


A composite image of Earth, the Moon, and the Sun in space. The Earth is on the left, showing a blue and white horizon. The Moon is on the right, appearing as a dark, cratered sphere. The Sun is on the left, appearing as a bright, glowing star with a lens flare. The background is a dark, starry space.

# Earth and Space Science

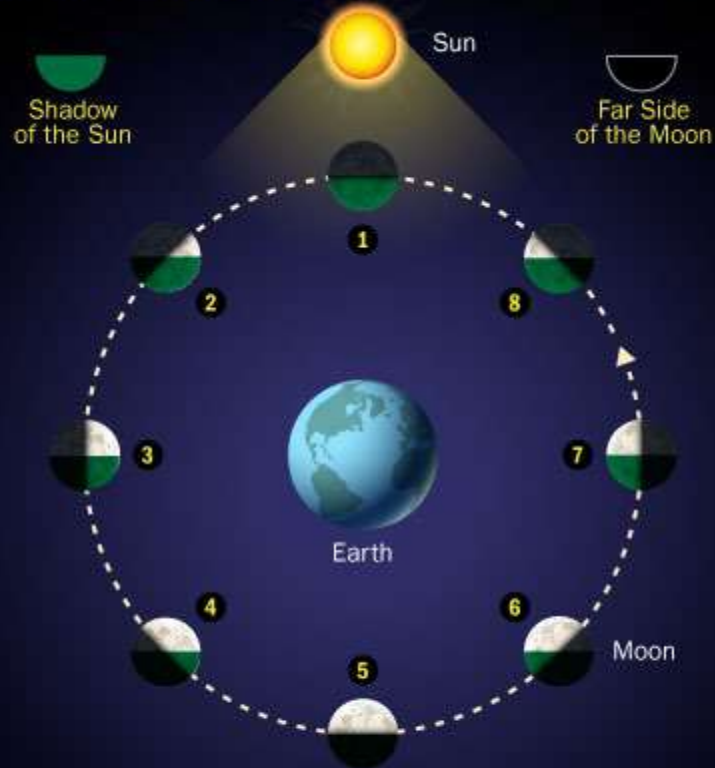
Unit 2 Lecture 4: Phases of the  
Moon, Eclipses, Tides, and  
Magnetosphere

# Phases of the Moon



- ◇ As the moon moves around the Earth, from one night to the next we see different amounts of the illuminated half of the Moon.
- ◇ These different appearances of the Moon are called **lunar phases**.

# How the Moon Works Phases of the Moon



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# Phases of the Moon (cont).

- ◊ When the moon is at position A, it is in roughly the same direction in the sky as the Sun as seen from Earth.
- ◊ Hence the dark hemisphere of the Moon faces the Earth.
- ◊ This phase, in which the Moon is not visible, is called new moon.

# Phases of the Moon (cont).

- ◆ As the Moon continues around its orbit from position A, more of the illuminated half of the Moon becomes exposed to our view.
- ◆ The result, show at position B, is a phase called waxing crescent moon (“waxing” is a synonym for “increasing”).

# Phases of the Moon (cont).

- ◆ About a week after the new moon, the Moon is at position C; we then see half of the Moon's illuminated hemisphere and half of the dark hemisphere.
- ◆ This phase is called first quarter moon.
- ◆ The name means that this phase is one-quarter of the way through the complete cycle of lunar phases.
- ◆ Note that a first quarter moon appears to be half illuminated, *NOT* one-quarter illuminated!

## Phases of the Moon (cont).

- ◇ During the next week, the Moon reaches position D.
- ◇ Now, still more of the illuminated hemisphere can be seen from Earth, giving us the phase called waxing gibbous moon (“gibbous” is another word for “swollen”).



# Phases of the Moon (cont).

- ◆ When the Moon stands opposite the Sun in the sky (position E) we see the fully illuminated hemisphere.
- ◆ This phase is called full moon.

# Phases of the Moon (cont).

- ◆ Over the following two weeks, we see less and less of the illuminated hemisphere as the Moon continues along its orbit.
- ◆ The moon is said to be *waning*, or decreasing in illumination as seen from Earth.
- ◆ The phases are called waning gibbous moon (position F), last quarter moon (position G), and waning crescent moon (position H).

