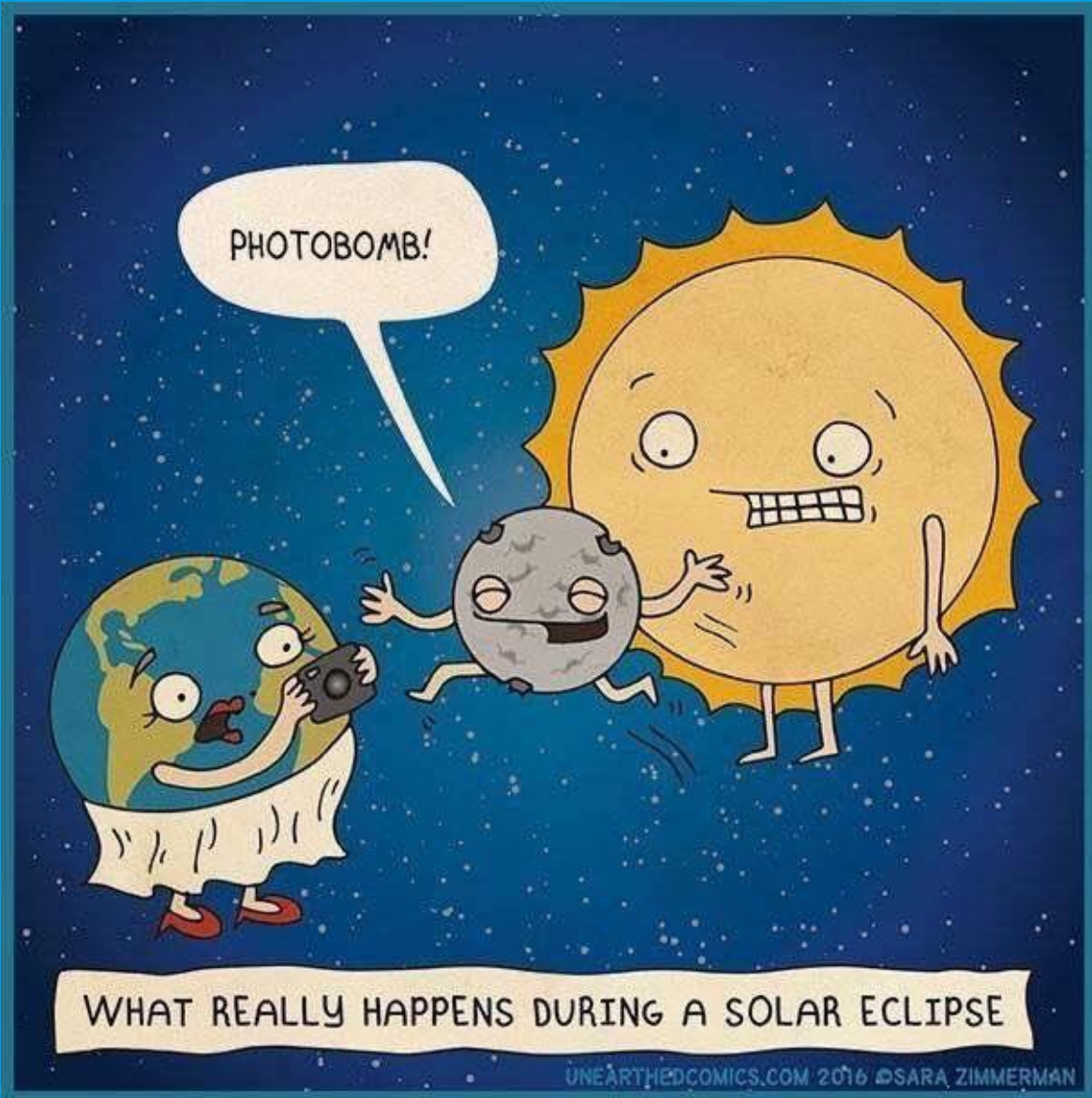
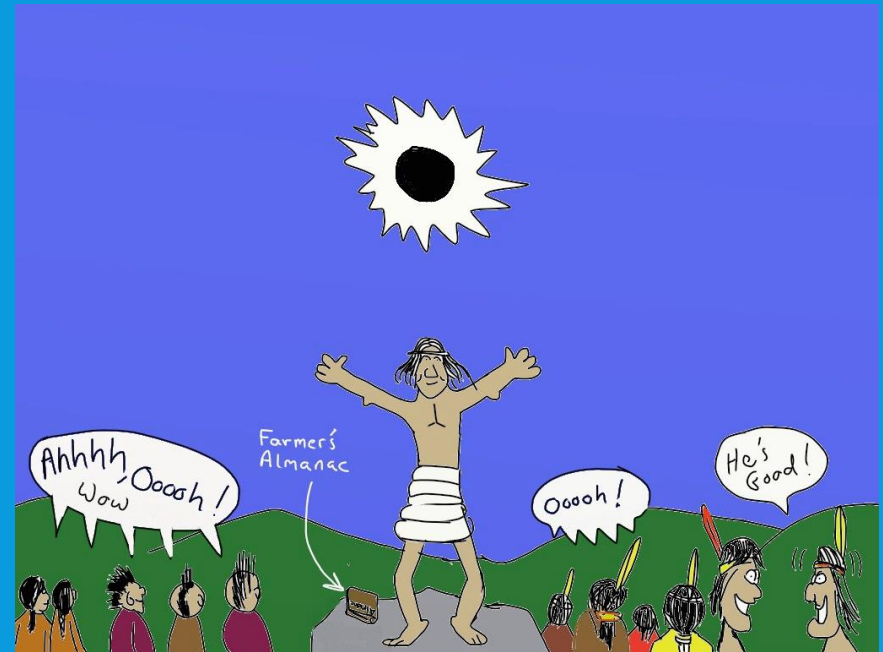


All About Eclipses

Sandi Brenner
Instructor of Astronomy
Bryant University
March 11, 2024



Why is the word "eclipse"?



Summary

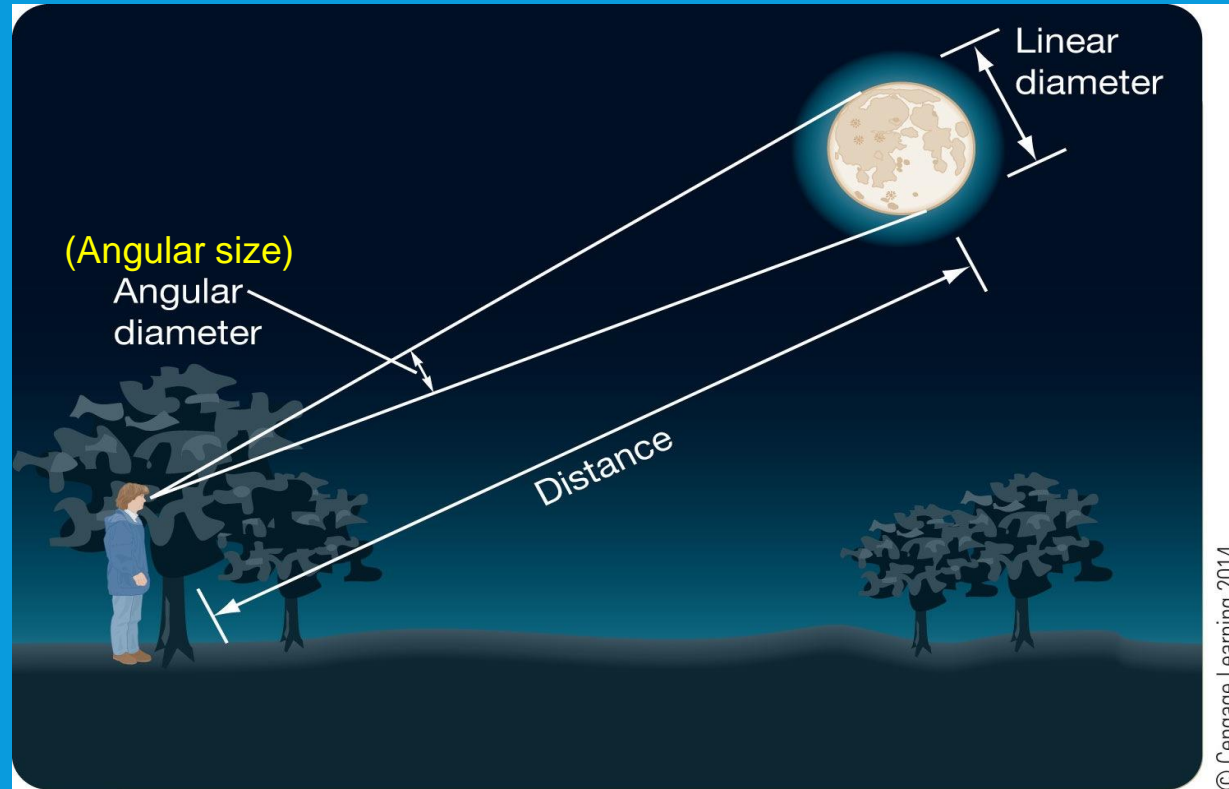
A borrowing from French.

