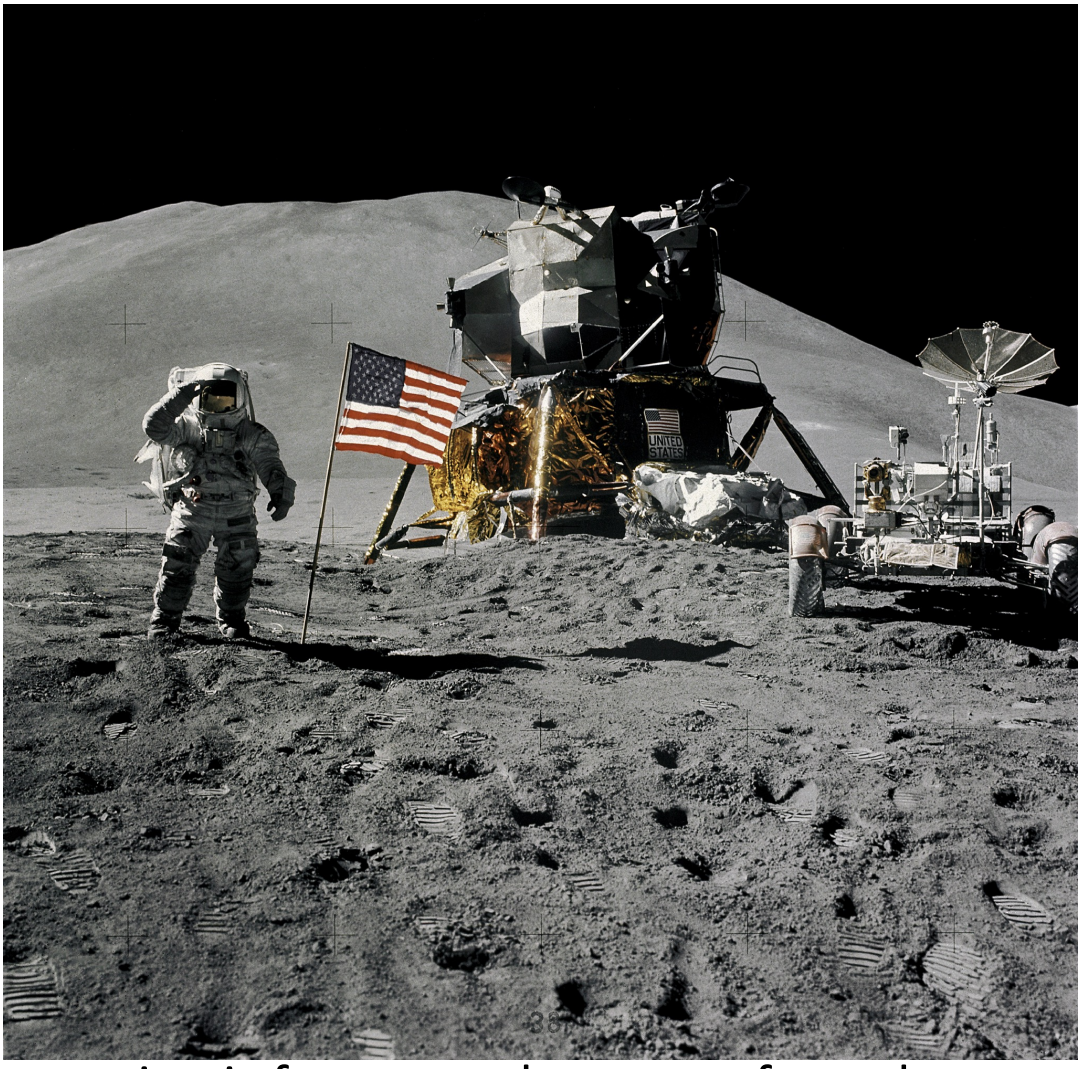
This is where the fun of our particular combination begins. The moon is a fair size of the Earth, even if it's a small fraction of the density. Compare our moon to the largest moons of Jupiter, then note that Jupiter is massive compared to the Earth. We believe the combination of small planet and large moon – as we are – is not a common thing, which means they must have had an interesting origin story.

Introducing Theia and the Giant Impact Hypothesis for the formation of the Earth-Moon system as we know it. This is more for the visual than anything else, but does hit (no pun intended) the point home.

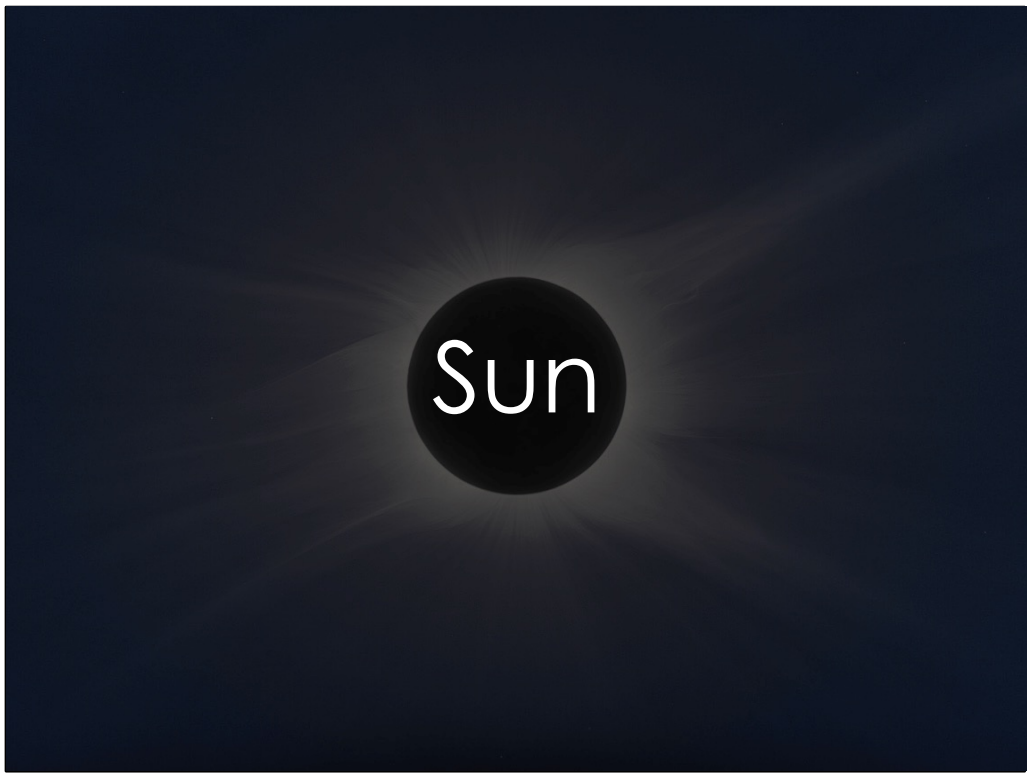


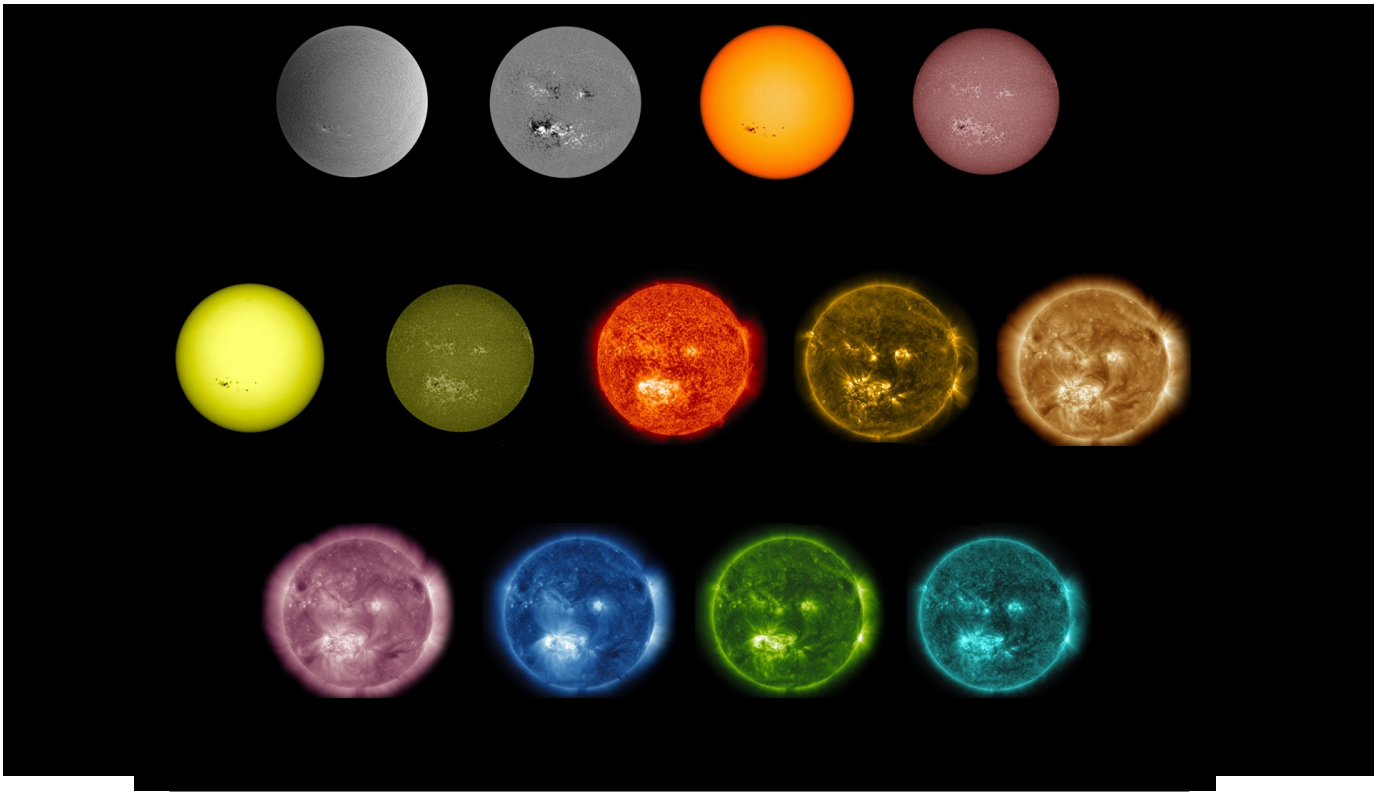
What would a Theia explain?

The smaller crowds had a piece of Mars rock for handling and a piece of Moon rock for just looking at – the moon rock is a tiny fraction the size of the Mars rock and still more expensive because of how difficult it is to differentiate moon rock from earth rock.



