Can We Measure the Diameter of the Sun?

How can we measure sizes and distances of objects in space?

The measurement of sizes and distances in space has been crucial to establishing our current conception of the universe. Many of these measurements have histories that go back thousands of years. For example, a little over 2,000 years ago the ancient Greeks used several methods (one based on observation of a Lunar eclipse, and one based on the phenomenon of *parallax*) to estimate the distance from the Earth to the Moon. Once that distance (about 384,000 km) was known, other distances, such as the distance from the Earth to the Sun (about 149 million km) could be estimated using geometry and the parallax. Due to instrumental precision, the parallax method is useful only to distances of about 100 parsecs (326 light years) for Earth-based telescopes, and out to about 1,000 parsecs (3,260 light years) for space-based telescopes. Longer distances are determined via *red shift* (not discussed here).

If we know the distance to the Sun…

Using very simple instrumentation and a little bit of mathematics, we can actually estimate the diameter of the Sun. In order to do so, we are going to use a pinhole camera and the distance between the Earth and the Sun.

First, just examine the behavior of a simple pinhole camera: make a small pinhole in a piece of paper, take another piece of paper for projecting the image, and head outside. Face the pinhole toward the Sun, and examine the projected image on the other piece of paper. Change the distance between the pinhole and the paper, and observe the changes in the image.

Make a few measurements: measure the distance between the sheets of paper, and the size of the image. Do this for about three different distances.

Making a more precise measurement

Now that you have some idea of how the pinhole camera works, and of the relationship between the size of the image and the distance of the image from the pinhole, let's try making a more precise measurement. To do this, use a long cardboard tube with aluminum foil on one end (put a pinhole in the aluminum foil), and a piece of vellum graph paper on the other end (so that you can see the image and estimate its size). Measure the length of your tube, and the size of the image.

Is the size of the image related to the size of the Sun?

Can you think of a way to relate the size of the pinhole camera image to the size of the Sun?

(Hint: If you know the characteristics of your measuring instrument and the distance between the Earth and the Sun, you have enough information to estimate the diameter of the Sun!)

Talk it over with your partners/group members, then try to calculate the size of the Sun!

Questions

1) Briefly explain your strategy for calculating the diameter of the Sun.

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2) First, use your "simple" pinhole camera measurements to estimate the diameter of the Sun. Calculate at least two estimates using two different measurements.

3) Use the more precise pinhole camera instrument to estimate the diameter of the Sun.

4) Look up the actual diameter of the Sun. How far off were your estimates? Did the more precise instrument give you a better estimate?