Etymon: French *eclipse*.

< **Old French** *eclipse*, *esclipse*, < **Latin** *eclipsis*, **Greek** *ἡκλειψις*, noun of action < *ἐκλείπειν* to be eclipsed, literally to forsake its accustomed place, fail to appear.

From: Oxford English Dictionary

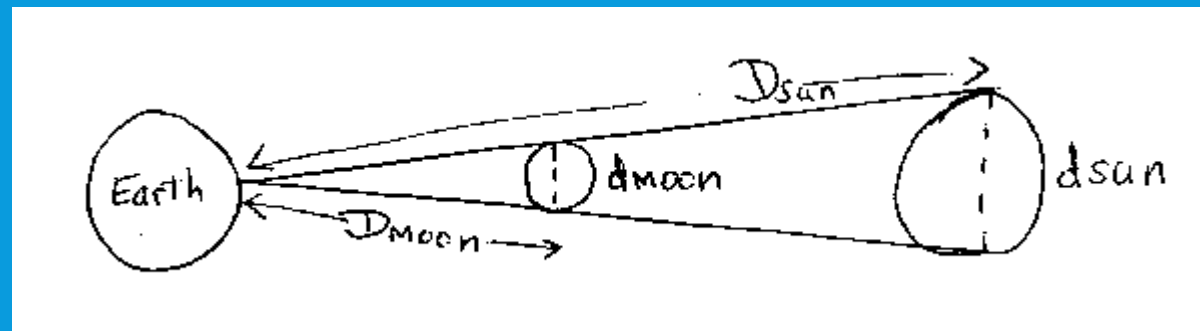
Why do we have eclipses?



The Sun is ~400 times larger than the Moon, but it's also ~400 times farther away

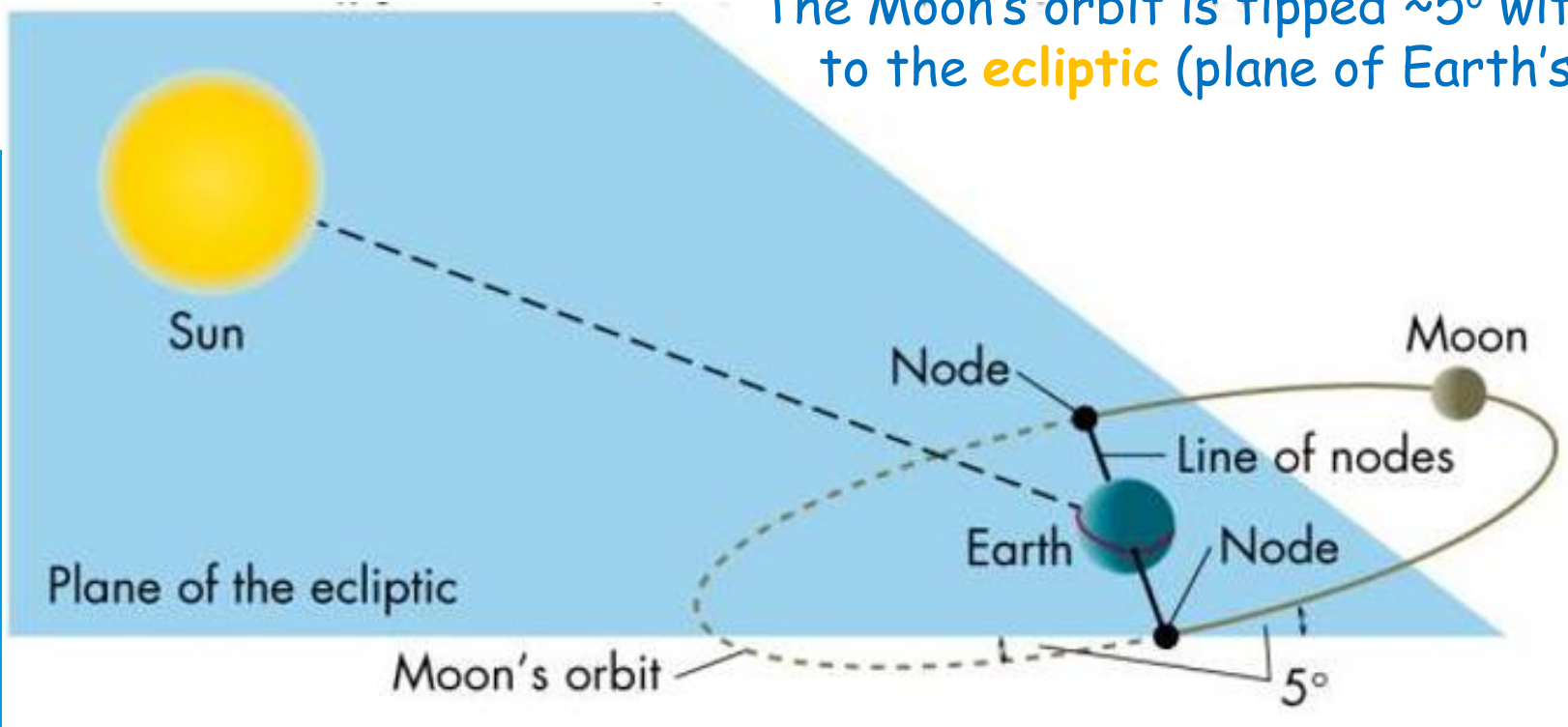
Both the Sun and the Moon have an angular size of $1/2^\circ$ so they appear as the same size in the sky

Angular size of an object depends on both the object's linear diameter (its actual size) and its distance



Why don't we experience two eclipses each month?

The Moon's orbit is tipped $\sim 5^\circ$ with respect to the **ecliptic** (plane of Earth's orbit.)



