Why Does Sunlight Spread?
It’s easy to demonstrate that sunlight that passes through a small hole, or that is reflected from a small mirror, forms a disk of light with a diameter that steadily increases with increasing distance. Students with some knowledge of optics often incorrectly attribute this “spreading” to diffraction. The figure below shows what such a student might picture.

In reality, simple geometry is sufficient to explain why sunlight “spreads”. Consider two light rays from different parts of the sun that meet at an angle $\theta$ at the hole. The angle between the rays is unaffected by the hole as shown in the figure below.

Angular Size
The maximum angle between the rays is known as the angular size of the sun, $\alpha$. To find this angle we can use the small angle approximation, a simplification for trigonometric calculations.

Therefore the angle is simply the ratio of the solar diameter to the solar distance. Similarly, the angular size of a solar image is the ratio of its diameter to its distance from the hole or mirror.

Angular Size and Time
The angular size of the sun is approximately $1/100$ radian, or 0.5 degree. Since there are 360 angular degrees in a day, and 1440 minutes of time, the sun moves across the sky by its own diameter every two minutes. To confirm this, we taped a black sheet of paper with a hole in it to a window in a hallway. We observed the solar image on a piece of paper across the hallway. The initial image was traced and traced again after two minutes and four minutes elapsed.

Accuracy of Our Method
The six measurements are shown as the red points in the plot below; these points are in very good agreement with the solid black line, which is a prediction with no adjustable parameters. The diameter of the image, $d$, is proportional to $D$ for sufficiently large values of $D$. However, for $D=0$, $d$ must be equal to the diameter of the hole, $d_0$. Therefore we assumed that the prediction curve can be represented by a hyperbolic function:

$$d = \sqrt{d_0^2 + \alpha^2 D^2}$$

A least-squares analysis shows that the method has a sensitivity of better than one-half percent, more than sufficient to observe seasonal variations in $\alpha$ (see figure at left).

Measuring the Angular Size of the Sun
To determine the angular size of the sun we covered a mirror with black paper that had a ~3 mm hole made with a pencil. The mirror was attached to a stand then placed in a hallway facing the sun. To measure the reflected solar image, we created a measuring template with six concentric circles ranging from 5.0 to 30.0 mm in diameter. One person held the template in the path of the reflected image and varied the template’s distance from the mirror until the image fit one of the circles. The other person measured this distance with a measuring tape. We repeated this procedure for each circle.

The figure below shows what such a student might picture.

In the figure below, the solar distance, $D$, is on the $x$-axis and the angular size, $\alpha$, is on the $y$-axis.

Shadows
Simple geometry also explains why an object’s shadow blurs as the height of the object increases.

A majority of the sunlight is blocked out by the object causing a defined dark shadow to be projected behind the object. As the object’s distance from the screen increases a small amount of sunlight is able to “get behind” the object.

The three parts of a solar eclipse (umbra, penumbra, antumbra) are also explained by the angular size of the moon and sun and the relative position of an observer.