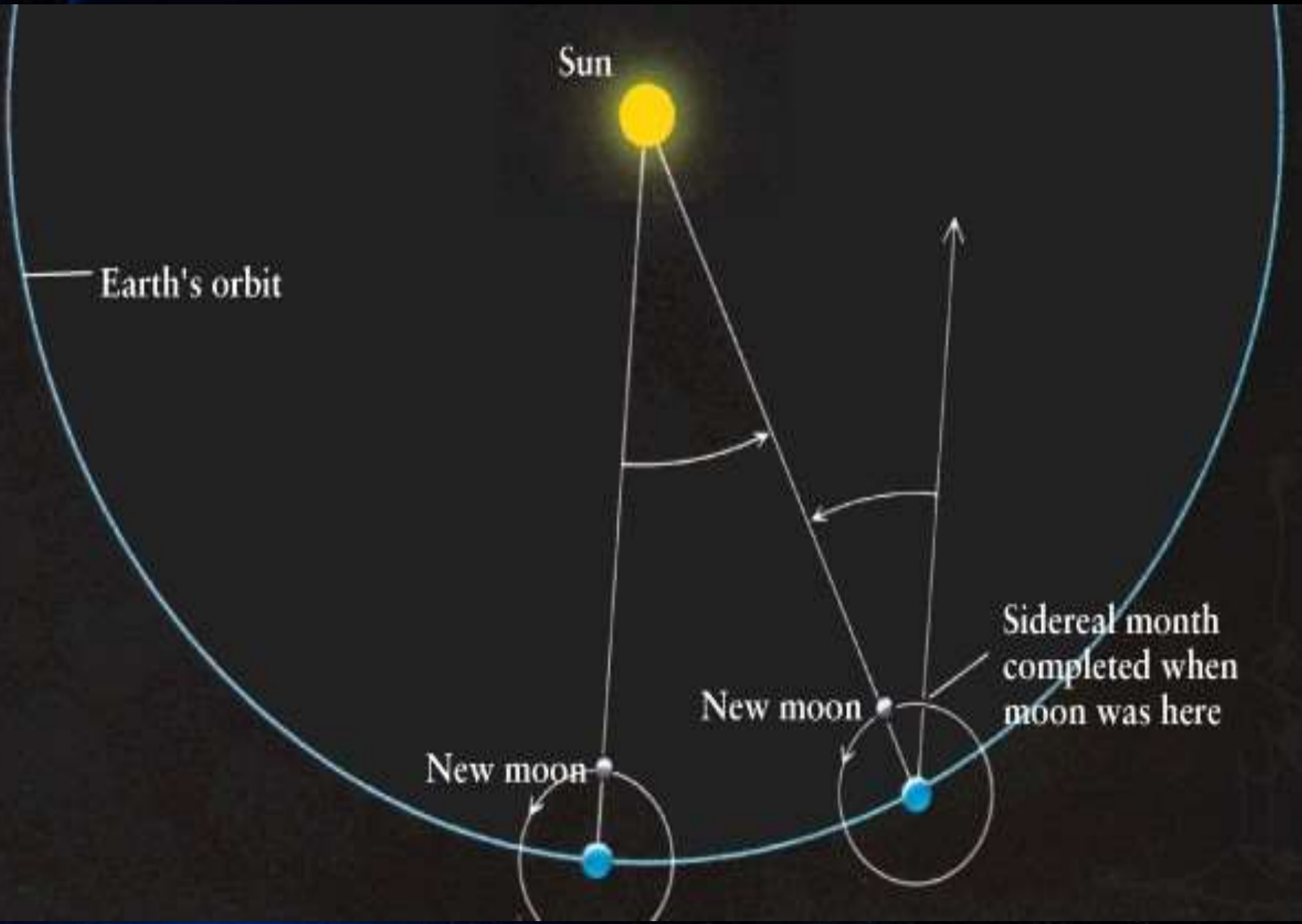
# Rotation of the Moon



- ◇ The Moon rotates in a special way; it takes exactly as long to make one rotation on its axis as it does to make one full revolution around the Earth.
- ◇ This situation is called synchronous rotation.
- ◇ As shown in the following picture, this keeps only one side of the Moon facing the Earth at any time.

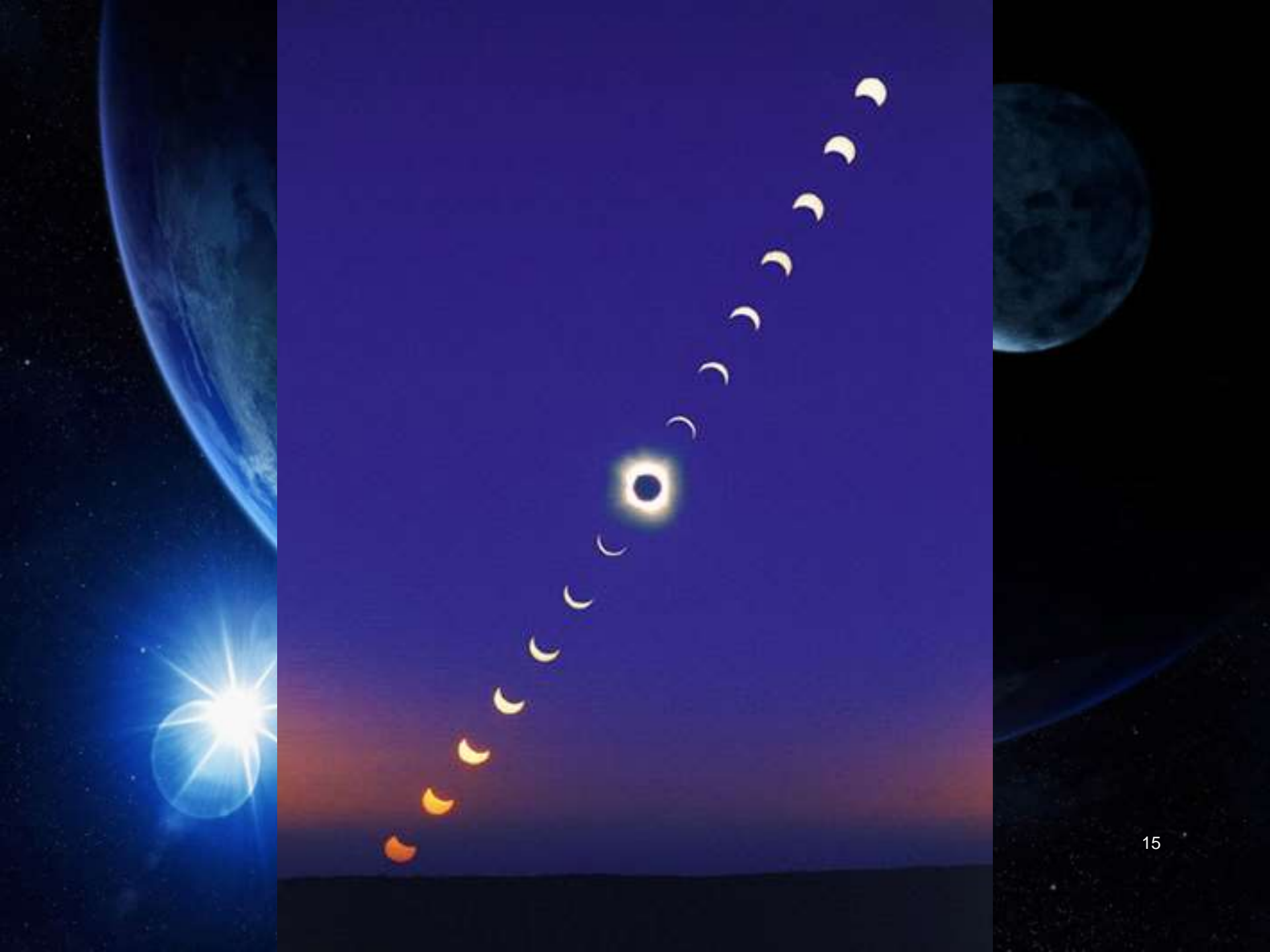
# Phases of the Moon (cont).