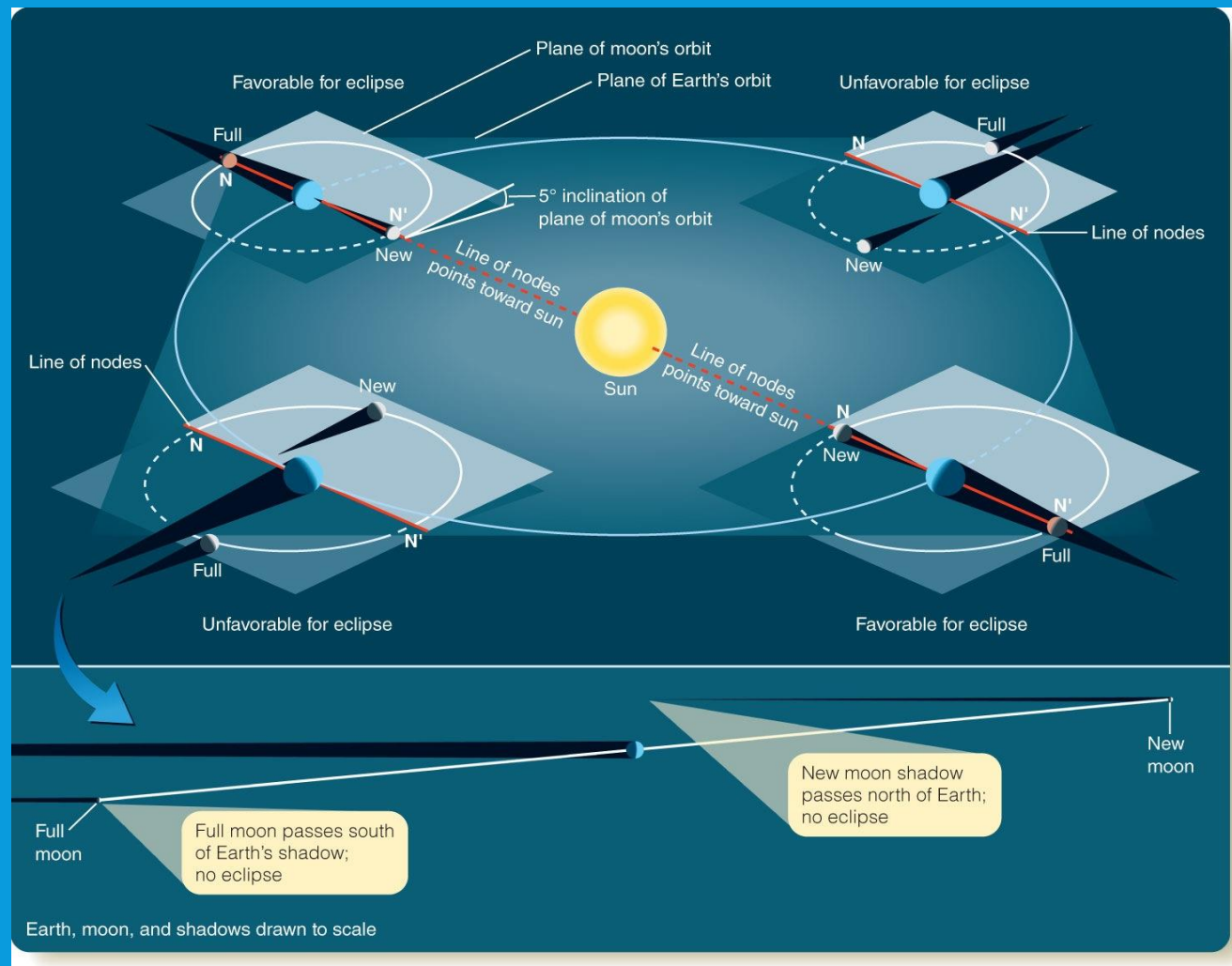
The Moon's path is alternately slightly north (above) and slightly south (below) the Earth's orbital plane
(no eclipse occurs)

A node is where the Moon's orbit intersects the Earth's orbital plane (the line connecting the two nodes - "line of nodes")

When does an eclipse occur?

An eclipse will occur only if:

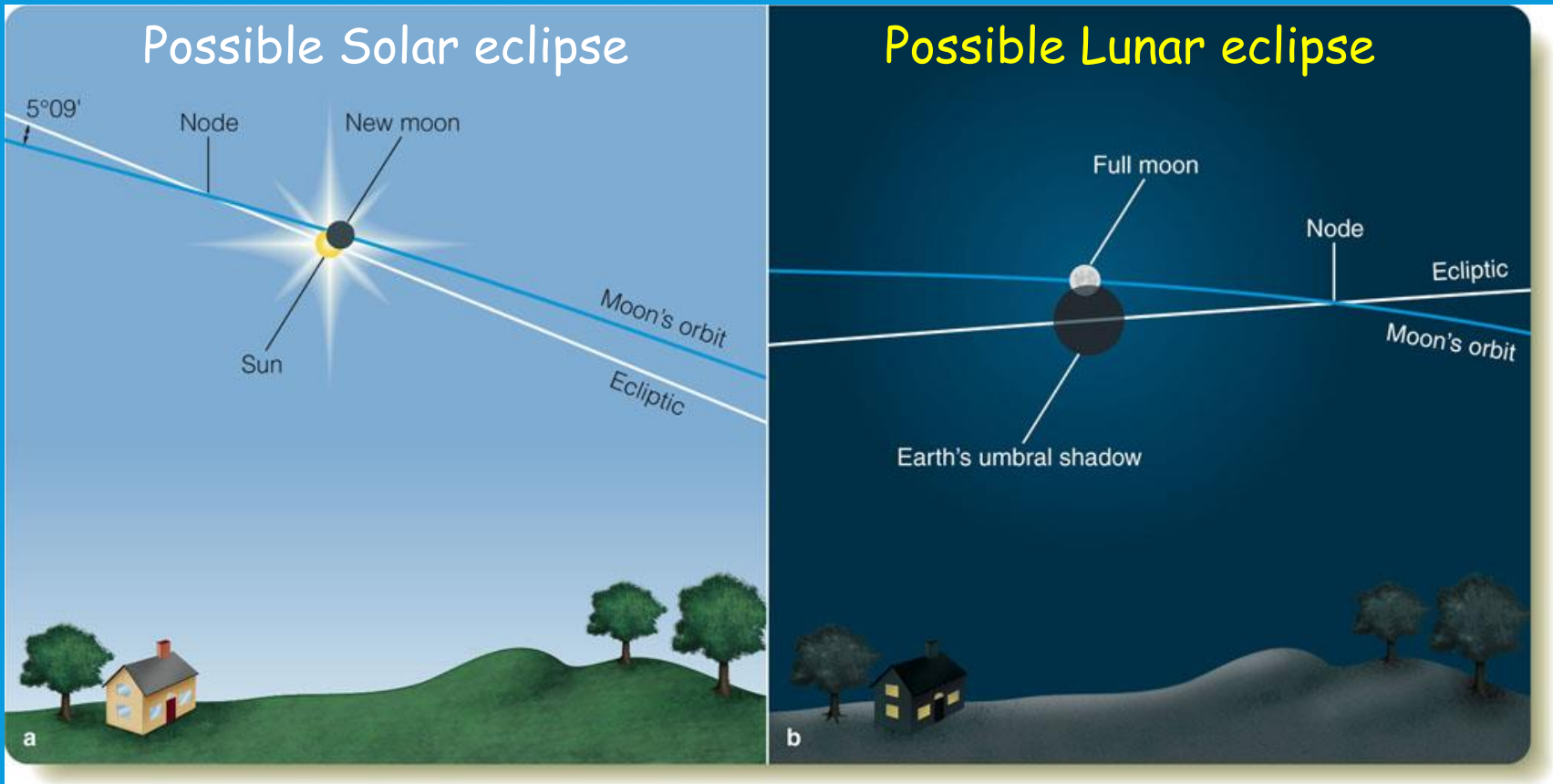
- the three bodies (Moon, Earth, Sun) are in alignment
- and
- The New/Full Moon must be at/near a node (the line of nodes points at the Sun)