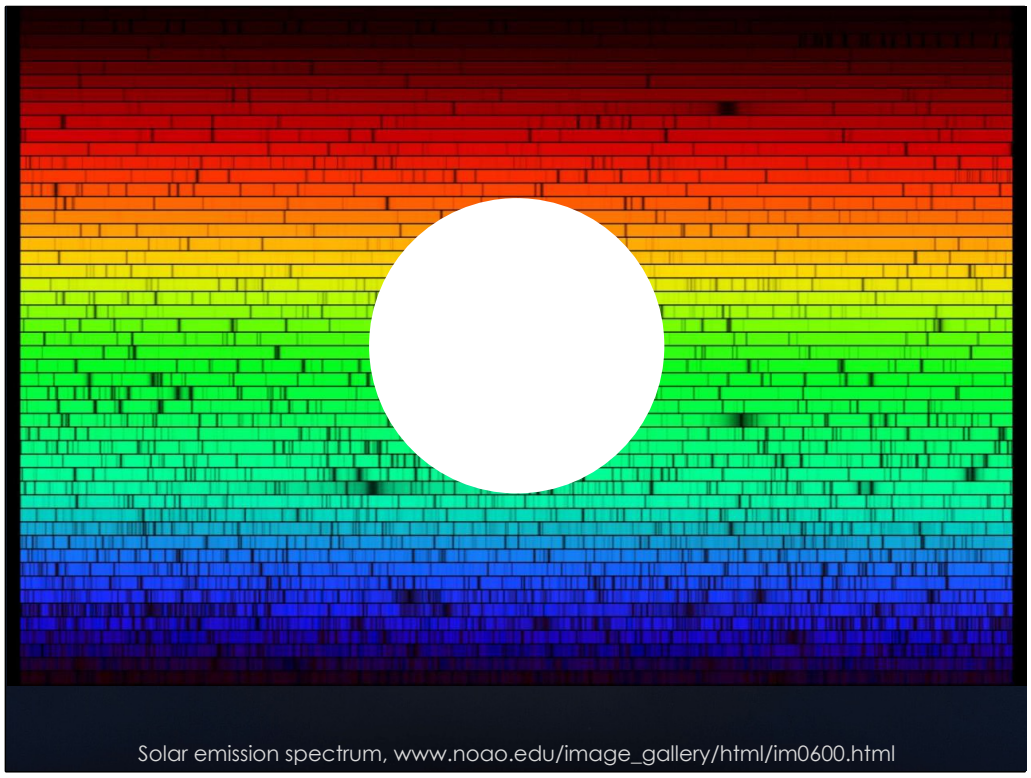
An information is from sample returns from the moon.


Sun



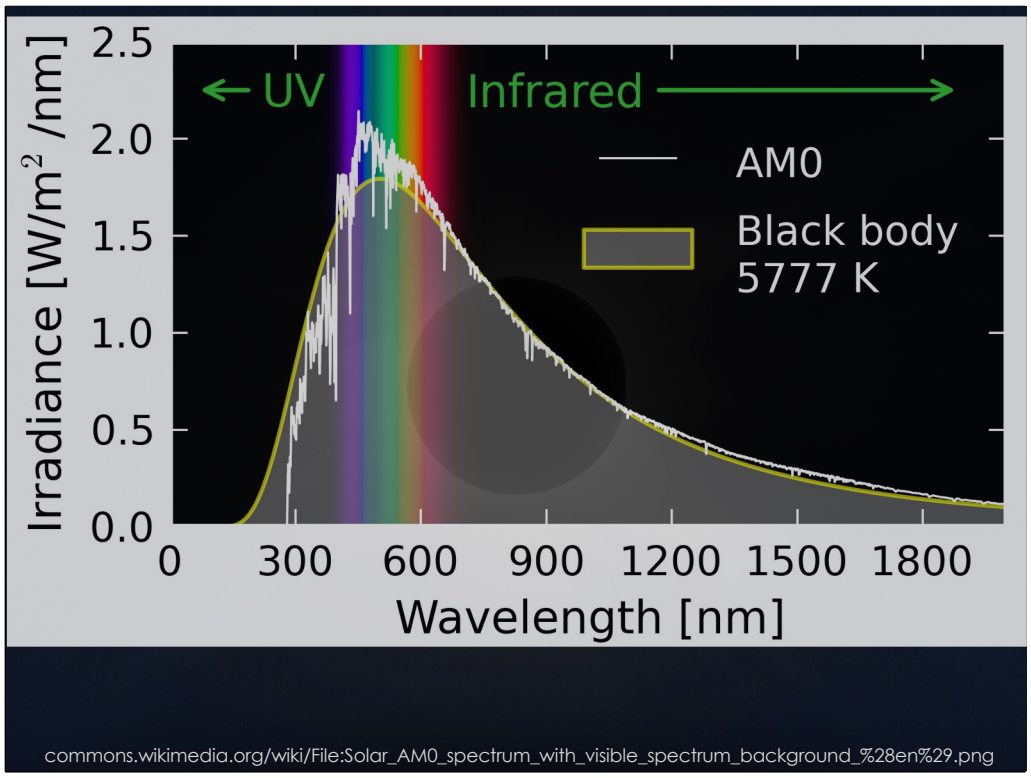
So, what color is the Sun?

Actually, it’s (nearly) ALL colors. The sun pumps out the whole rainbow.



Solar emission spectrum, www.noao.edu/image_gallery/html/im0600.html

The entire rainbow combines to produce white light!



If you were floating in space, this is the spectrum of the sun you'd be exposed to – and you'd note that the Sun is white.

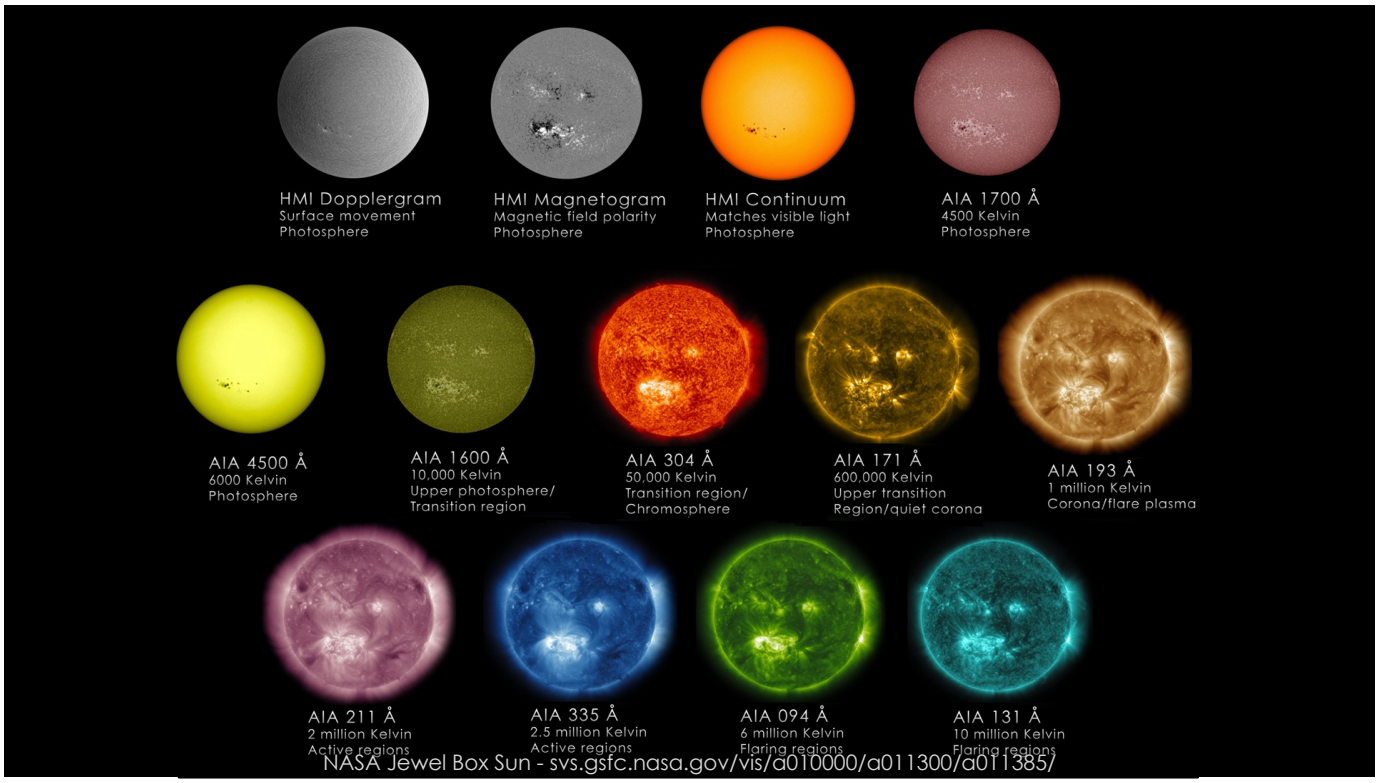
Why is visible light visible? Partly because the Sun pumps out the most light in the visible part of the spectrum.

To evolution – if we peaked in the UV or IR, how would that affect our vision? Our sensory systems?

You ll
amount of very specific wavelengths.