- ◆ The sidereal month is the time it takes the Moon to complete one full orbit of the Earth, measure with respect to the stars.
- ◆ This true orbital period is equal to 27.3 days.
- ◆ The synodic month, or lunar month, is the time it takes the Moon to complete one cycle of phases (that is, from new moon to new moon or from full moon to full moon) and thus is measured with respect to the Sun (rather than the stars).
- ◆ The length of the “day” on the Moon is a synodic month, not a sidereal month.



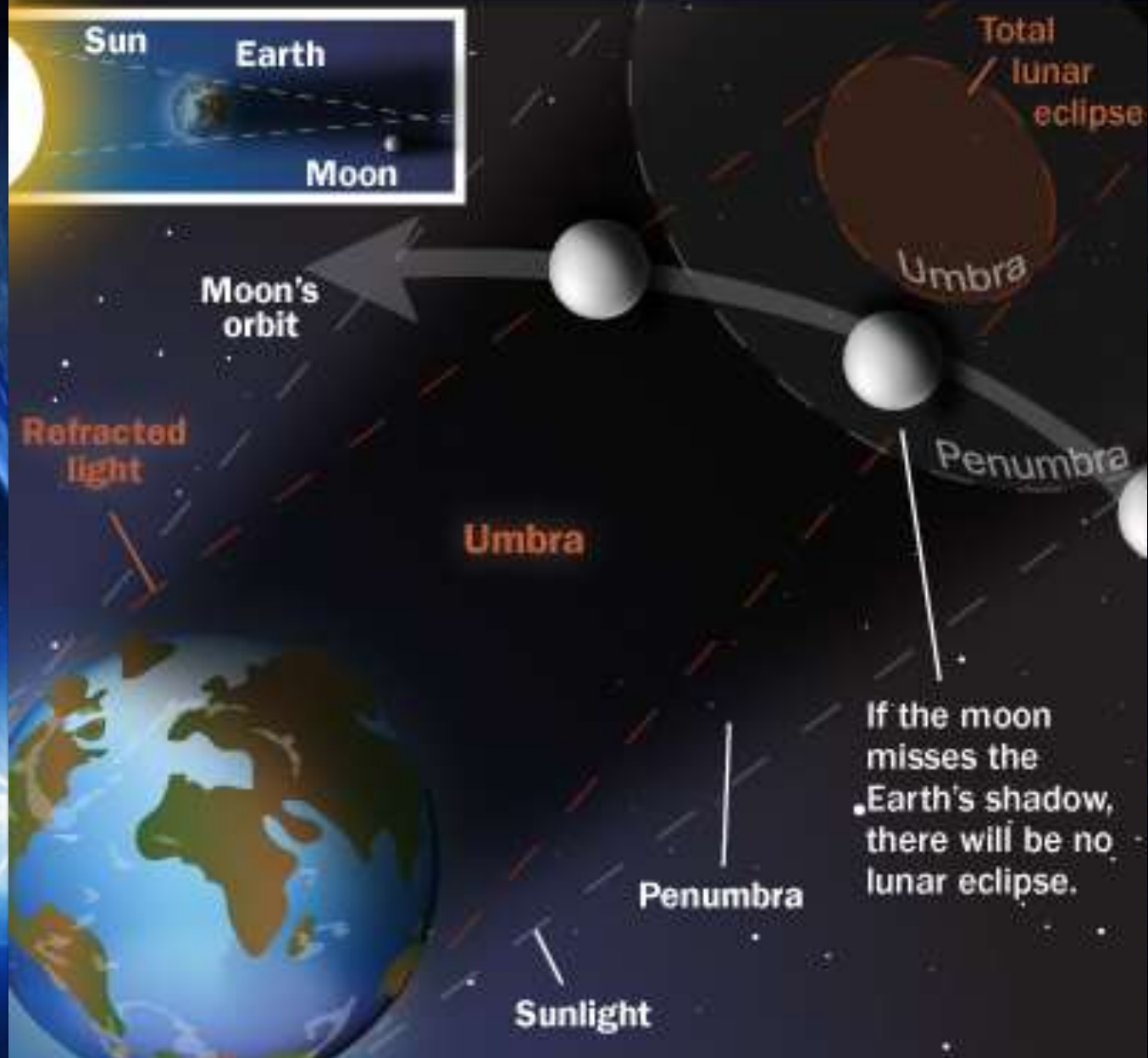
A blue-tinted image of Earth and the Moon in space. The Earth is on the left, showing continents and oceans. The Moon is on the right. A bright sun is in the lower left corner, creating a lens flare. The word "Eclipses" is written in white serif font in the center.