No eclipse
here

Eclipse Geometry

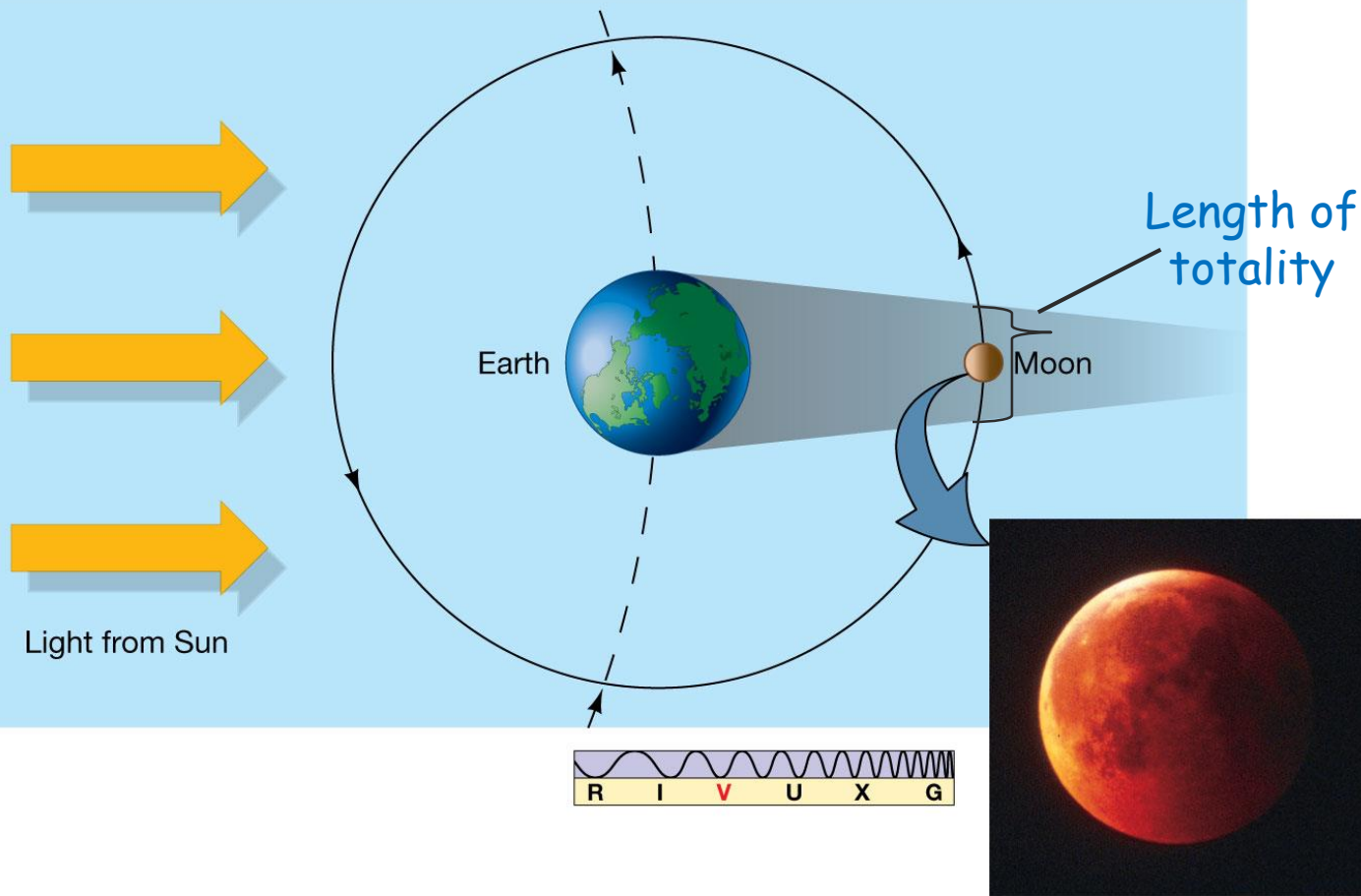
Intersection of the Moon (in its orbital path) and the ecliptic (Earth's orbital plane)



Note - the above examples of eclipses will be Partial Eclipses since the Moon is near the Node (and not 'at' the Node)

Lunar Eclipse Geometry

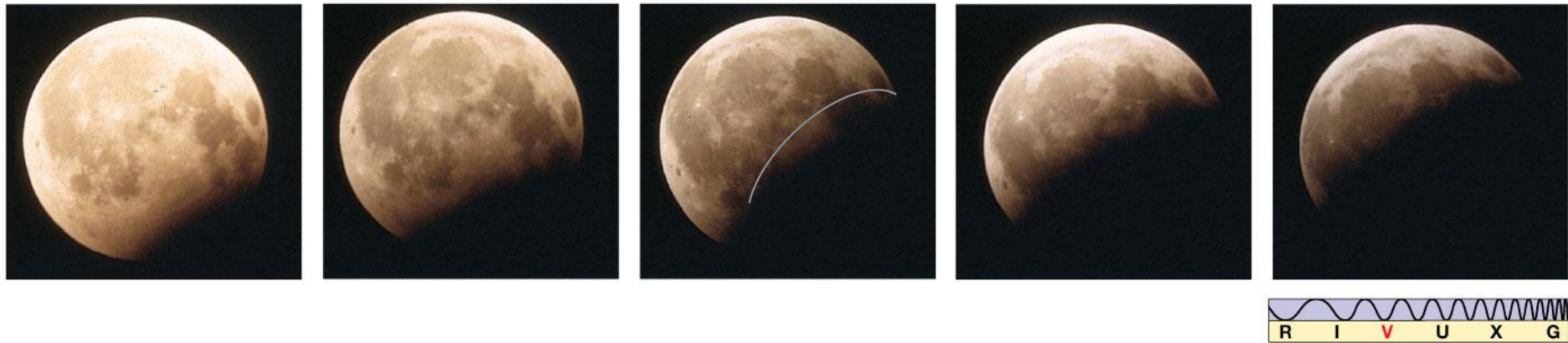
Lunar eclipses can only occur at the Full Moon phase



The Moon passes through the Earth's shadow, so the Earth blocks the Sun's direct light from reaching the Moon...

The Moon becomes a reddish color during a Total Lunar Eclipse because the only sunlight getting to the Moon has been refracted (bent) around the Earth's atmosphere

Views of a Lunar Eclipse



© 2011 Pearson Education, Inc.

These images show the Earth's shadow (blue curve) sweeping across the Moon during a lunar eclipse.

Aristotle (~350 BC) observed lunar eclipses and reasoned that the Earth caused the shadow and that the Earth must be round!