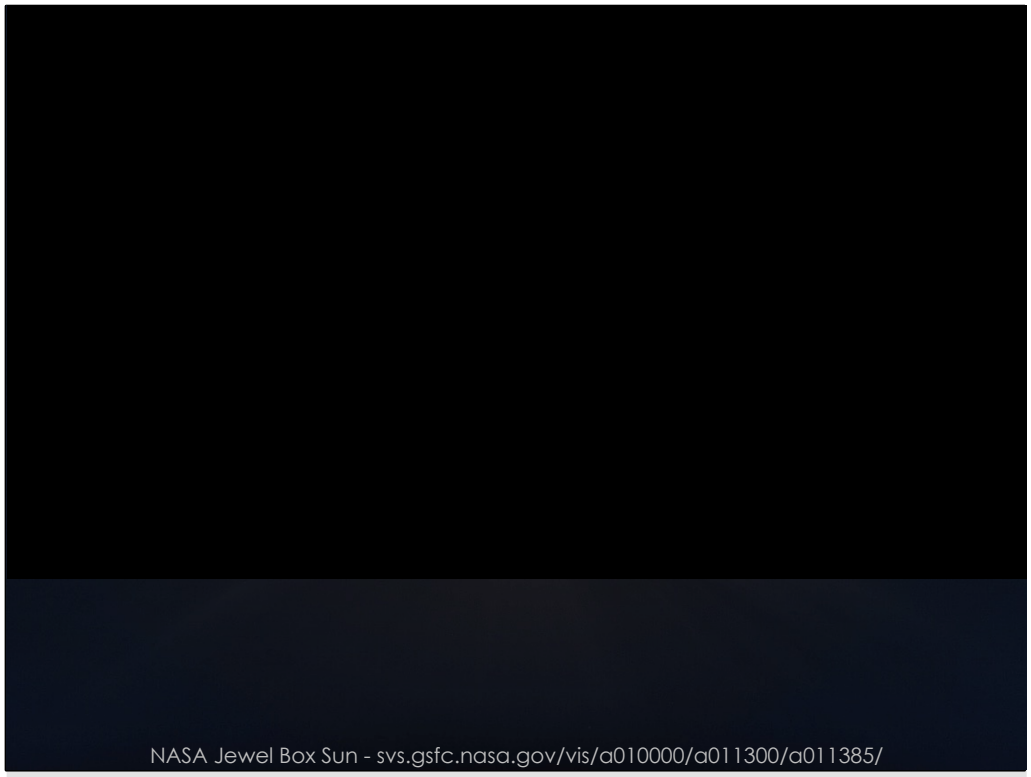
And you'll see this.

The Sun – just looking at Halpha light. Prominences, surface undulations, sunspots, all in a beautiful – and safe - view.

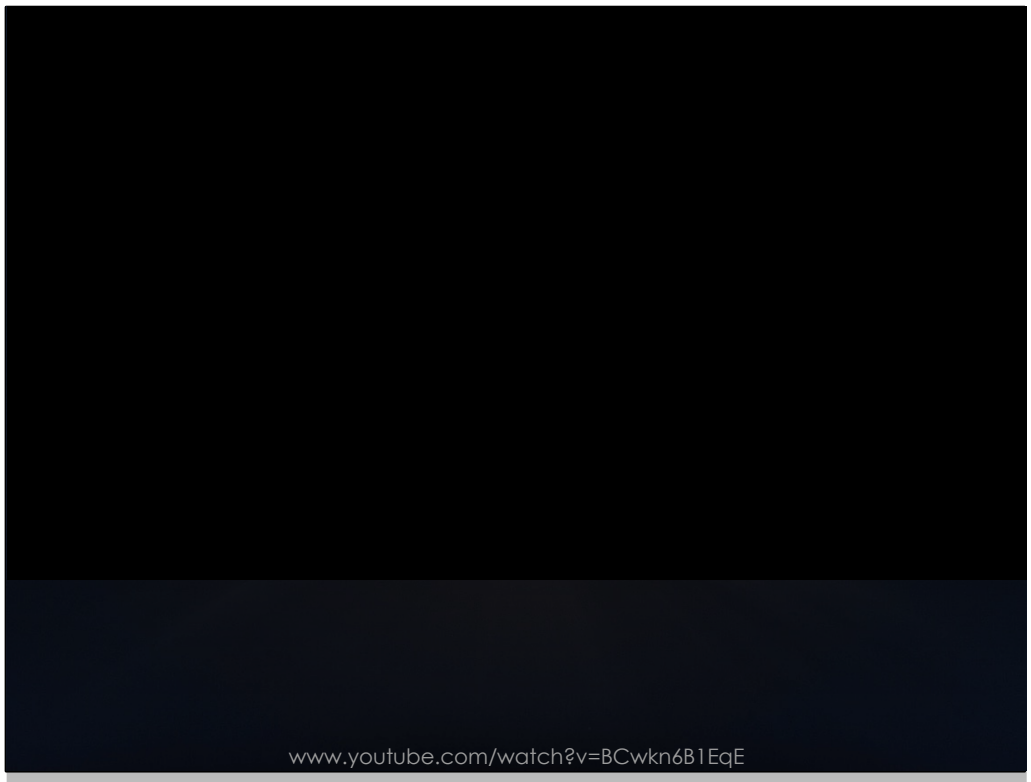


Now, we have telescopes in space that observe the sun at different wavelengths to study different features – and all of these (above) are observing only features and atoms on the sun's surface.

You can buy filters that do similar from reputable sources (Calcium filters produce the blue image at bottom, sodium filters produce the yellow image at middle).



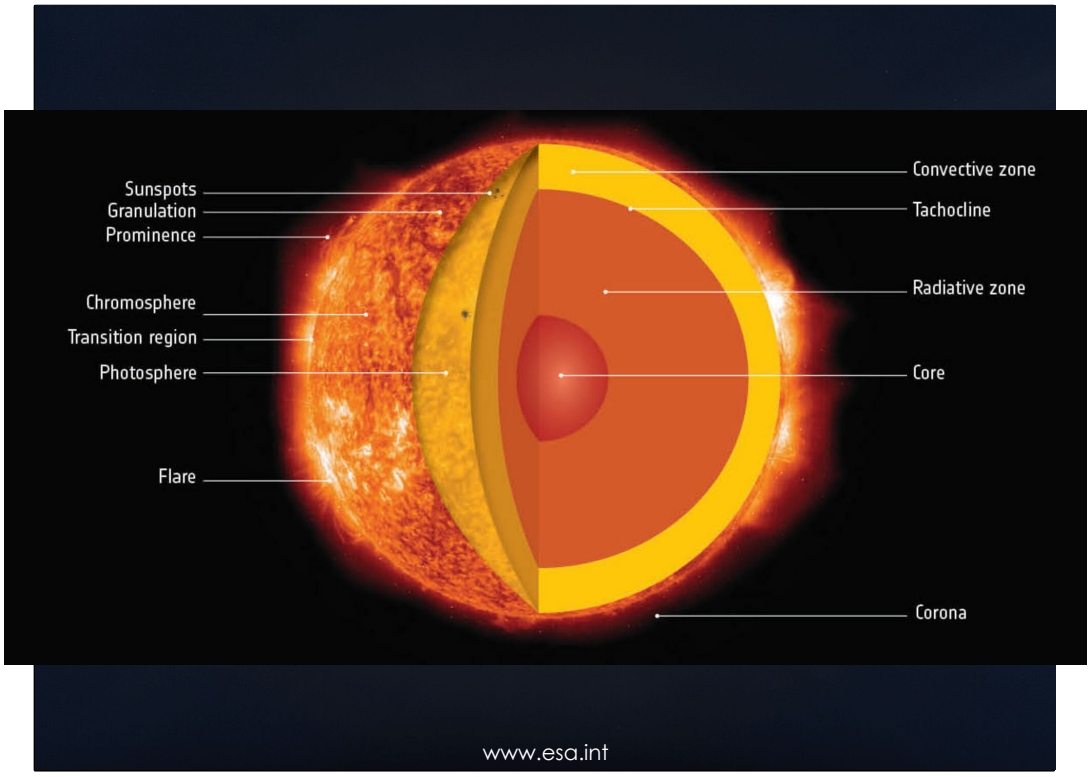
NASA Jewel Box Sun - svs.gsfc.nasa.gov/vis/a010000/a011300/a011385/



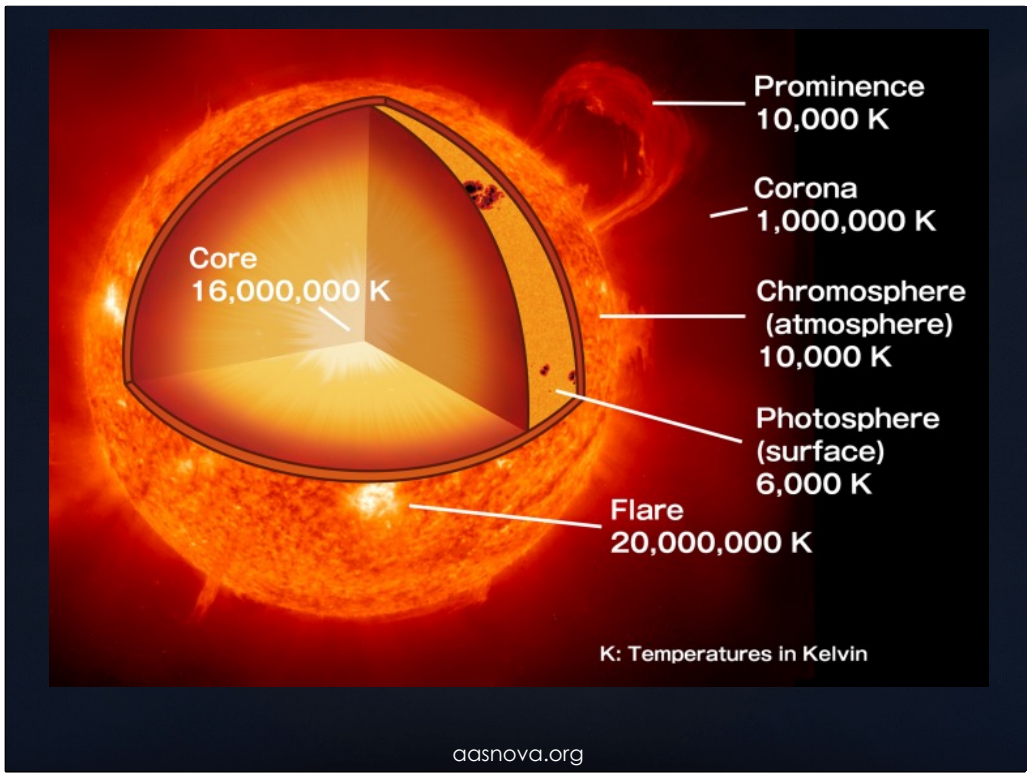
Fun diversion, see:
en.wikipedia.org/wiki/Solar_storm_of_1859

Bright And Beautiful, But Not Sunlight

www.youtube.com/watch?v=88uS_plon_s



It is amazing how much we still do not know about the Sun, but we have good handles on major features and the physics therein.