# Eclipses

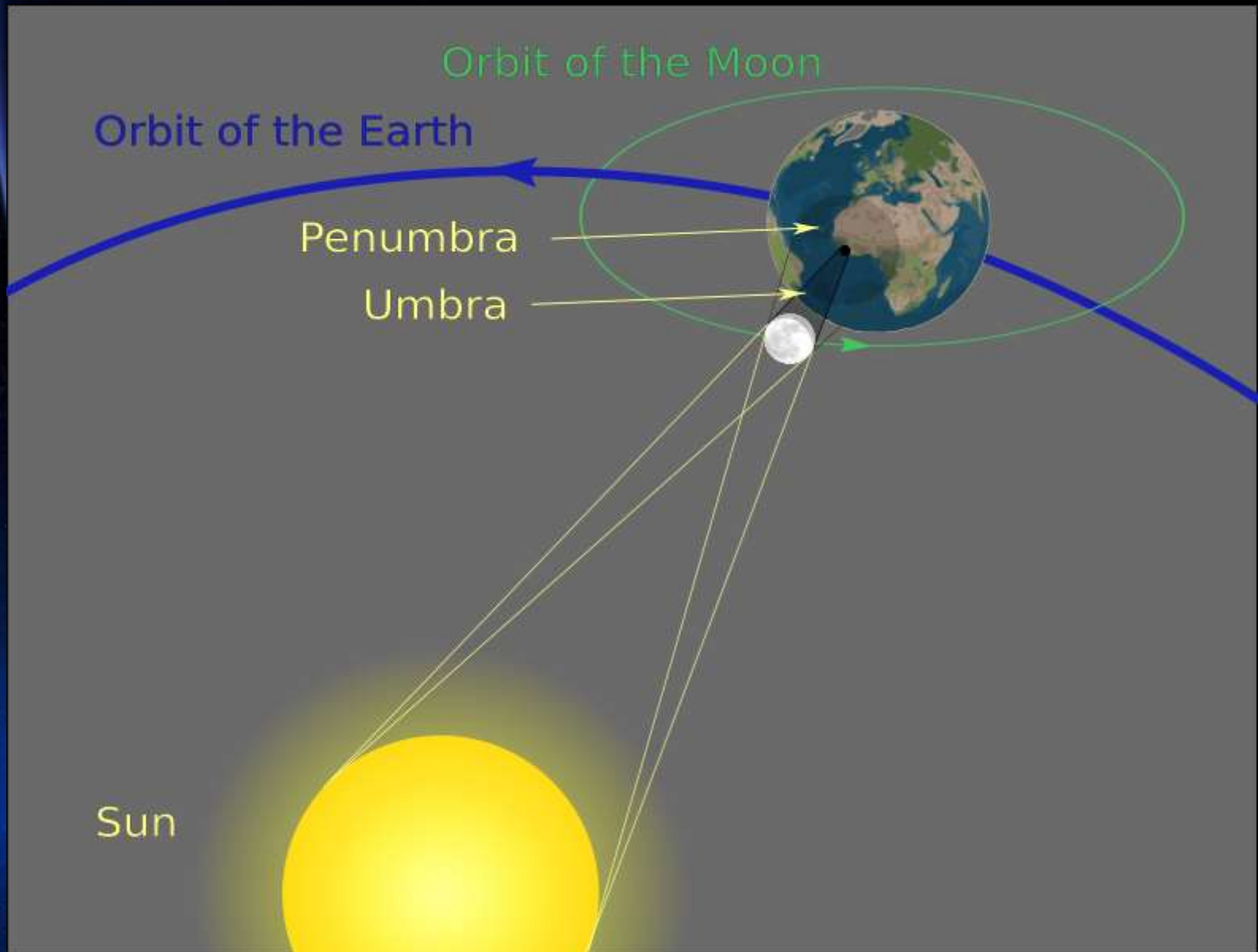


# How Lunar Eclipses Work

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# Eclipses (cont.)



- ◆ From time to time the Sun, Earth, and Moon all happen to lie along a straight line.
- ◆ When this occurs, the shadow of the Earth can fall on the Moon or the shadow of the Moon can fall on the Earth.
- ◆ Such phenomena are called eclipses.

# Eclipses (cont.)



- ◆ A **lunar eclipse** occurs when the Moon passes through the Earth's shadow.
- ◆ This occurs when the Sun, Earth, and Moon are in a straight line, with the Earth between the Sun and Moon, so that the Moon is at full phase (position E).

# Eclipses (cont.)



- ◇ A solar eclipse occurs when the Earth passes through the Moon's shadow.
- ◇ As seen from Earth, the Moon moves in front of the Sun.
- ◇ The Moon must be in a straight line with and between the Earth and Sun for this to occur.
- ◇ Therefore can only occur with at a new moon.