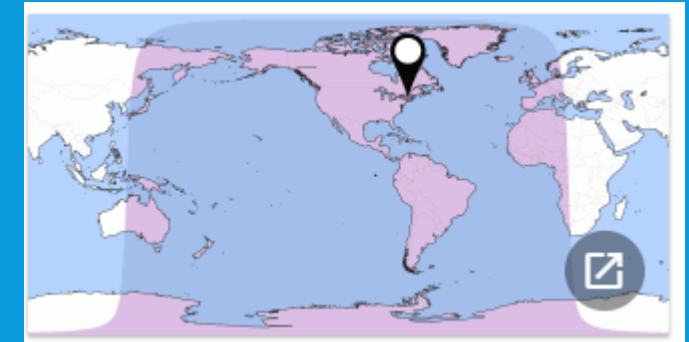
Penumbral Lunar Eclipse

March 25, 2024

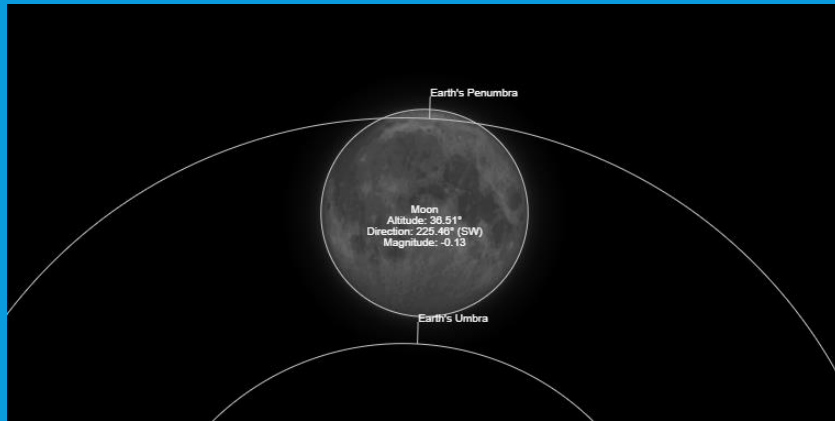
Mar 25, 2024 at 3:12 am



View at this
eclipse's
maximum extent
in RI

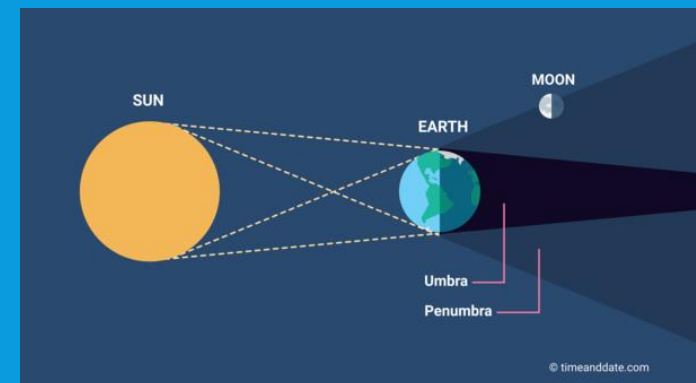


Note the extent of how
many people on Earth can
view this event
(as compared to a total
solar eclipse)



A penumbral lunar eclipse takes place when the Moon moves through the faint, outer part of Earth's shadow, the penumbra.

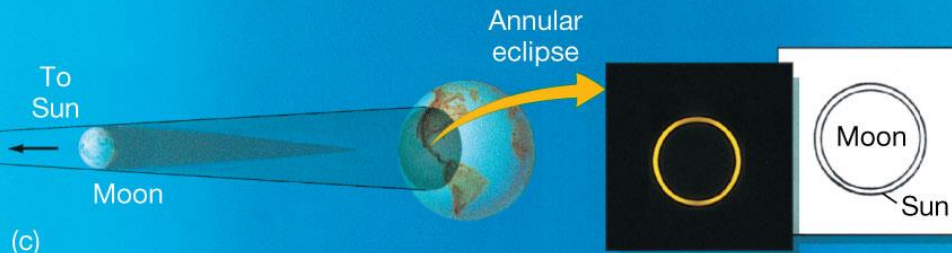
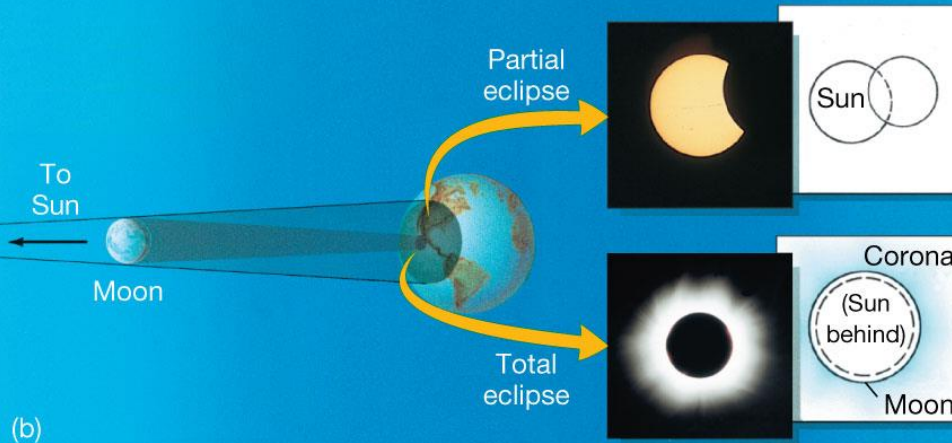
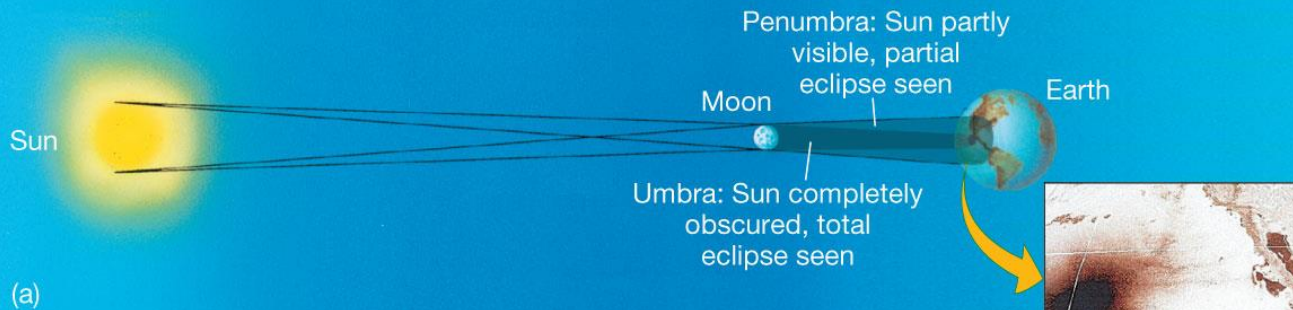
This type of eclipse is not as dramatic as other types of lunar eclipses and is often mistaken for a regular Full Moon.



Solar Eclipse Geometry

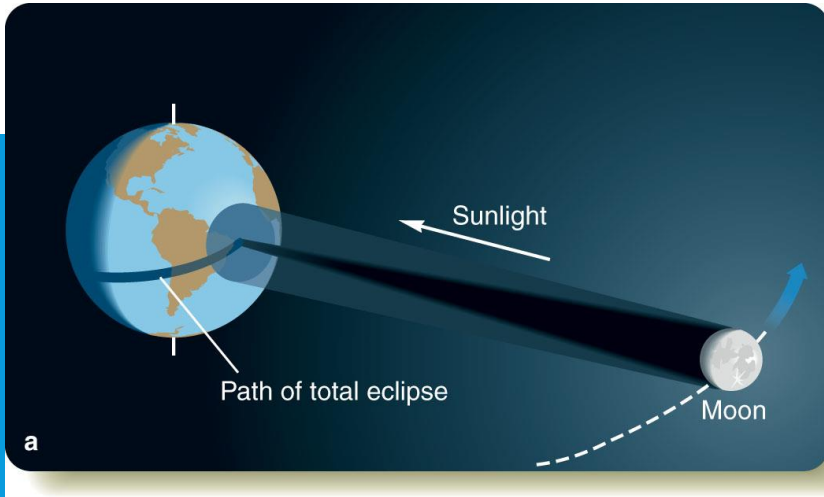
Solar eclipses
can only occur
at the
New Moon
phase