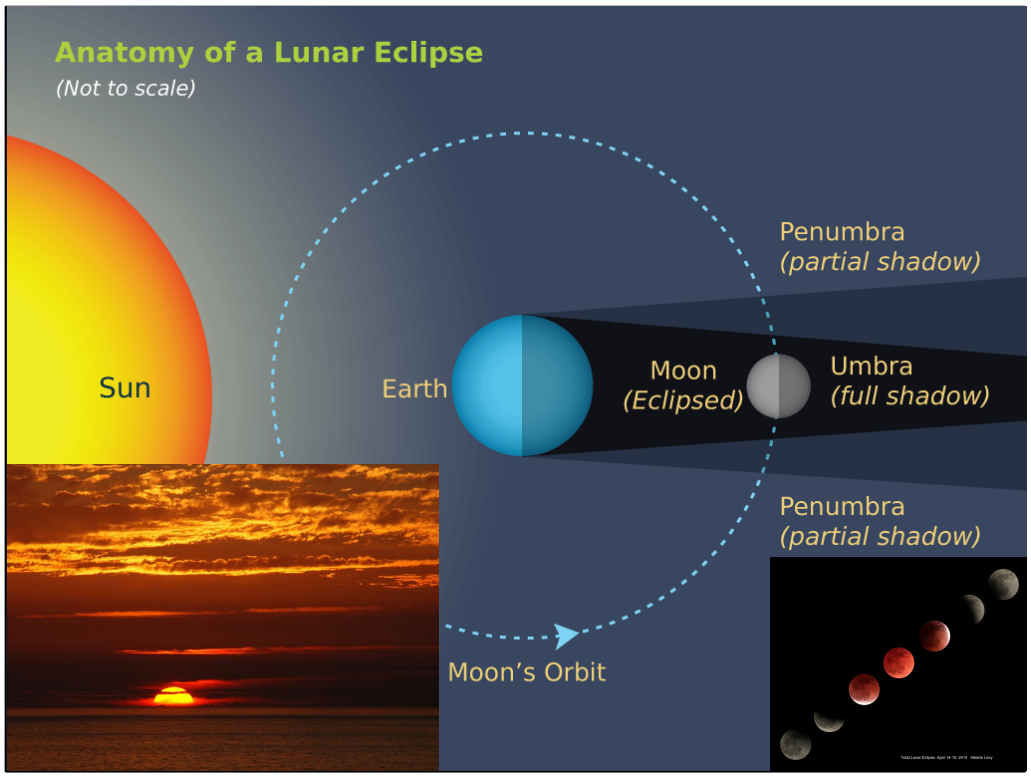


These temperatures are so crazy that they don't even register to us.

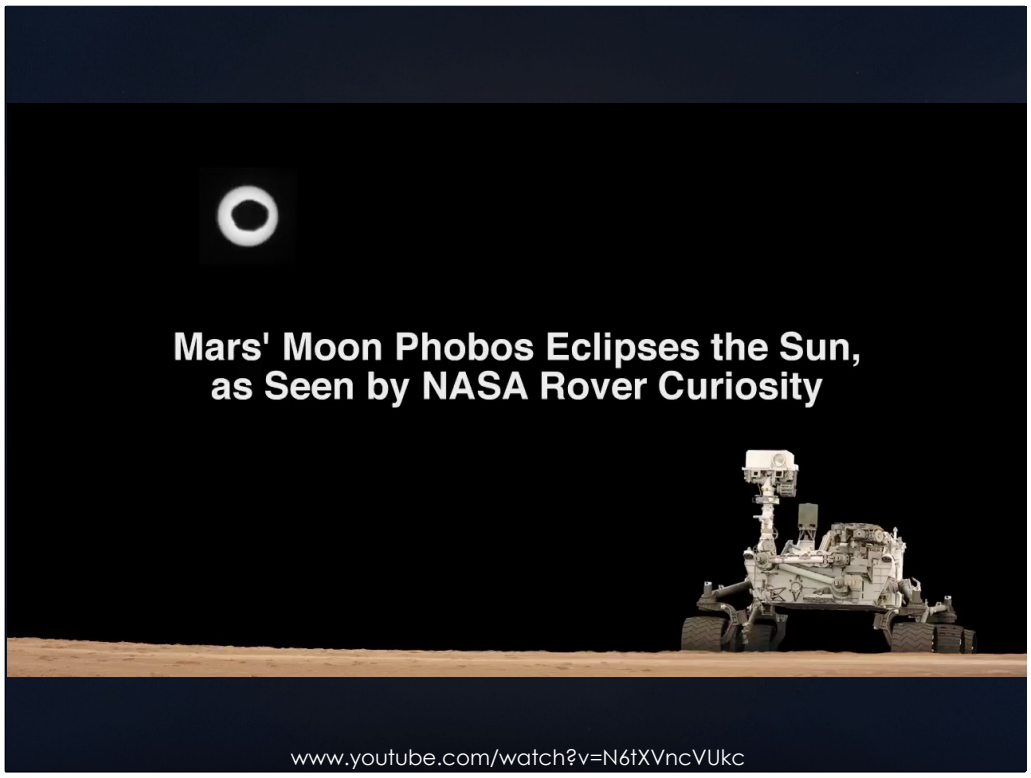
A small number of slides just to focus on lunar eclipses, which happen more often and deserve their own lecture.

Total Lunar Eclipse
Monday, September 28
8:11 p.m. to 1:22 a.m.

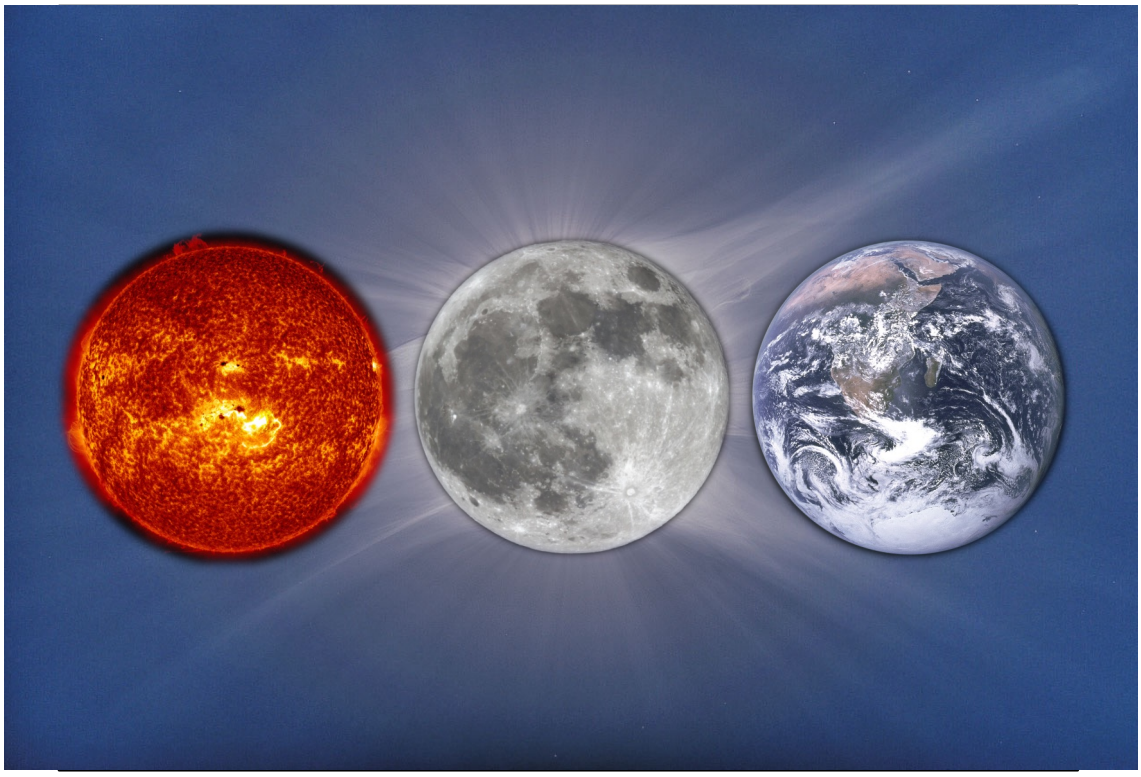
Total Lunar Eclipse. April 14-15, 2014 Alberto Levy


Anatomy of a Lunar Eclipse
(Not to scale)
Penumbra
(partial shadow)
Sun
Earth
Moon
(Eclipsed)
Umbra
(full shadow)
Penumbra
(partial shadow)
Moon's Orbit

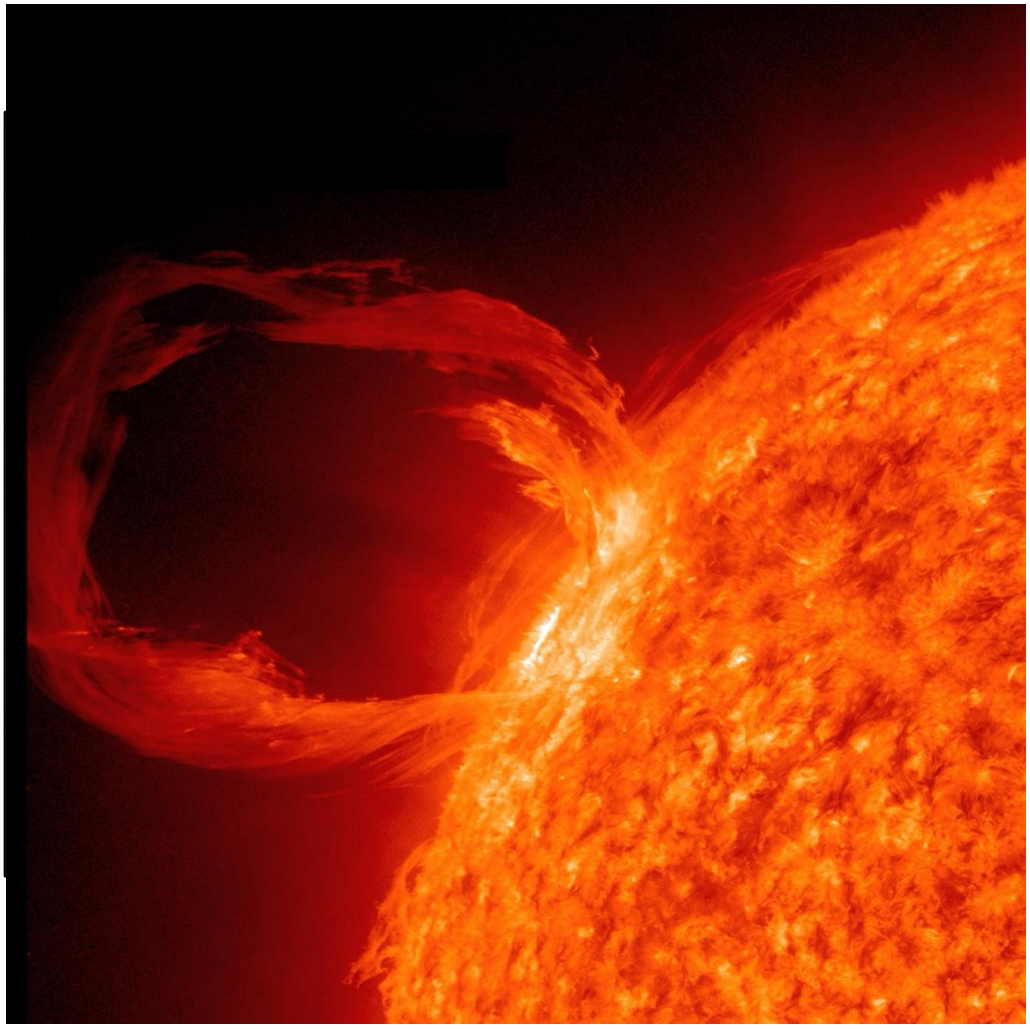

Eclipses – What, When, Why?