# Eclipses (cont.)



- ◆ Both new moon and full moon occur at intervals of  $29 \frac{1}{2}$  days. Hence, you might expect that there would be a solar eclipse every  $29 \frac{1}{2}$  days, followed by a lunar eclipse about two weeks (half a lunar orbit) later.
- ◆ But in fact, there are only a few solar eclipses and lunar eclipses per year.

## Eclipses (cont.)



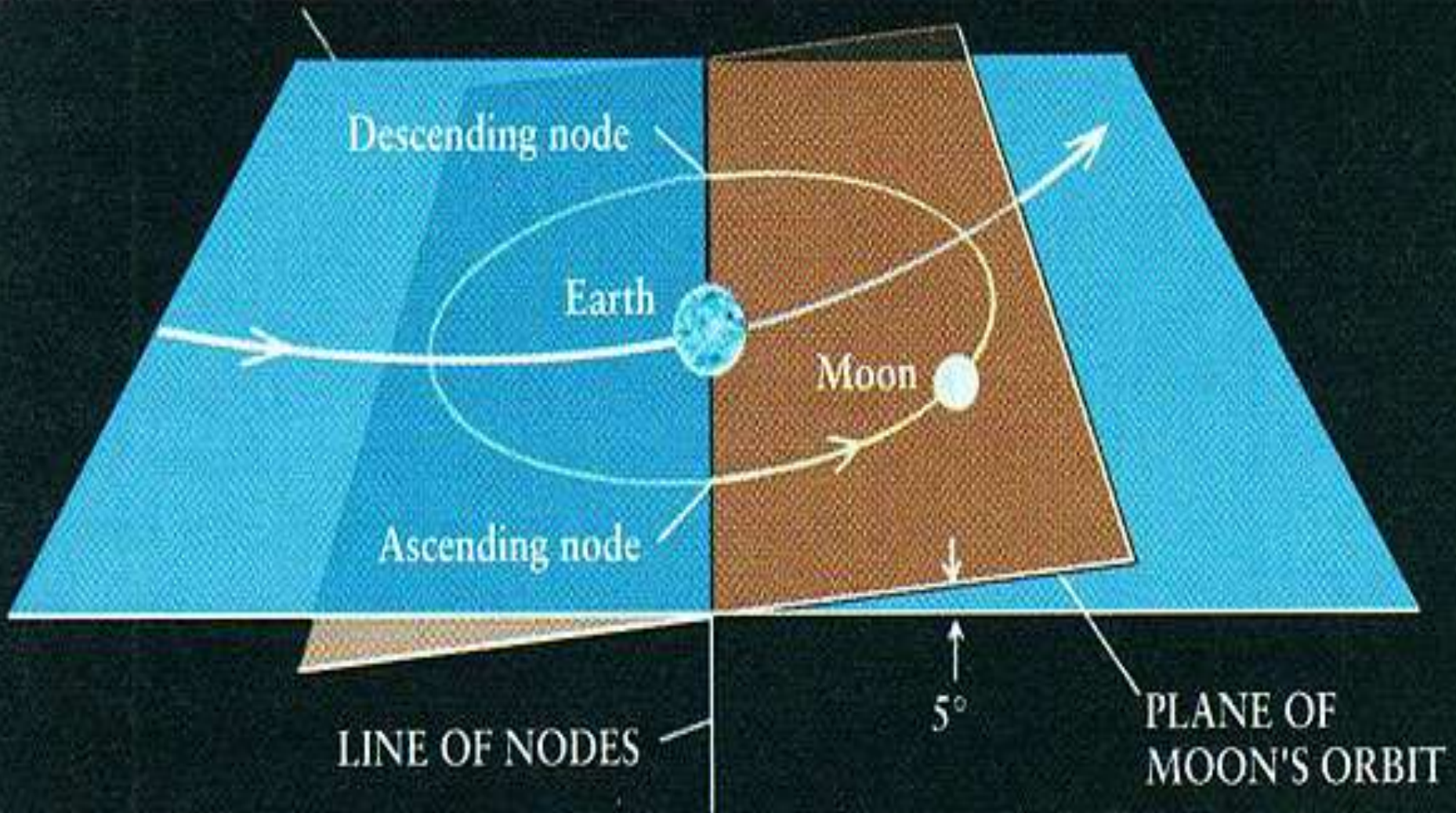
- ◇ Solar and lunar eclipses are so infrequent because the plane of the Moon's orbit and the plane of the Earth's orbit are not exactly aligned, as shown in the following picture.
- ◇ The angle between the Moon's orbit and the Sun's orbit is roughly  $5^\circ$ .