The Earth passes
through the Moon's
shadow, so the Moon
covers (or partially
covers) the bright
disc of the Sun



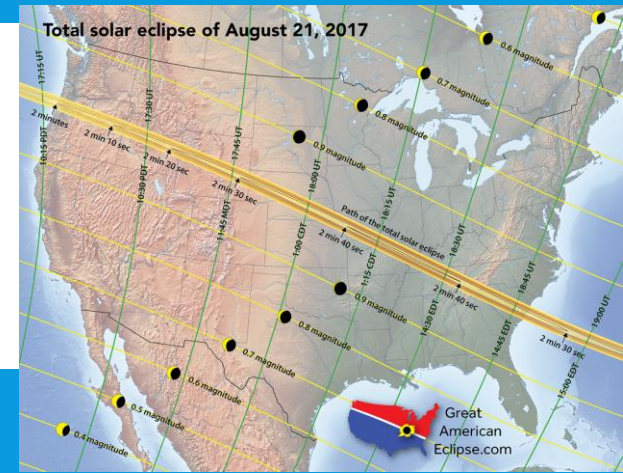
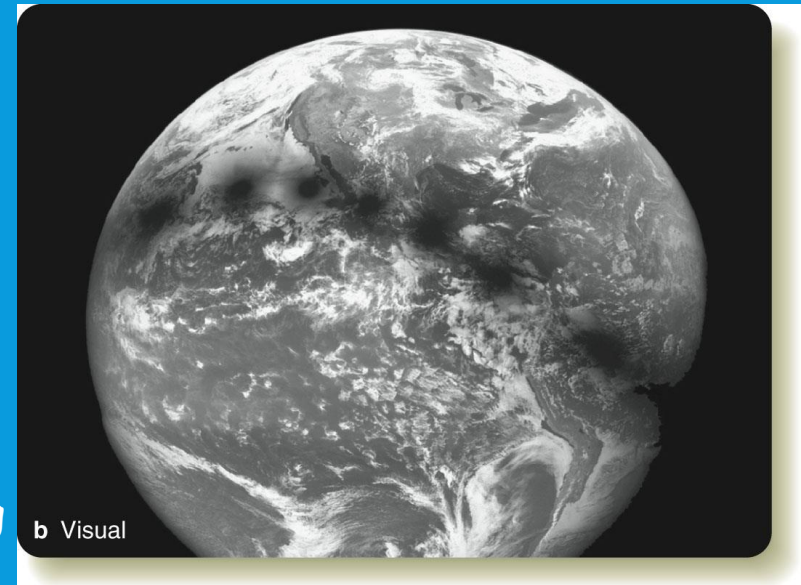
The umbra is the region of total shadow
The penumbra is the region of partial shadow

Eclipse Path: Path of Totality



The umbra of the Moon's shadow 'touches down' on Earth causing a total solar eclipse

Eight photos made by a weather satellite have been combined to show the Moon's shadow moving across Mexico, Central America, and Brazil



Note - a *Partial solar eclipse* will result if the alignment is not perfect
OR your location is outside of the Path of Totality
(only a portion of the Sun's disc is covered)

The Great American Eclipse

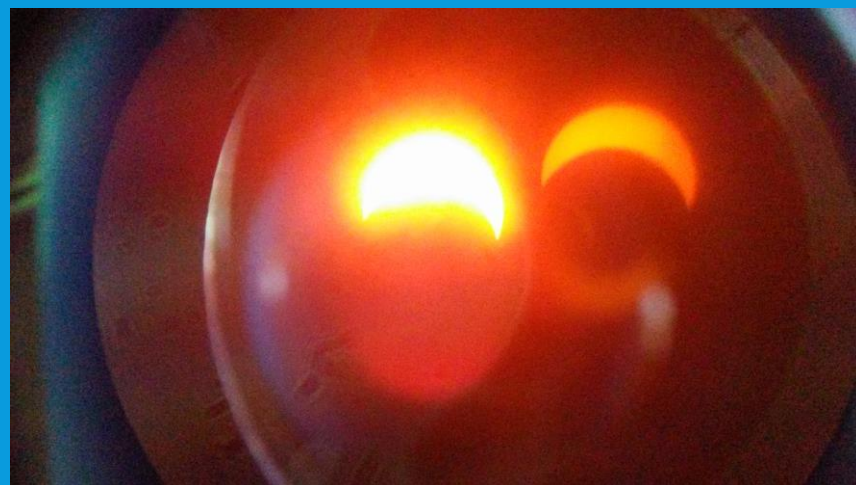
Total Solar Eclipse: Aug 21, 2017

*Locally: Partial Solar Eclipse in RI
(RI was outside of the Path of Totality)*

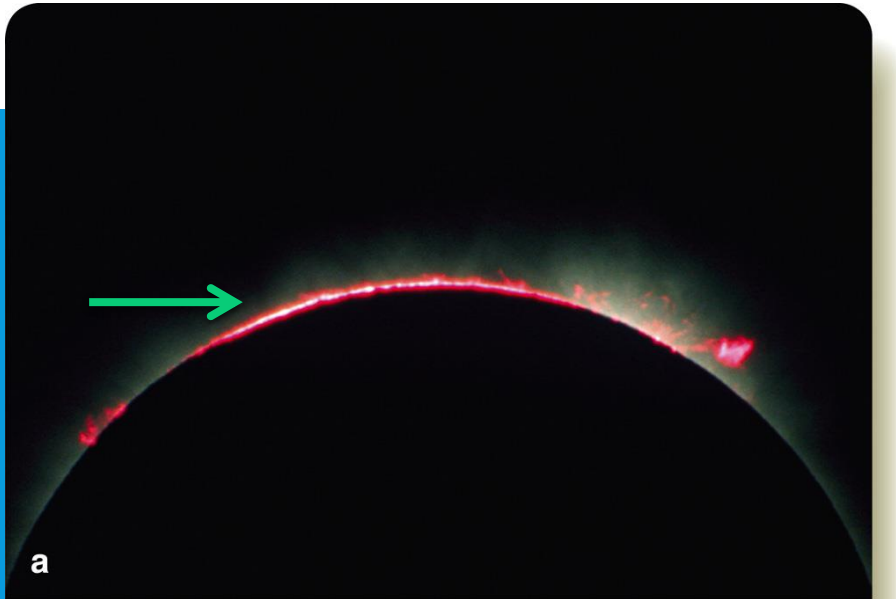
Photos taken by a
camera attached to a
telescope
(by Rebecca Reddy at
the Greenville Public
Library)