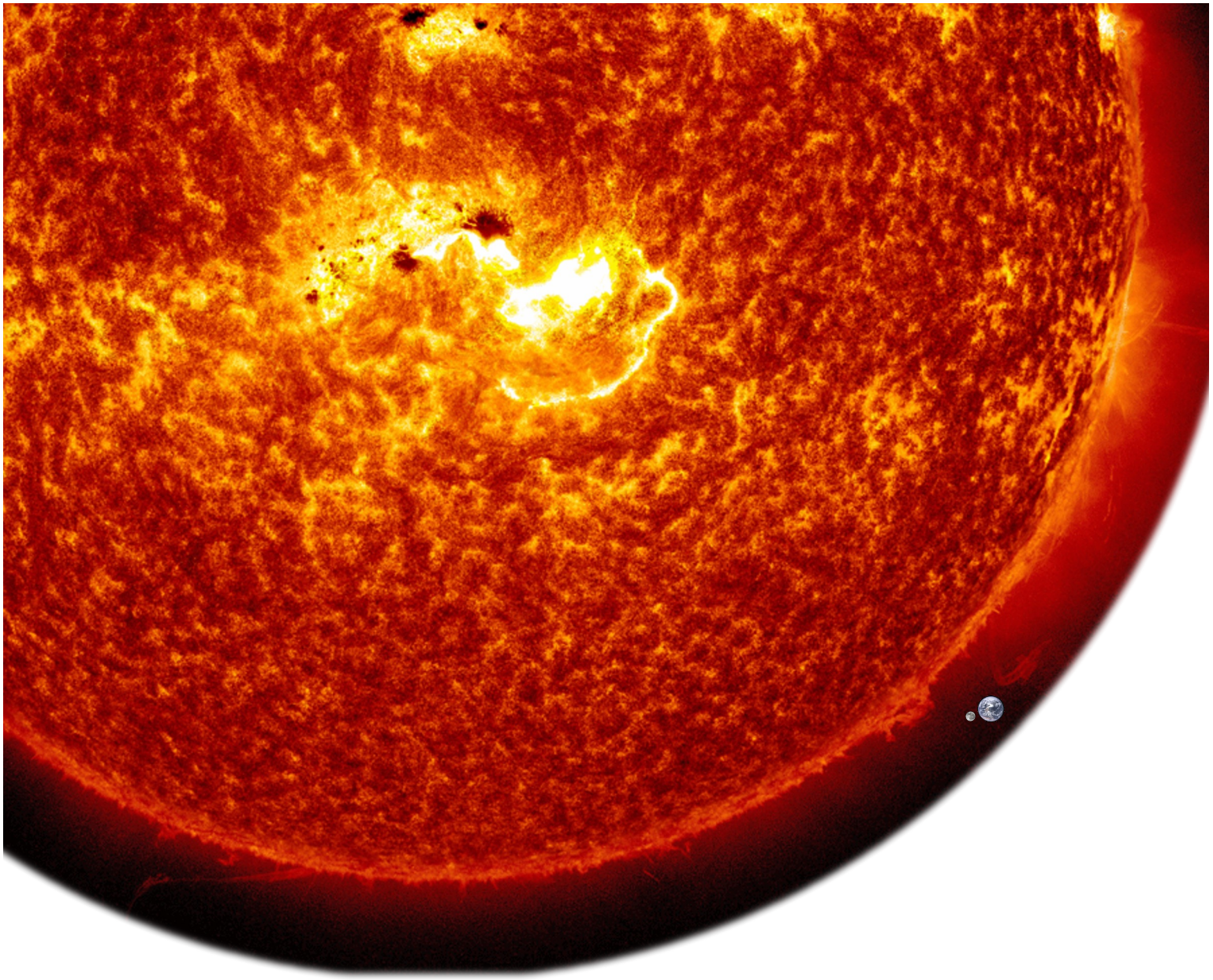


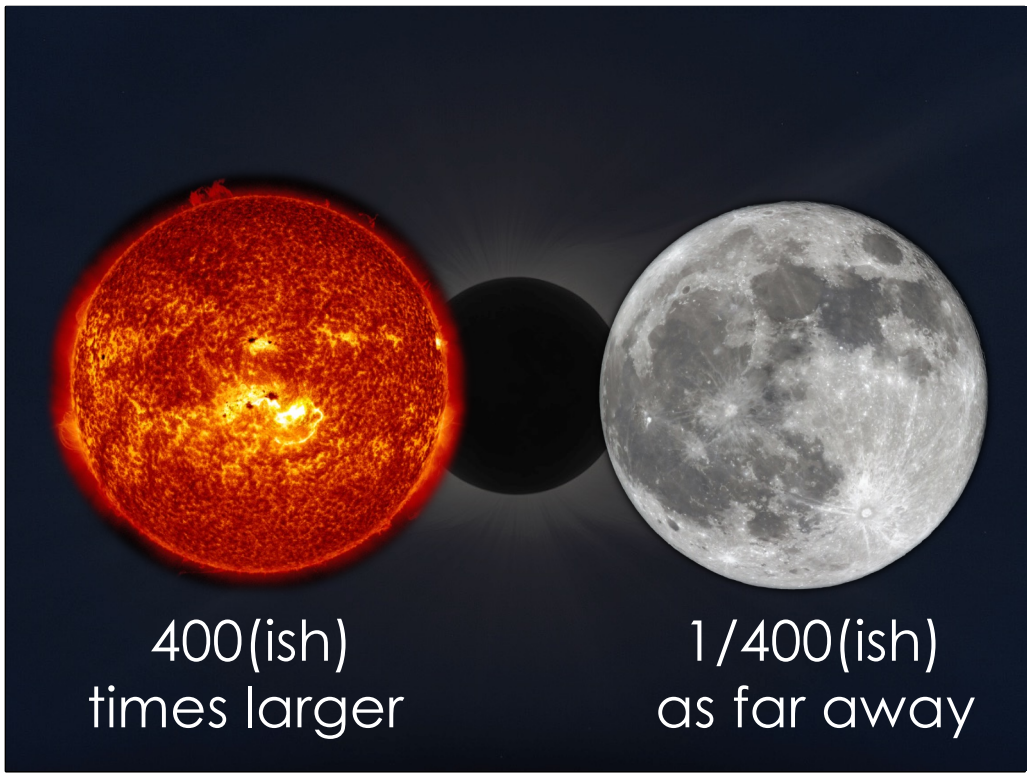
Phobos and Curiosity – it's an eclipse.



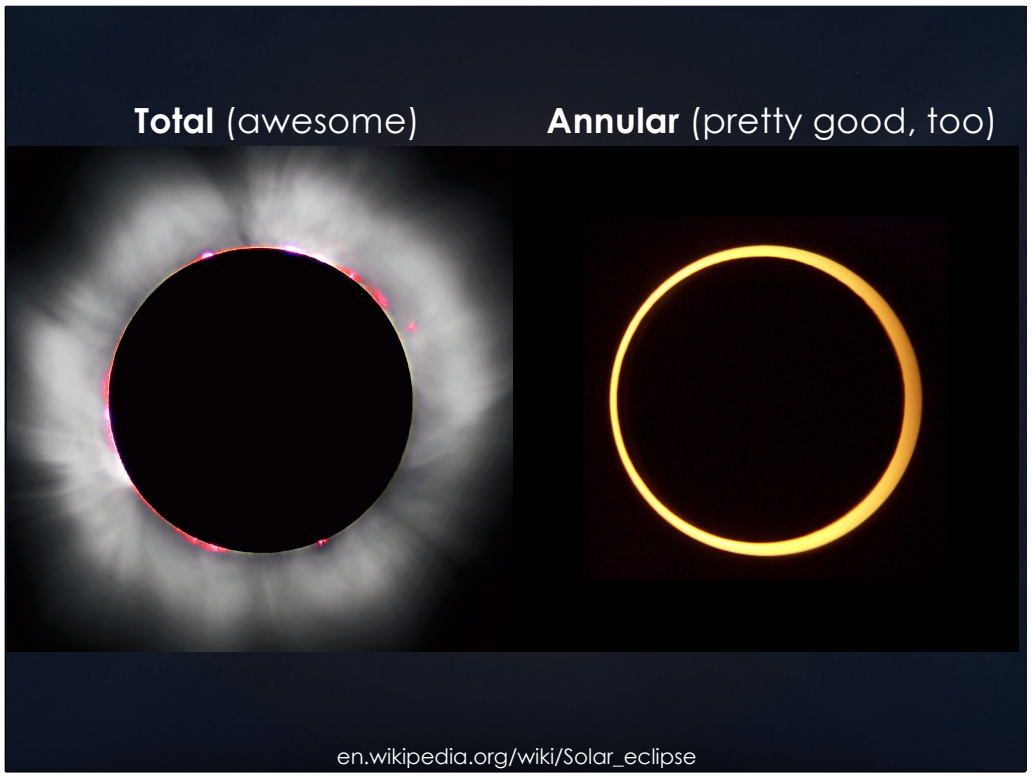
Cast of characters – not to scale.

