

Illuminating Science Through Darkness 2 - In Earth's Shadow

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What to do when there is a "Bad Moon Arising!"

Traditionally a total lunar eclipse is an interesting public event for astronomy teachers but it doesn't have as much value scientifically as a total solar eclipse. It's more interesting for its historical effects and its various colorations. Here's what you can do when a total eclipse is scheduled to occur.

Lunar Shadow Coloration



The earth's shadow isn't totally dark, even in the umbra, the dark central shadow cone behind the earth. This is because we have an atmosphere and some of the sunlight coming at it does miss the earth but hits the air and is bent or refracted away from its straight line path right into the shadow cone. The easiest light to bend is red so the shadow seen on the Moon often has a reddish tinge to it. This is a sign that most of the sunrises and sunsets in the world at that time are occurring in clear air.

What if the air isn't clear? What if the light is blocked or scattered differently? Then the red light doesn't make it through and the Moon is a gray or even black disk in the sky during totality. This happens often when there has been tremendous volcanic activity filling the atmosphere with aerosols and dust particles.

The Moon can look any color in between the two extremes. In the 1970's I witnessed two eclipses that were as red as drops of blood. In the 1960's one eclipse took place in an atmosphere so choked with volcanic debris that the Moon was virtually black, and in fact, faded below the level of brightness a human eye can see! You could not see the eclipsed Moon, unless you used binoculars!



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Astronomers use the Danjon scale to describe what color the eclipsed Moon has. Created by a French astronomer, the "L" value of an eclipse varies from 0 to 4, see the box below. The L value can lie in between the units in any eclipse. If you use this as a teachable moment, take an average, and make a histogram of the results to discuss variations and error analysis.

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Note that often the shadow has more than just a red color. There are sometimes bluish tinted regions, yellowish and white zones such that the Moon actually looks a lot like a soap bubble with iridescent edges! A useful project is to document the color zones on a series of Moon circles over time and see how they shift around.

Now you see it..!

A shadow edge is not only fuzzy but for the penumbra, it's invisible. The penumbra is so diffuse that nobody can see it first touching the Moon. Only when it gets thick enough does a little dusky shading appear on the Moon's leading edge. Usually this is about 20 minutes before the Moon contacts the umbra. Try timing the four moments of first/last contacts: when penumbral shading is first visible, and last seen, and when umbral contact starts and ends. The times vary a bit depending on the use of binoculars or just eyes.



Danjon Color Scale

- L = 0 Very dark eclipse, Moon almost invisible, especially at mid-totality.
- L = 1 Dark eclipse, gray or brownish in coloration. Details distinguishable only with difficulty.
- L = 2 Deep red or rust-colored eclipse. Very dark central shadow, while outer edge of umbra is relatively bright.
- L = 3 Brick-red eclipse. Umbral shadow usually has a bright or yellow rim.
- L = 4 Very bright copper-red or orange eclipse. Umbral shadow has a bluish, very bright rim.