Photo taken by me with my
cell phone through the
eyepiece of the telescope

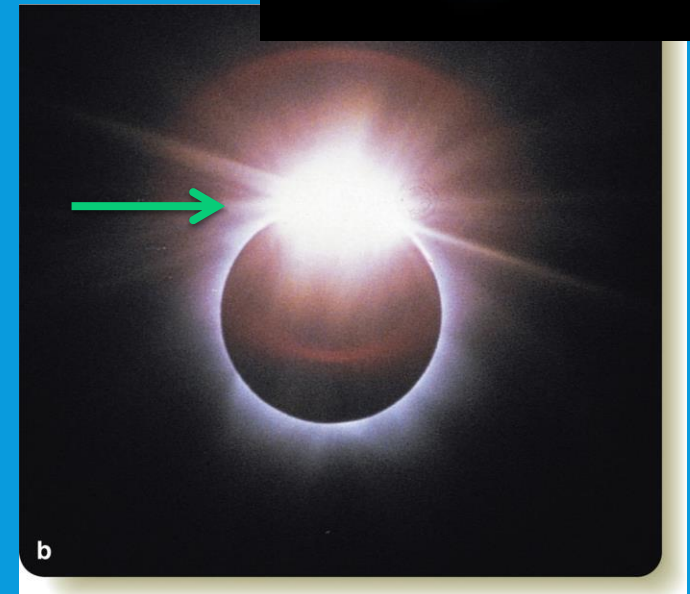
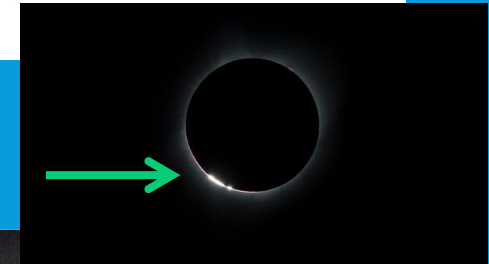
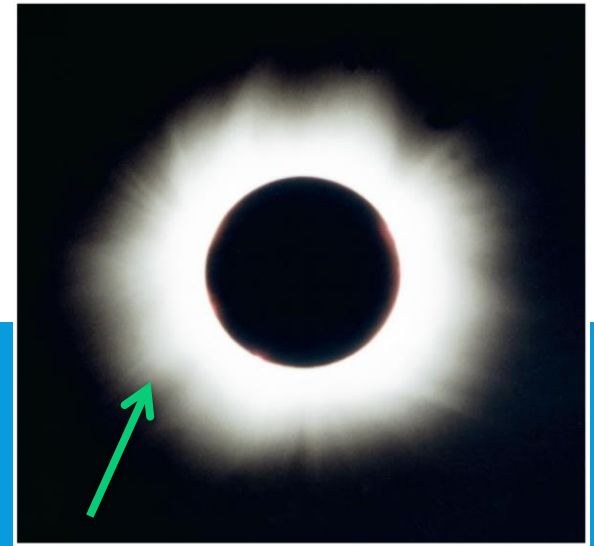


Total Solar Eclipse Perfect Alignment!



Observed only during a total solar eclipse
when the bright surface of the Sun
(photosphere) is covered by the Moon:

- the Chromosphere: thin, red atmospheric layer
- the Corona: larger, whitish halo
- Baily's Beads/Diamond Ring Effect: seen just before & at the end of totality



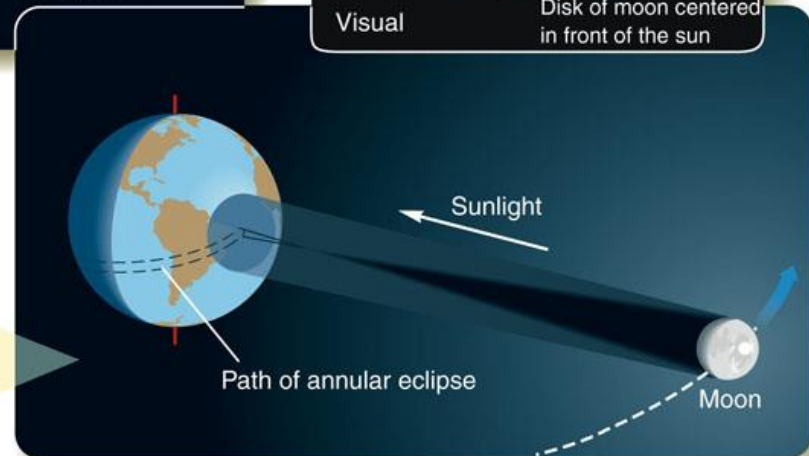
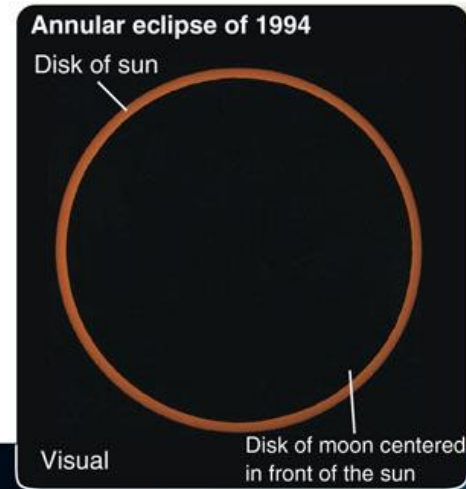
Annular Solar Eclipse

Named for the annular ring of sunlight that is seen



The angular diameters of the moon and sun vary slightly because the orbits of the moon and Earth are slightly elliptical.

If the moon is too far from Earth during a solar eclipse, the umbra does not reach Earth's surface.



Annular eclipses occur when the Moon would be at or near the farthest point in its orbit

Annular Solar Eclipses



May 2012 near Albuquerque,
New Mexico,

During an Annular eclipse, the
corona and chromosphere are not
visible as even the small amount
of the Sun's disc that is visible
completely overwhelms the faint
glow of the corona



October 2005 as seen
from Spain

Total Solar Eclipse April 8, 2024

*Note - in Rhode Island, the event
will be viewed as a Partial Solar Eclipse
(we are outside of the Path of Totality)*

Apr 8, 2024 at 3:29 pm

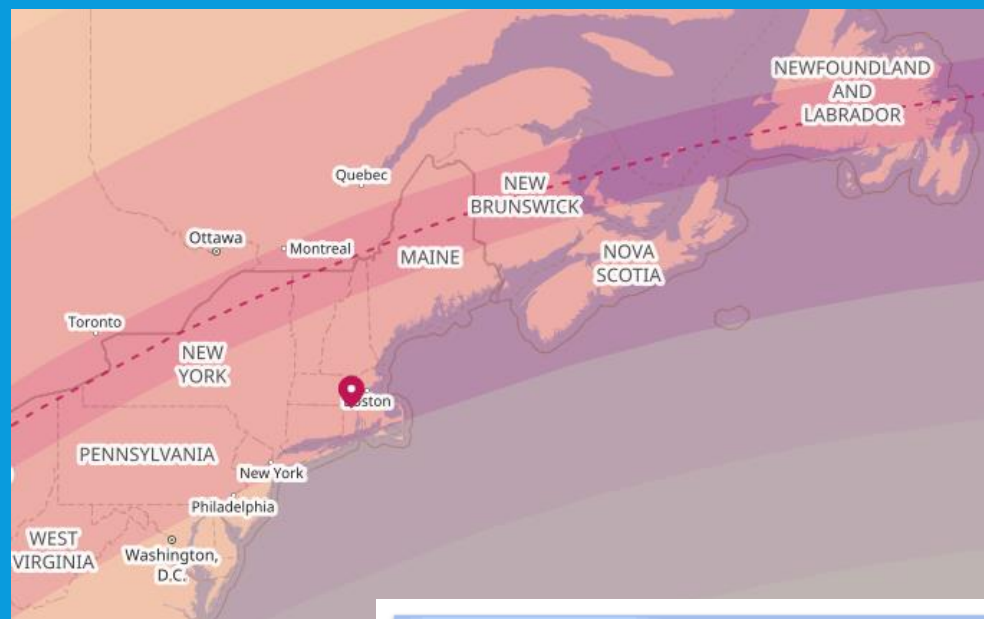


*View at this
eclipse's
maximum
extent in RI*

Partial begins: 2:15:08 pm
Maximum: 3:29:06 pm
Partial ends: 4:38:43 pm

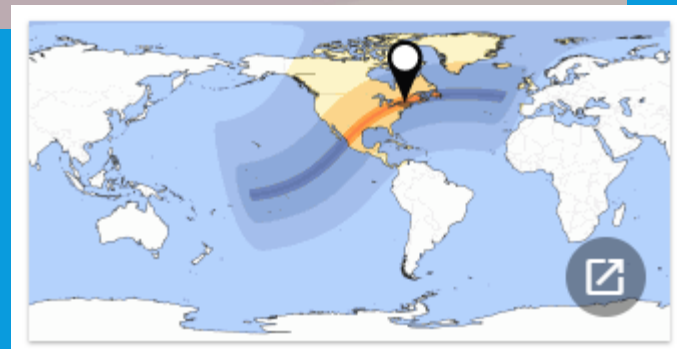
Magnitude of this eclipse: 0.923

The magnitude of an eclipse is the *fraction of the diameter of the disk of the eclipsed body that is covered by the eclipsing body*