So, 

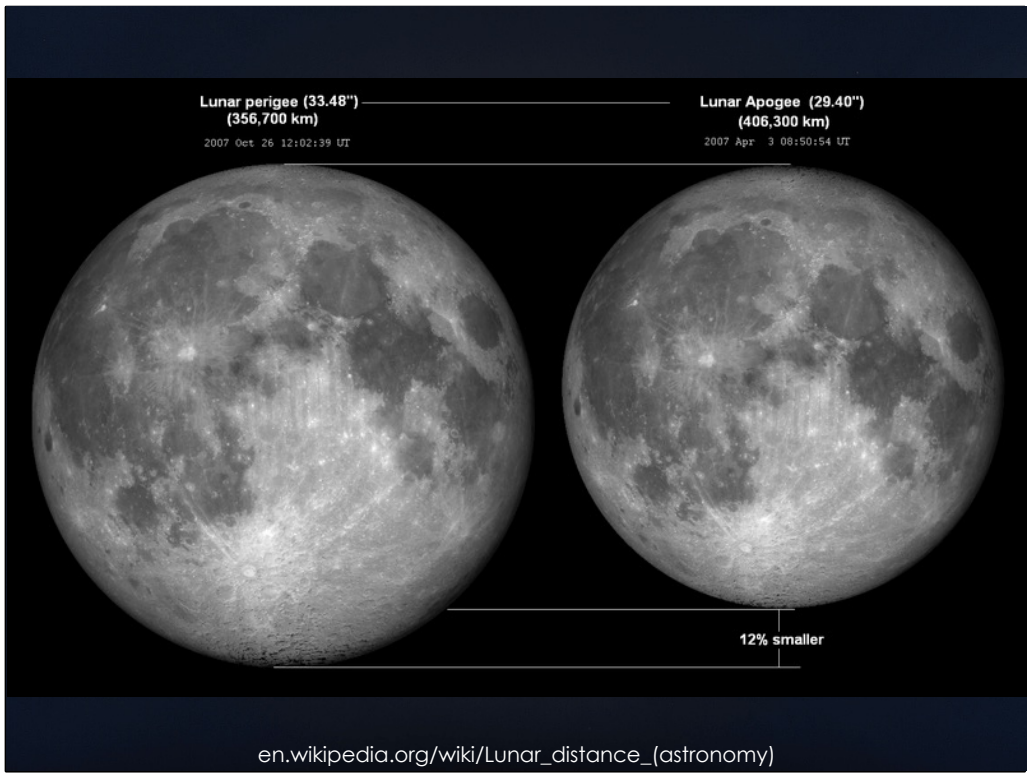




A remarkable situation!

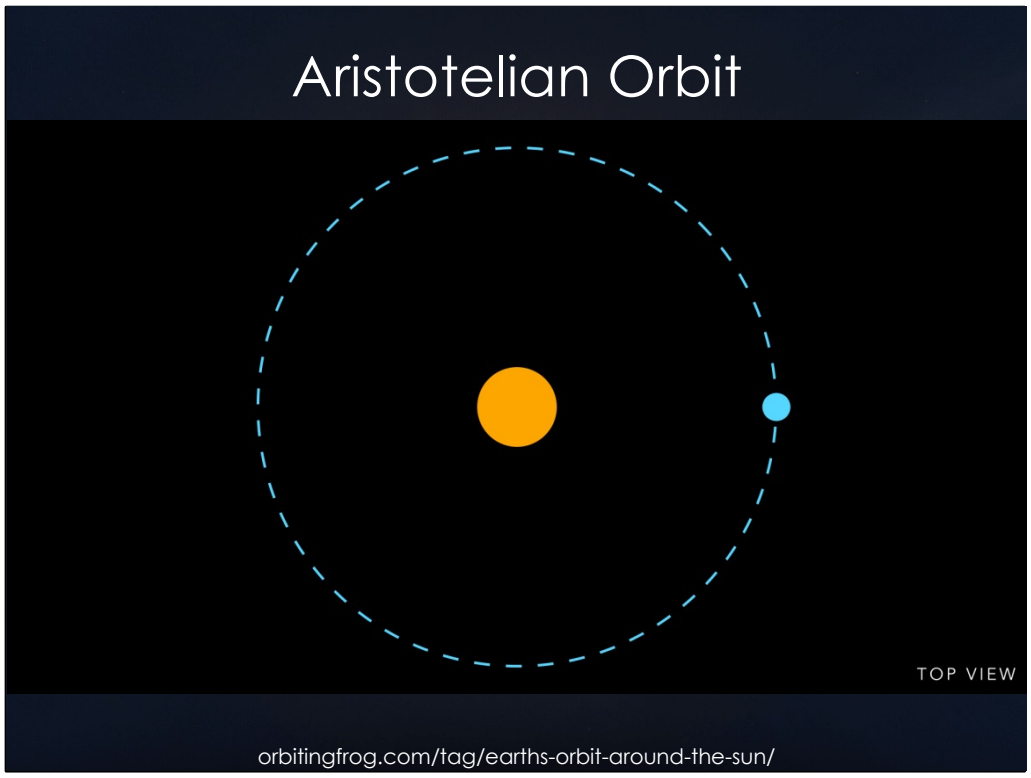


We have a range of eclipse types. Why is that?



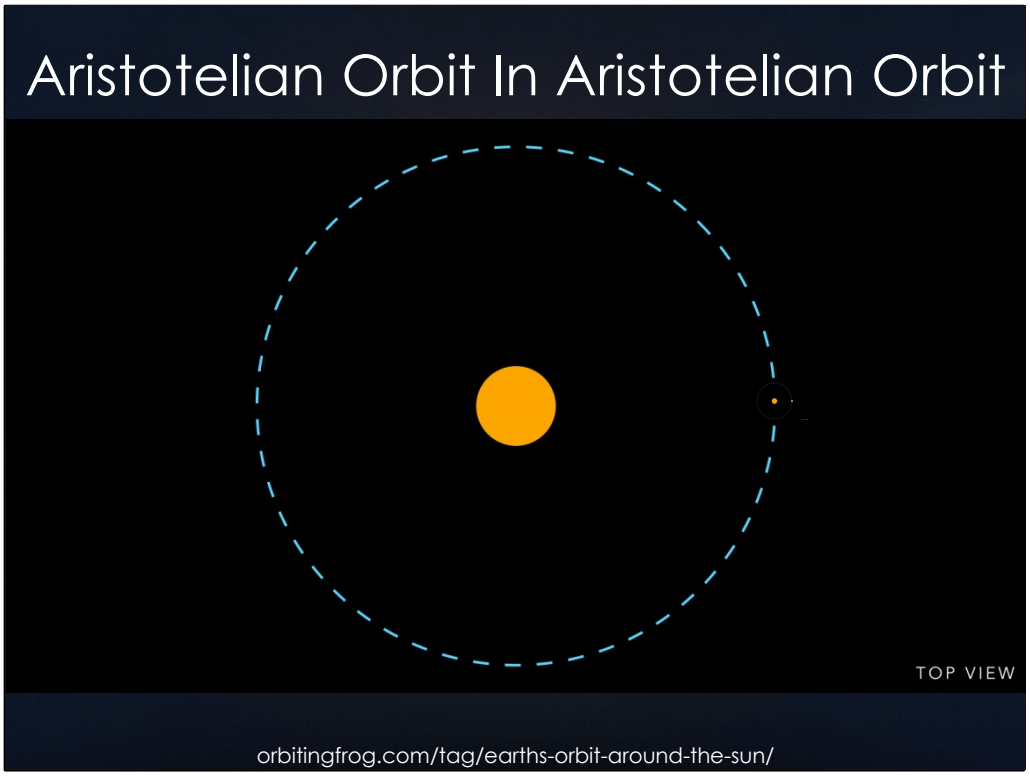
Elliptical orbits explain why the moon looks bigger and smaller as it goes through its path around the Earth. It also means we now have to listen to “supermoon” on a year basis.

Aspects of the physics that defined the universe for these two provide some details.

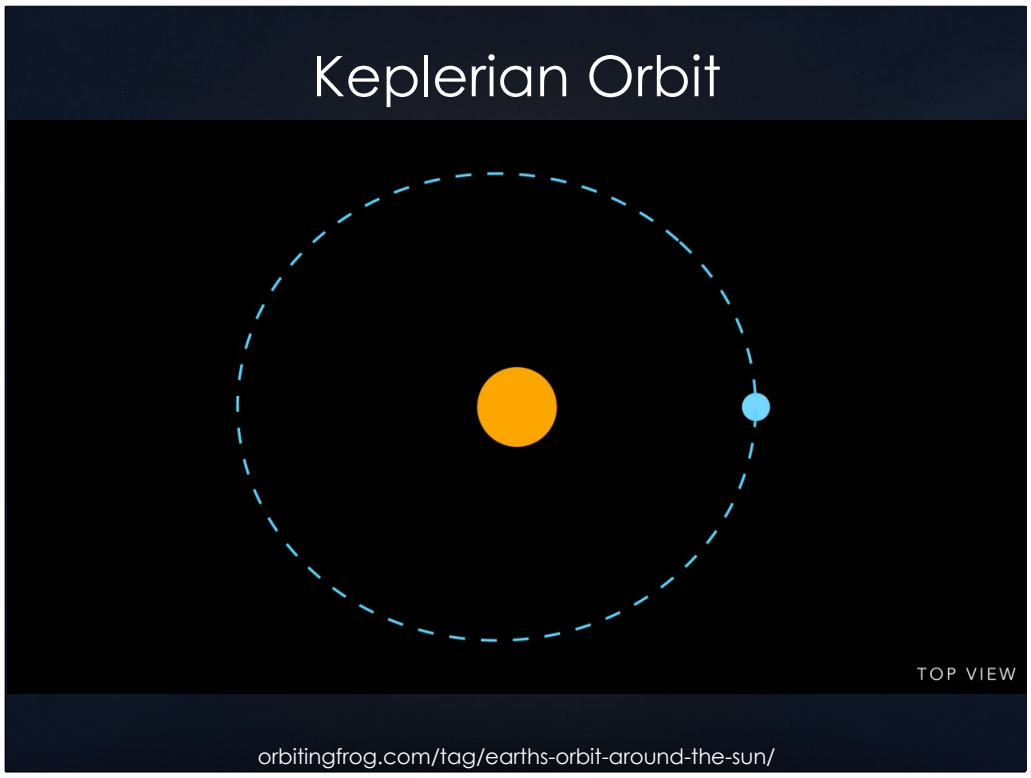


Perfect circular orbit! If it all worked perfectly, we'd have eclipses every new moon.

