

The solar eclipse and the lunar eclipse

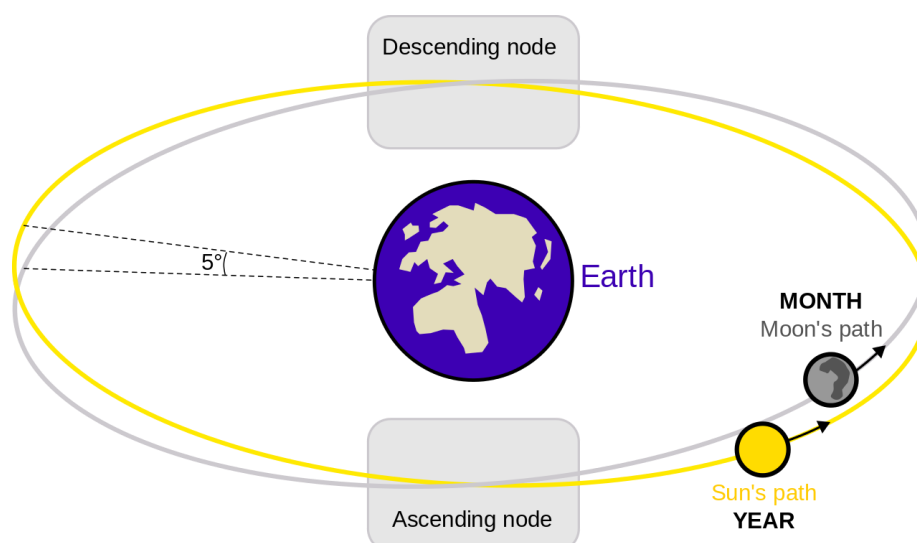
A solar eclipse is a phenomenon that the Sun is blocked by the Moon, which makes the Sun (totally or partially) invisible. In a total eclipse, the whole Sun is blocked by the Moon. It suddenly gets dark like night during the day. In a partial eclipse, only part of the Sun is blocked by the Moon. Anyhow, a solar eclipse typically lasts several minutes before the Moon completely passes the Sun.

A lunar eclipse is a phenomenon that the Moon enters the shadow of the Earth, which makes the Moon (totally or partially) invisible. In a total eclipse, the whole Moon is in the shadow of the Earth. In a partial eclipse, only part of the Moon is in the shadow of the Earth. The rest of the Moon is visible.

In terms of visibility, there is a big difference between a solar eclipse and a lunar eclipse. If a solar eclipse happens, whether it is total or partial, only a small part of the world can observe it; only the places on the Earth where the shadow of the Moon lies can watch it. Remember that the Moon is much smaller than the Earth, so its shadow is smaller than the Earth. On the other hand, if a lunar eclipse happens, whether it is total or partial, half of the whole world can watch it. I mean, the places where the Moon is visible at that hour.

Problem 1. Explain why the solar eclipse is possible only when the Moon is a new moon, and the lunar eclipse is possible only when the Moon is a full moon. (Hint: See Fig. 1 of "The phases of the Moon.")

Having solved Problem 1, you may think that we have a solar eclipse every new moon and a lunar eclipse every full moon. This is not true. We usually have only two or three solar eclipses and two or three lunar eclipses per year. Let me explain why. It's because the plane on which the Sun moves (i.e., ecliptic) and the plane on which the Moon moves are not the same but they are slanted by about 5 degrees. See the figure below.



The intersections of the two planes are called "lunar nodes." You see that there are two lunar nodes: the ascending node and the descending node. In the ascending node, the Moon ascends above the ecliptic, and in the descending node, the Moon descends below the ecliptic.

So, unless both the Moon and the Sun are not located at the nodes, the Earth, the Moon, and the Sun can never be on a straight line, in which case we have eclipses. From the picture, it is also easy to see that we have a solar eclipse if the Sun and the Moon are at the same node and that we have a lunar eclipse if the Sun and the Moon are at the opposite nodes.

Notice also that it takes about half a year for the Sun to move from one lunar node to the other. In other words, the Sun is usually at the lunar nodes twice a year. So usually, we have two solar eclipses and two lunar eclipses per year. However, we sometimes have more. The reason is that the lunar nodes are not points but domains around the points as the Sun and the Moon are not points. It is not necessary that the center of the Sun, the center of the Moon and the center of the Earth are on a straight line for eclipses to happen. It is just sufficient that the one shadows part of the other. That is the reason why the lunar nodes are marked as domains rather than as points in Fig. 1. Therefore, solar (or lunar) eclipses sometimes happen in two consecutive months. Moreover, a solar (or a lunar) eclipse can happen in the beginning of the year (i.e., early January) and can happen again at the end of the year (i.e., late December). Furthermore, the lunar nodes themselves move slowly, while the inclination angle 5 degrees is maintained. Therefore, while there are usually 6 months between solar (or lunar) eclipses, sometimes there are 5. These are the reasons why we can have more than two solar (or lunar) eclipses in a year.

Problem 2. Explain why solar eclipses happen half a month before or after lunar eclipses.

Summary

- When the Sun is covered by the Moon, we cannot see the Sun. This is called "solar eclipse." A solar eclipse is visible at the place of the Earth where the shadow of the Moon lies.
- When the Moon is in the shadow of the Earth, we cannot see the Moon. This is called "lunar eclipse."