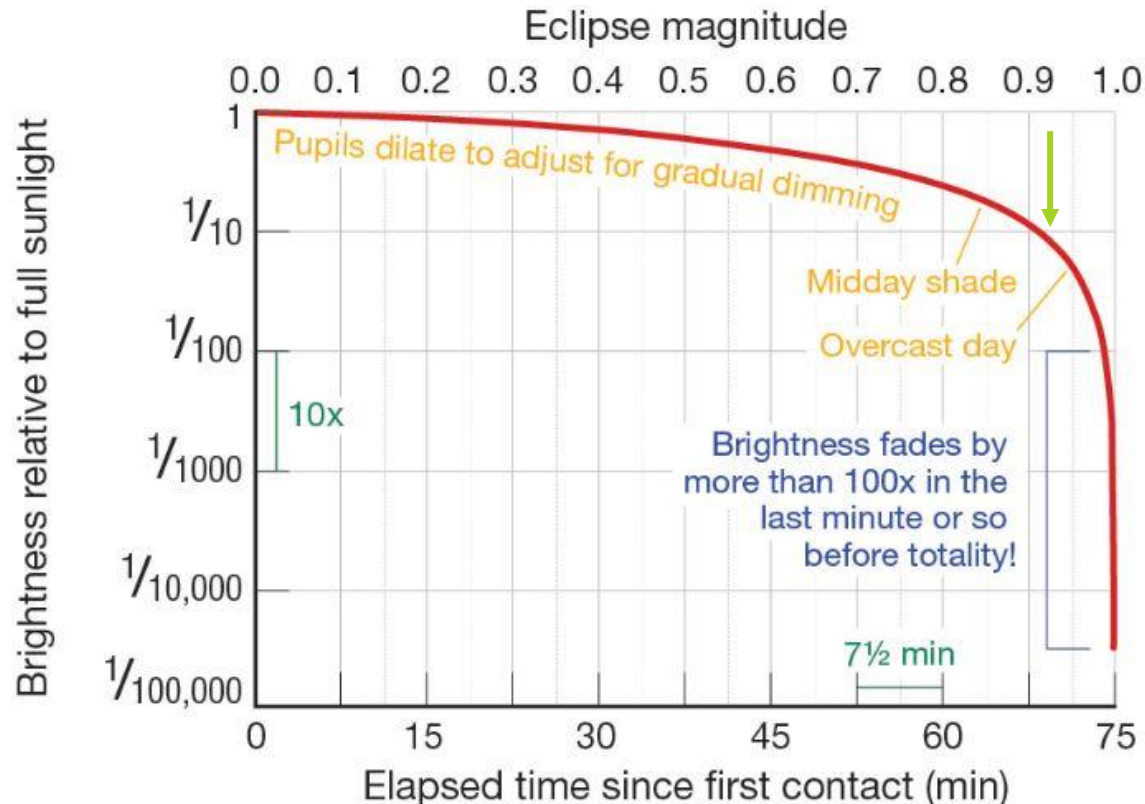
Obscuration for this eclipse: 91.50%

The eclipse obscuration is the *fraction of the Sun's area that is covered by the disk of the Moon*



Magnitude of the April 8th solar eclipse in RI: 0.923

Change in Illumination During a Total Solar Eclipse



This graph shows the reduction in daylight as the Moon covers the Sun from 1st contact (the beginning of the partial eclipse) to 2nd contact (the beginning of the total eclipse) 1¼ hour later for a typical solar eclipse. Eclipse magnitude refers to the fraction of the Sun's diameter covered by the Moon; eclipse obscuration (mentioned in the text) is the fraction of the Sun's area covered by the Moon and is more closely related to the change in brightness. Most of the reduction in ambient illumination occurs in the final minute or so before totality, and daylight returns just as quickly at totality's end.

Courtesy the author

How to safely view the April Solar Eclipse



Safe to use:

- Eclipse glasses
- Telescope with solar filter
- Pinhole projector
- Kitchen 'gadgets': colander, grater, grill sheet with holes

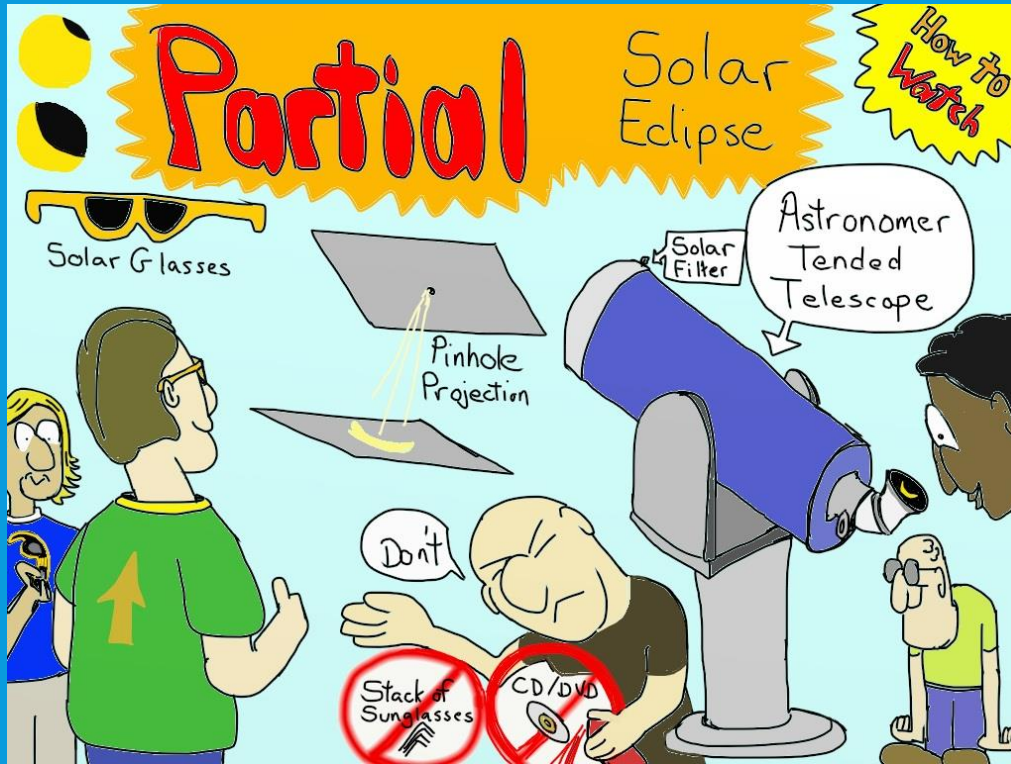
Do NOT use your naked eyes, sunglasses, or UNFILTERED cameras/binoculars/telescopes!

Photos taken by an unfiltered Smartphone camera may damage the camera... use a solar filter



Thank you for attending!

Here's hoping for clear skies
on April 8th!



Please join us for
our Solar Eclipse
Watch Party
beginning at 2pm!

For information on reputable
sellers of solar filters:

<https://eclipse.aas.org/eye-safety/viewers-filters>

