

## Quadrant II – Transcript and Related Materials

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### Notes

A solar eclipse occurs when the moon gets between Earth and the sun, and the moon casts a shadow over Earth. A solar eclipse can only take place at the phase of new moon, when the moon passes directly between the sun and Earth and its shadows fall upon Earth's surface. But whether the alignment produces a total solar eclipse, a partial solar eclipse or an annular solar eclipse depends on several factors, all explained below.

The fact that an eclipse can occur at all is a fluke of celestial mechanics and time. Since the moon formed about 4.5 billion years ago, it has been gradually moving away from Earth (by about 1.6 inches, or 4 CM per year). Right now the moon is at the perfect distance to appear in our sky exactly the same size as the sun, and therefore block it out. But this is not always true.

How Solar Eclipses Work: When the moon covers up the sun, skywatchers delight in the opportunity to see a rare spectacle. See how solar eclipses occur in this Space.com infographic. How Solar Eclipses Work: When the moon covers up the sun, skywatchers delight in the opportunity to see a rare spectacle. See how solar eclipses occur in this Space.com infographic.

Types of solar eclipses

There are four types of solar eclipses: total, annular, partial and hybrid. Here's what causes each type:

## Total solar eclipses

These are a happy accident of nature. The sun's 864,000-mile diameter is fully 400 times greater than that of our puny moon, which measures just about 2,160 miles. But the moon also happens to be about 400 times closer to Earth than the sun (the ratio varies as both orbits are elliptical), and as a result, when the orbital planes intersect and the distances align favorably, the new moon can appear to completely blot out the disk of the sun. On the average a total eclipse occurs somewhere on Earth about every 18 months.

There are actually two types of shadows: the umbra is that part of the shadow where all sunlight is blocked out. The umbra takes the shape of a dark, slender cone. It is surrounded by the penumbra, a lighter, funnel-shaped shadow from which sunlight is partially obscured.

During a total solar eclipse, the moon casts its umbra upon Earth's surface; that shadow can sweep a third of the way around the planet in just a few hours. Those who are fortunate enough to be positioned in the direct path of the umbra will see the sun's disk diminish into a crescent as the moon's dark shadow rushes toward them across the landscape.

During the brief period of totality, when the sun is completely covered, the beautiful corona — the tenuous outer atmosphere of the sun — is revealed. Totality may last as long as 7 minutes 31 seconds, though most total eclipses are usually much shorter.

## Partial solar eclipses

A partial solar eclipse occurs when only the penumbra (the partial shadow) passes over you. In these cases, a part of the sun always remains in view during the eclipse. How much of the sun remains in view depends on the specific circumstances.

Usually the penumbra gives just a glancing blow to our planet over the polar regions; in such cases, places far away from the poles but still within the zone of the penumbra might not see much more than a small scallop of the sun hidden by the moon. In a different scenario, those who are positioned within a couple of thousand miles of the path of a total eclipse will see a partial eclipse.

The closer you are to the path of totality, the greater the solar obscuration. If, for instance, you are positioned just outside of the path of the total eclipse, you will see the sun wane to a narrow crescent, then thicken up again as the shadow passes by.

## Annular solar eclipses

An annular eclipse, though a rare and amazing sight, is far different from a total one. The sky will darken ... somewhat; a sort of weird "counterfeit twilight" since so much of the sun still shows. The annular eclipse is a subspecies of a partial eclipse, not total. The maximum duration for an annular eclipse is 12 minutes 30 seconds.

However, an annular solar eclipse is similar to a total eclipse in that the moon appears to pass centrally across the sun. The difference is, the moon is too small to cover the disk of the sun completely. Because the moon circles Earth in an elliptical orbit, its distance from Earth can vary from 221,457 miles to 252,712 miles. But the dark shadow cone of the moon's umbra can extend out for no longer than 235,700 miles; that's less than the moon's average distance from Earth.

So if the moon is at some greater distance, the tip of the umbra does not reach Earth. During such an eclipse, the antumbra, a theoretical continuation of the umbra, reaches the ground, and anyone situated within it can look up past either side of the umbra and see an annulus, or "ring of fire" around the moon. A good analogy is putting a penny atop a nickel, the penny being the moon, the nickel being the sun.

#### Hybrid solar eclipses

These are also called annular-total ("A-T") eclipses. This special type of eclipse occurs when the moon's distance is near its limit for the umbra to reach Earth. In most cases, an A-T eclipse starts as an annular eclipse because the tip of the umbra falls just short of making contact with Earth; then it becomes total, because the roundness of the planet reaches up and intercepts the shadow tip near the middle of the path, then finally it returns to annular toward the end of the path.

Because the moon appears to pass directly in front of the sun, total, annular and hybrid eclipses are also called "central" eclipses to distinguish them from eclipses that are merely partial.