# Eclipses (cont.)

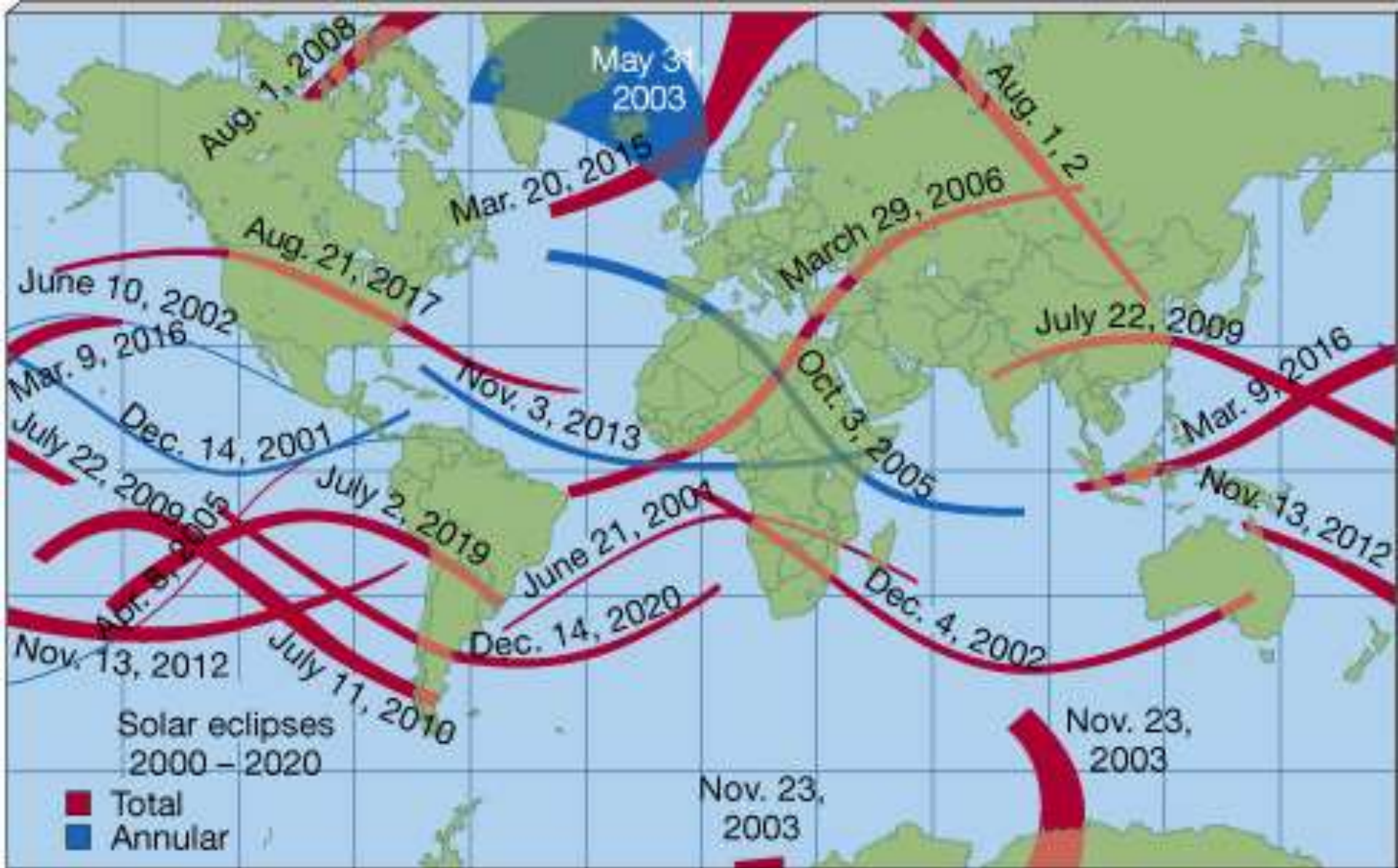


- ◇ Because of this tilt, new moon and full moon usually occur when the Moon is either above or below the Earth's orbit.
- ◇ When the Moon is not in the plane of the Earth's orbit, the Sun, Moon, and Earth cannot align perfectly, and an eclipse cannot occur.

PLANE OF EARTH'S ORBIT  
(= PLANE OF THE ECLIPTIC)

