WHAT CAUSES A LUNAR ECLIPSE?

A lunar eclipse can only happen at full moon. Only then is it possible for the moon to be directly opposite the sun in our sky, and to pass into the Earth's dark umbral shadow. Most of the time, however, the full moon eludes the Earth's shadow by swinging to the north of it, or south of it. For instance, the March 2015 full moon swung south of the Earth's shadow. Next month the full moon will swing north of the Earth's shadow.

The moon's orbital plane around Earth is actually inclined at 5degrees to the ecliptic – Earth's orbital plane around the sun. However, the moon's orbit intersects the ecliptic at two points called nodes. It's an ascending node where it crosses the Earth's orbital plane going from south to north, and a descending node where it crosses the Earth's orbital plane, going from north to south. **In short, a lunar eclipse happens when the full moon closely coincides with one of its nodes, and a solar eclipse happens when a new moon does likewise.** It's not a perfect alignment this time around, with the moon crossing its ascending node about 9 hours before the moon turns full. But that's close enough for the moon to stage a total lunar eclipse, even if it happens to be the shortest one of the 21st century!

The yellow circle shows the sun's apparent yearly path (the ecliptic) in front of the constellations of the Zodiac. The gray circle displays the monthly path of the moon in front of the zodiacal constellations. If a new moon or full moon aligns closely with one of the moon's nodes, then an eclipse is in the works. Lunar (and solar) eclipses come in cycles alternating after 9 years and 5.5 days. So, the same particular eclipse will again occur after 18 year eleven days and 8 hours. Lunar eclipses at the descending node have odd saros series numbers. **The name "saros" was coined to the eclipse cycle by Edmond Halley in 1691, based on an earlier Chaldean (Babylonian) expression for repeating dates. A series of eclipses that are separated by one saros is called a saros series.**

Three periodicities related to lunar orbit, the **synodic month**, the **draconic month**, and the **anomalistic month** coincide each saros cycle.

- A "synodic" month (used in western calendars) is defined as the time interval between two consecutive occurrences of a particular Moon phase as seen by an observer on Earth. **Its mean length is 29 days, 12 hours, 44 minutes, 2.8 seconds.** Due to the eccentric orbit of the lunar orbit around Earth (and to a lesser degree, the Earth's elliptical orbit around the Sun), the length of a synodic month varies up to seven hours.
- A "sidereal" month is approximately equal to the time it takes the Moon to pass twice a "fixed" star in a non-rotating frame of reference. It is about **27.32166 days (27 days, 7 hours, 43 minutes, 11.6 seconds**. The exact duration cannot be easily determined, because of the movement of reference stars.
- A "draconic" month (or nodal month) is the period in which **the Moon returns to the same node of its orbit and passes through the ecliptic plane, a 27.21222 day period**.
- An "anomalistic" month is the average time the Moon takes to go from perigee to perigee - the point in the Moon's orbit when it is closest to Earth. **An anomalistic month is about 27.55455 days on average**.

After one saros, the Moon will have completed roughly an integer number of lunar orbit cycles and synodic, draconic, and anomalistic periods (241, 223, 242, and 239) and the Earth-Sun-Moon geometry will be nearly identical: the Moon will have the same phase and be at the same node and the same distance from the Earth. In addition, because the saros is close to 18 years in length, the earth will be nearly the same distance from the sun, and tilted to it in nearly the same orientation (same season). Because the saros is not an integer number of days, but contains the fraction of 1/3 of a day, after three saros eclipse intervals, the local time of day of an eclipse will be nearly the same. This three saros interval (19,755.96 days) is known as a triple saros or *exeligmos* (Greek: "turn of the wheel") cycle.

AK, from Astronomy 2015 and Wikipedia.