Aristotelian Orbit In Aristotelian Orbit

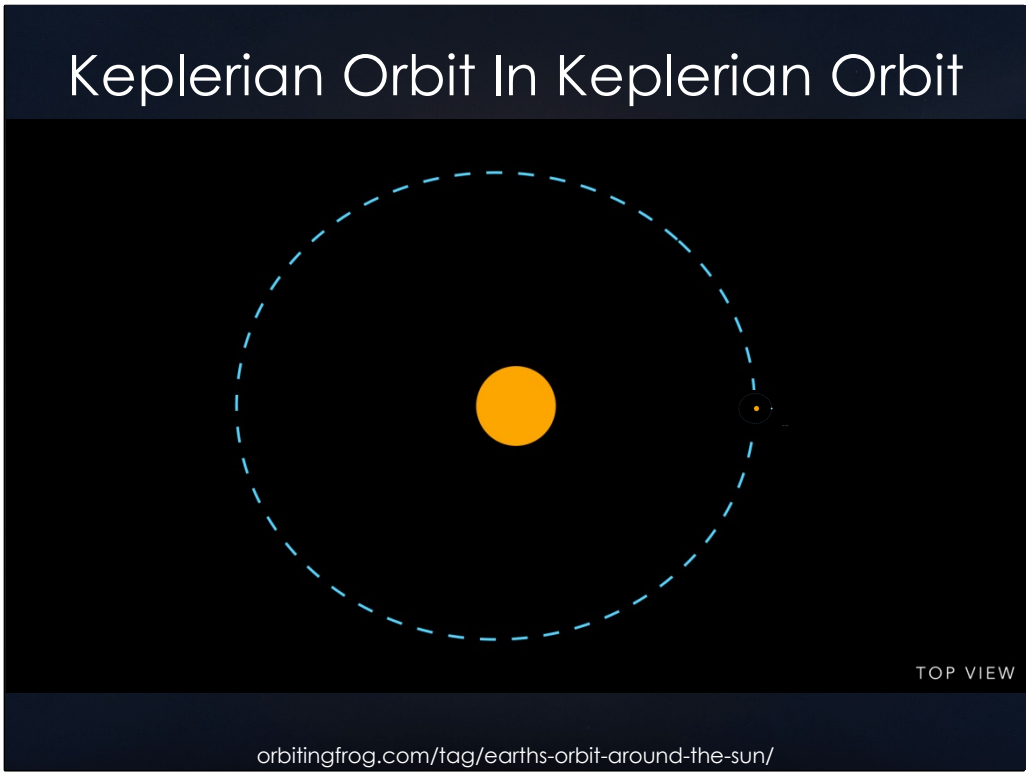


orbitingfrog.com/tag/earths-orbit-around-the-sun/

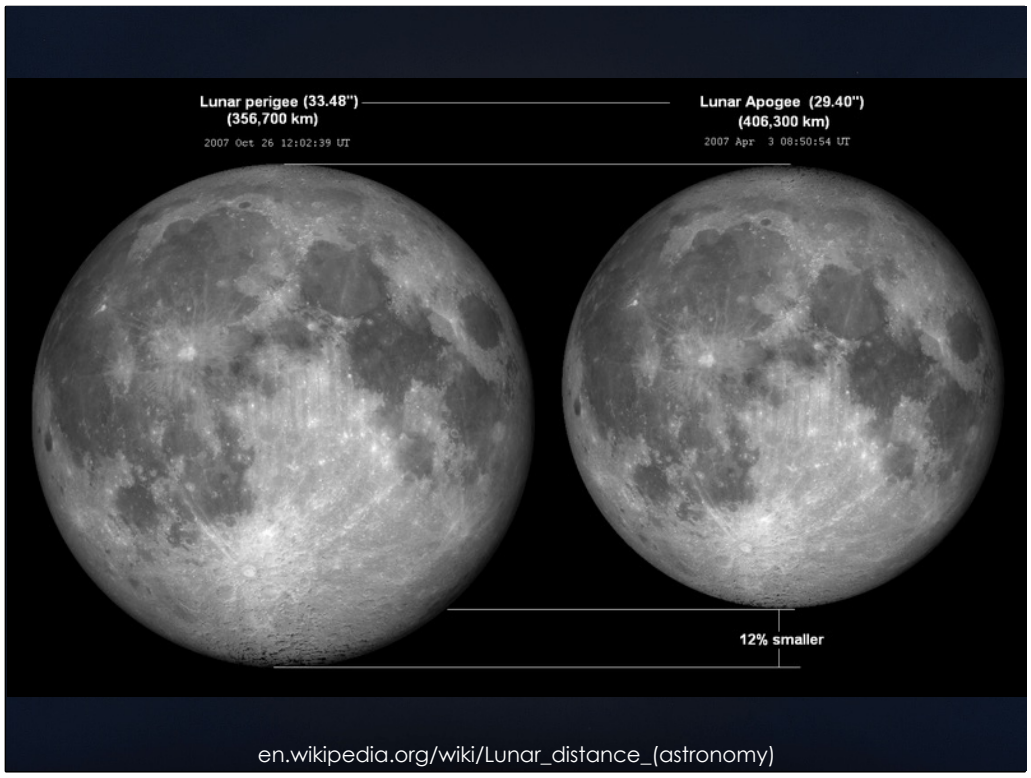


But we do not live with circular orbits, nor the epicycles needed to explain the non-circular nature of those things we observe.

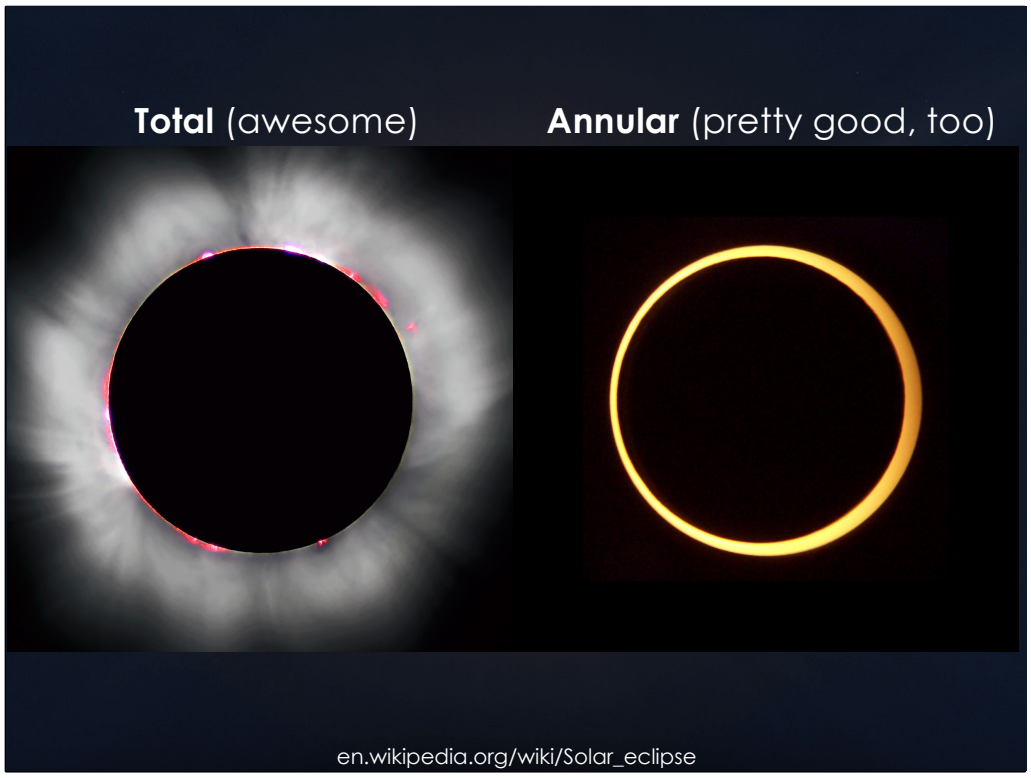
Keplerian Orbit In Keplerian Orbit



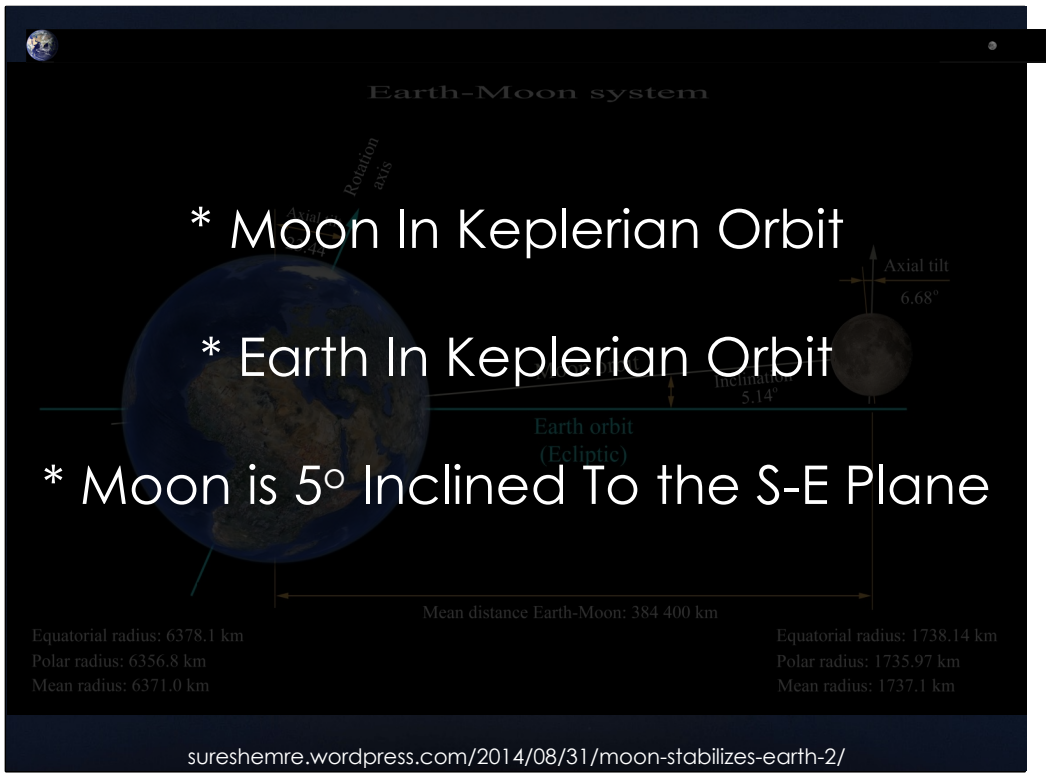
orbitingfrog.com/tag/earths-orbit-around-the-sun/



Elliptical orbits explain why the moon looks bigger and smaller as it goes through its path around the Earth. It also means we now have to listen to "supermoon" on a year basis.



And it's why we get full coverage (total) in some eclipses and annular (ring) eclipses in others.