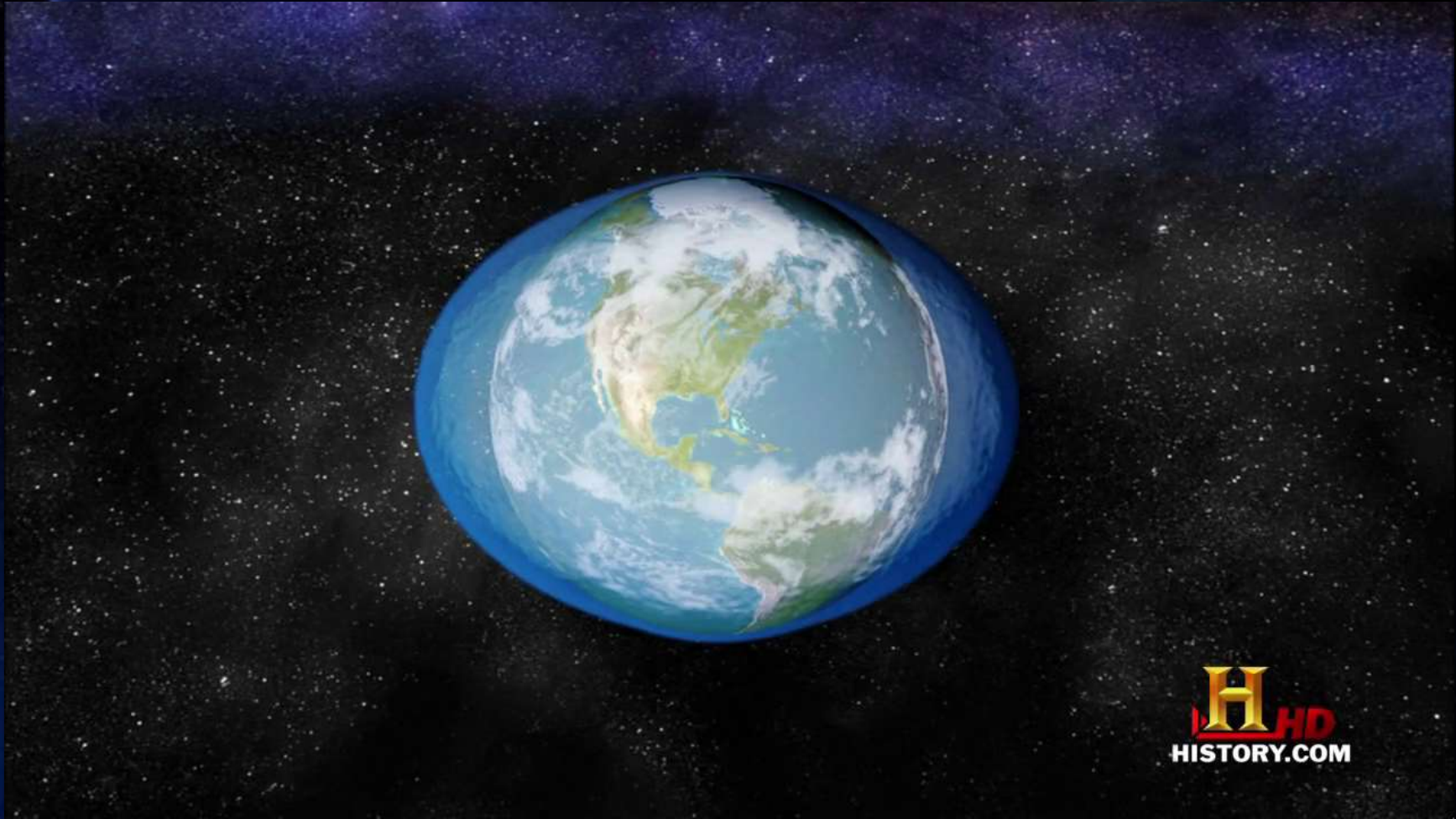






A blue-tinted image of Earth and the Moon in space. The Earth is on the left, showing continents and oceans. The Moon is on the right. A bright star with a lens flare is in the lower left. The text "The Tides" is centered in white.