* Moon In Keplerian Orbit

* Earth In Keplerian Orbit

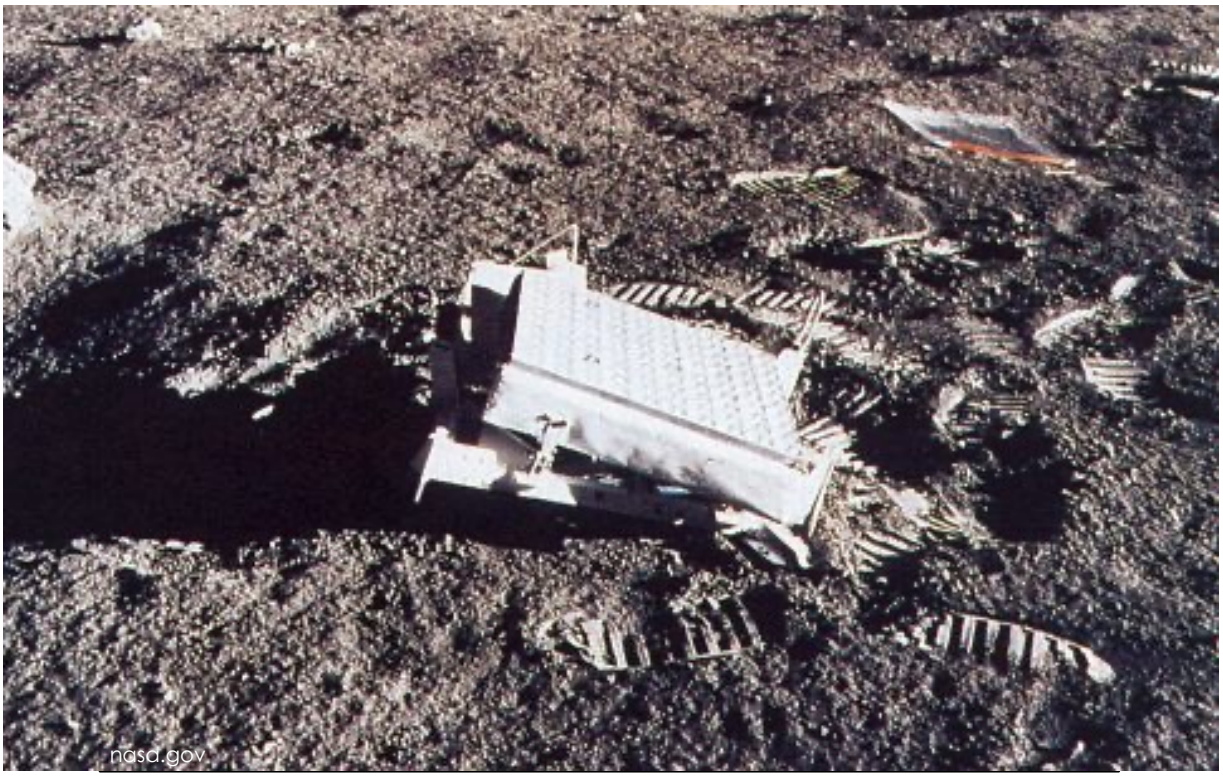
* Moon is 5° Inclined To the S-E Plane

And one more complicating slide to explain why we don't get eclipses as often as we'd like.

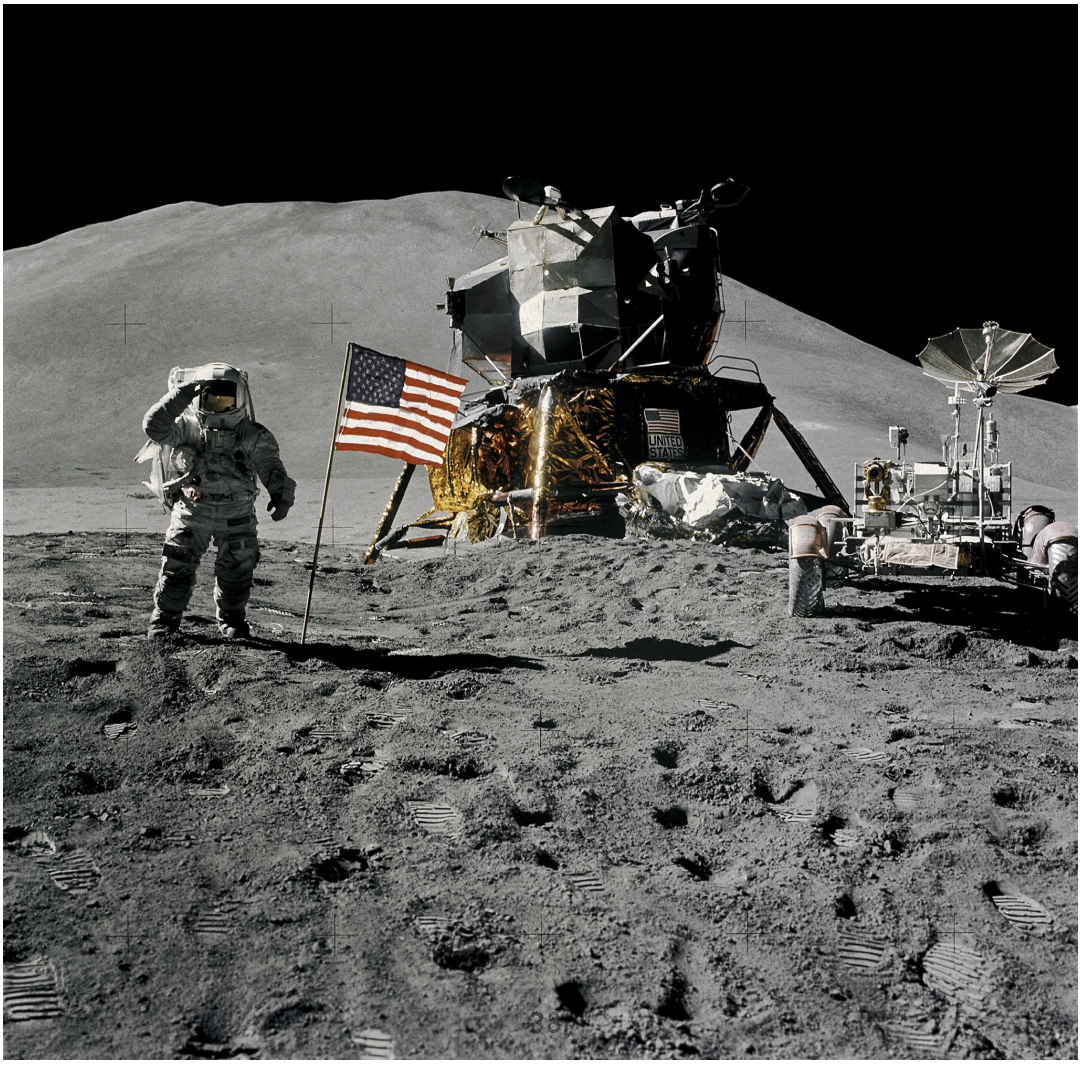
We will continue to have great American eclipses long after plate tectonics undoes our concepts of North and South America. A nice article at https://skyandtelescope.org/astronomy-resources/astronomy-questions-answers/when-will-the-last-total-solar-eclipse-occur/ says that, in the 620 to 1.2 billion year range, we'll no longer enjoy totality from the ground because the moon is drifting away. Of course, if we haven't figured out the science and engineering to simply move the moon back into place by that time, we deserve to not see totality anymore (my humble opinion).

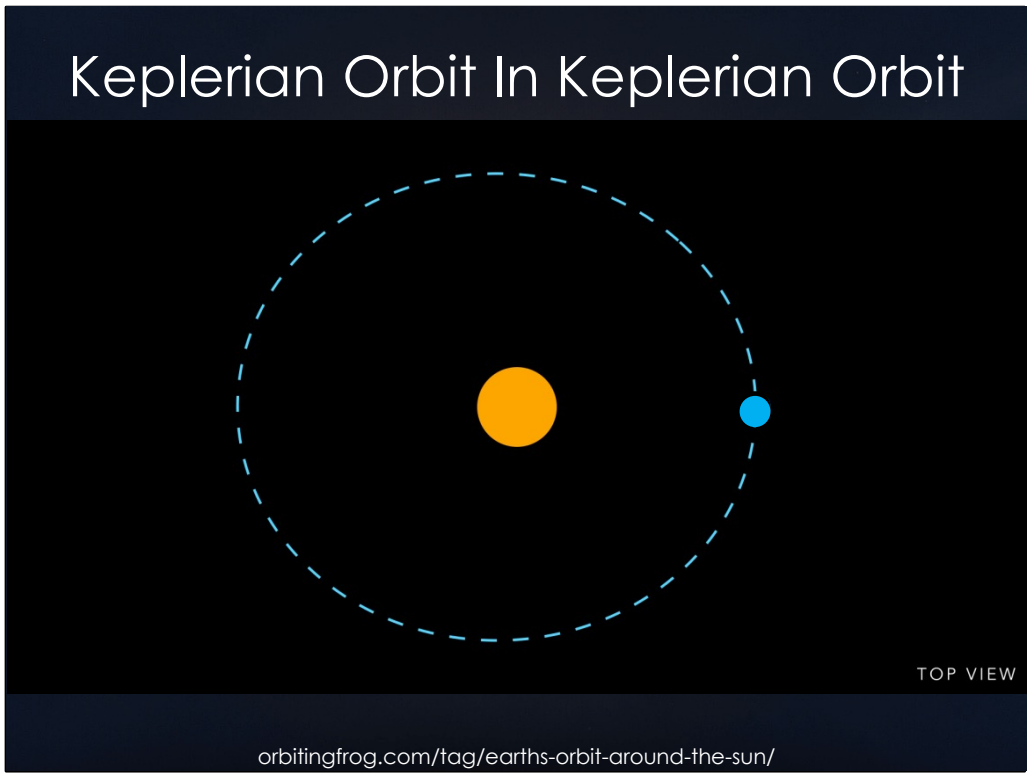
I didn’t want to do this during the lecture because my insurance wouldn’t cover it.

Leave it to the professionals. Note that arms out = slower spinning and arms in = ripping speeds.



As it happens, we know the moon is leaving us at a rate of about 2 cm/year. We know this because we put mirrors on the moon and shoot lasers at them, measuring the round-trip time. Yes, just that easy (mostly).

An 



Now, for those of you feeling bad karma and a concern with the state of the world right now, I will mention that we collectively hit the astronomical jackpot with this proposed original collision between the proto-Earth and Theia. The physics could have played the other way with a different grazing blow. Instead of losing total eclipses in 600 million years, we could all be ducking every 26 minutes.

And there are many places to track events in and around Rochester. Worse, if the clouds win, you can still watch totality from the comfort of your own smart phone (or get next to a real screen, please).


Thank You (and Questions)!
Solar Eclipse
Lunar Eclipse
Apocalypse