# The Tides



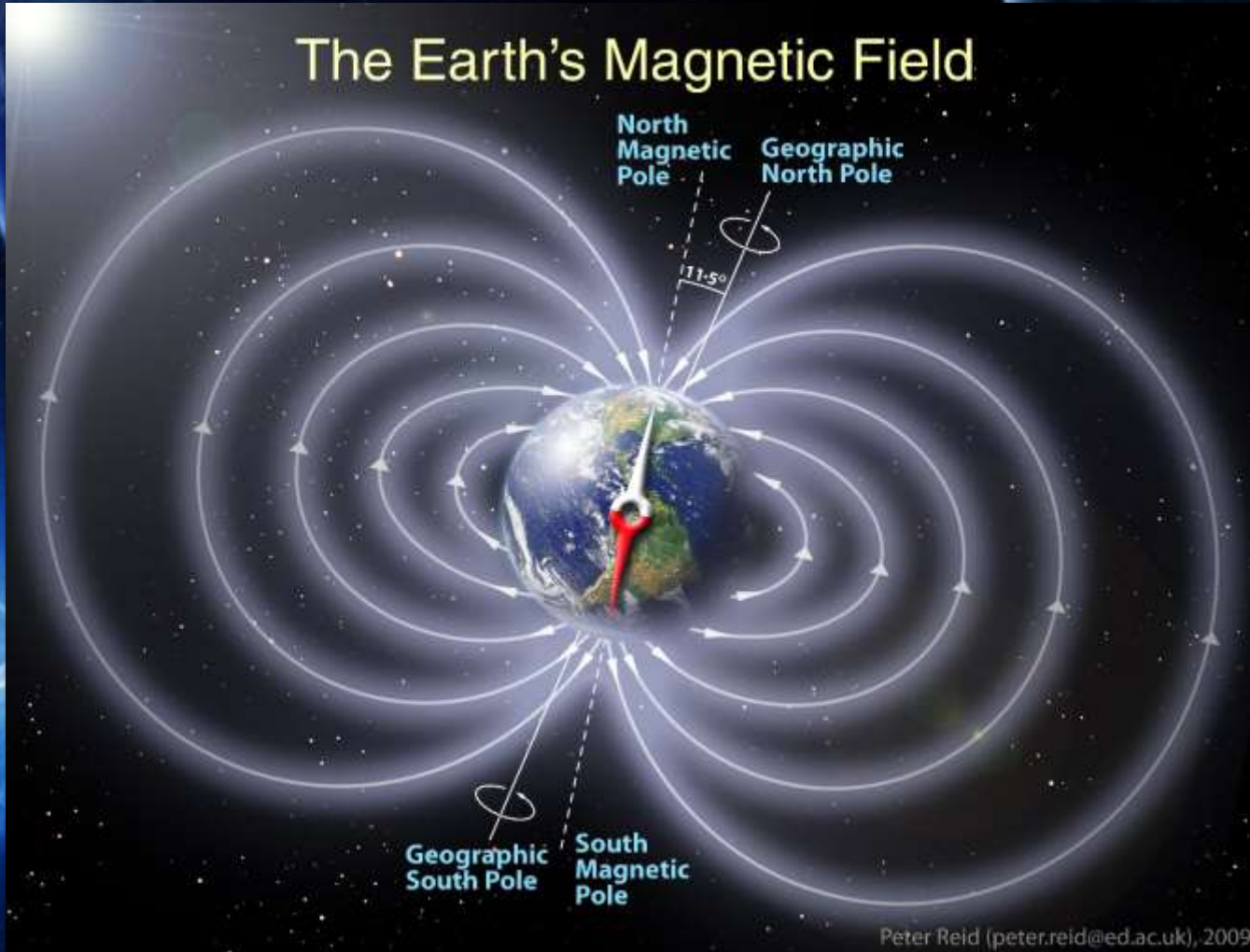
# The Tides

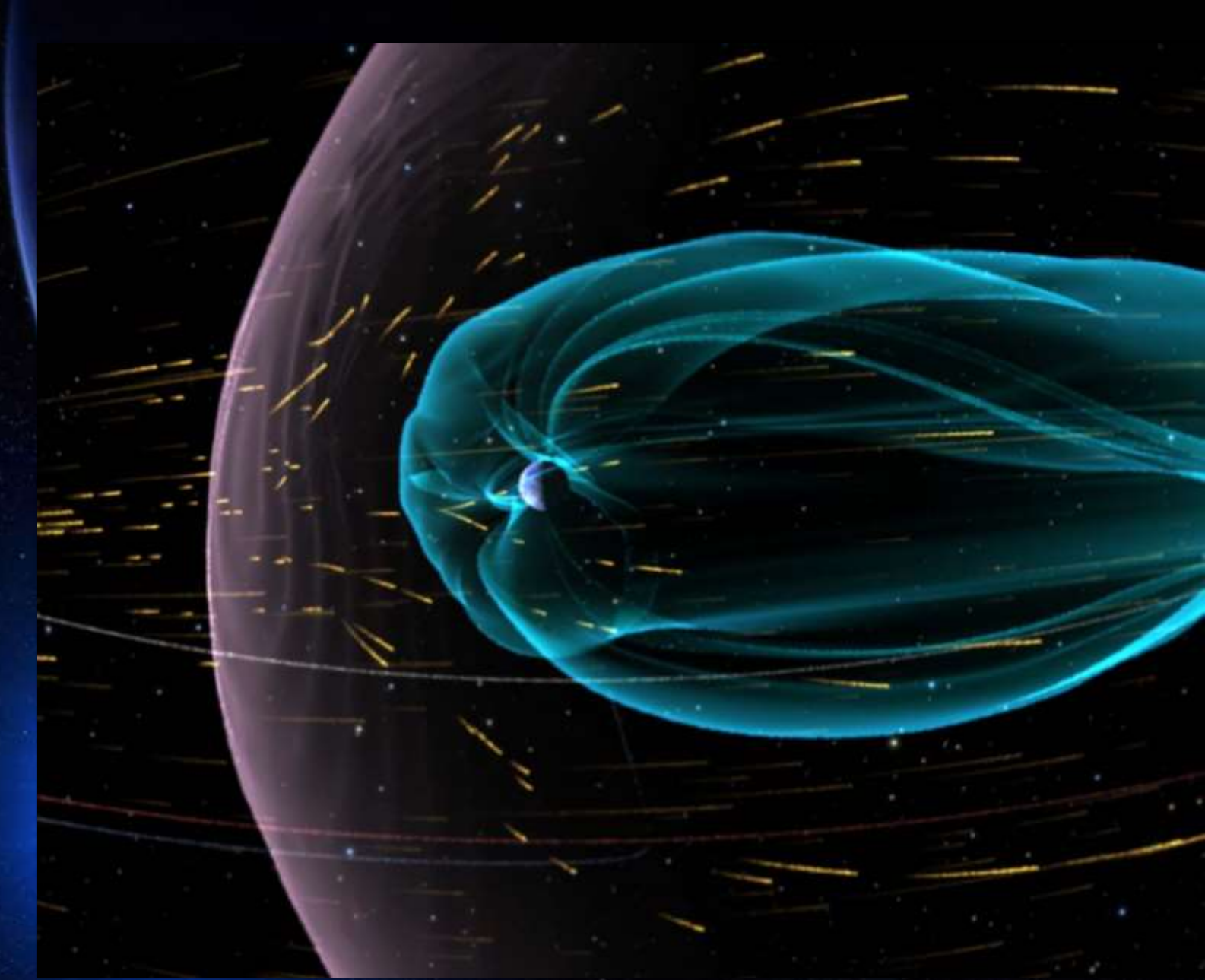
◇ <https://www.youtube.com/watch?v=IIMN-XVcpkE>

A blue-tinted image of Earth and the Moon in space. The Earth is on the left, showing a curved horizon and a blue atmosphere. The Moon is on the right, appearing as a smaller sphere. A bright star with a lens flare is in the bottom left. The word "Magnetosphere" is written in white serif font across the center.

# Magnetosphere

# Magnetic Field





# Magnetic Field (cont.)

- ◇ The basic function of the Magnetic Field is to protect us from the harmful radiation and damaging solar winds.
- ◇ The Magnetic Field is a barrier that helps to shield us
- ◇ Sometimes the particles from the solar winds comes back to the Earth at the poles and interact with the ionosphere which create the Auroras
- ◇ [https://www.youtube.com/watch?v=yEYy\\_nVC4L0](https://www.youtube.com/watch?v=yEYy_nVC4L0)





