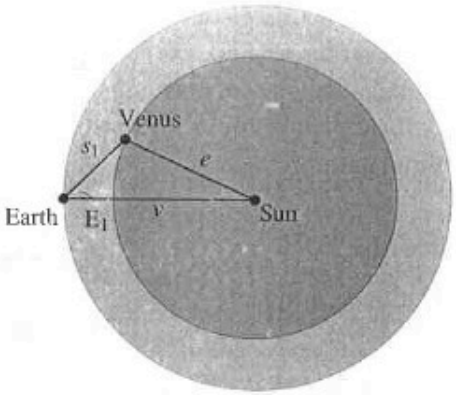
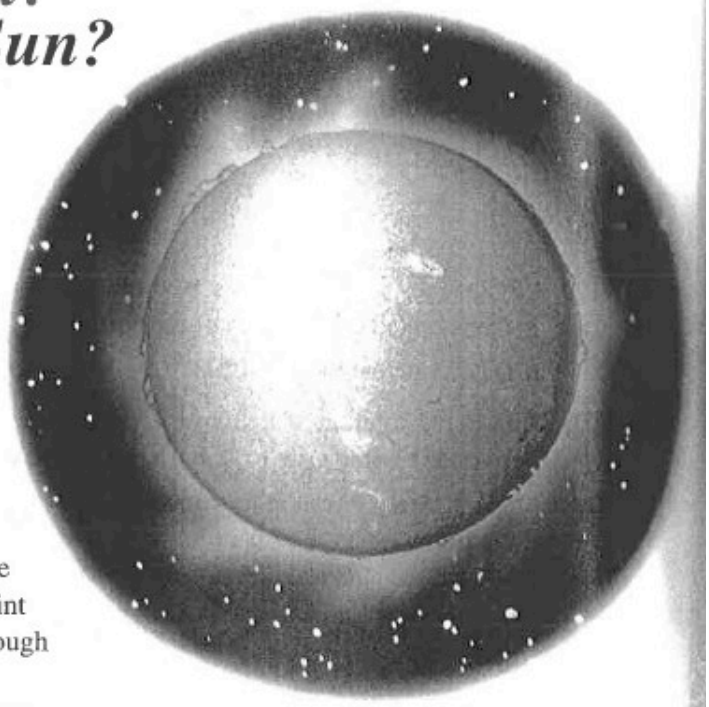
How Far Is the Sun? How Large Is the Sun?

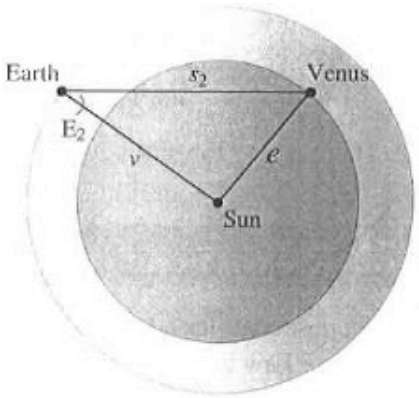




Have you heard the term "evening star"? People sometimes use this term to describe the first point of light in the western sky as the sun sets. Although this may look like a star, it is the planet Venus. The light you see is sunlight reflecting from Venus.

DEVELOP A MODEL

In our model we will assume that Earth and Venus move in circular orbits around the sun. They might appear as shown above. One month later, they would appear as shown at the right.



The distance v from Earth to the sun is the same in both cases. So is the distance e from Venus to the sun.

An observer on Earth can measure $\angle E_1$ and $\angle E_2$ on these two diagrams. Furthermore, by bouncing a radar signal off Venus, astronomers can calculate the distances s_1 and s_2. When these four measures are known, you can use trigonometry to calculate the distance v from Earth to the sun.

1. One evening, the planets appeared as in the first diagram. Astronomers measured $\angle E_1 = 31.8^\circ$ and $s_1 = 53.1$ million km. Use this information and your knowledge of trigonometry. Write an equation relating v and e.

2. One month later, the planets appeared as in the second diagram. This time astronomers measured $\angle E_2 = 29.3^\circ$ and $s_2 = 210.2$ million km. Use this information to write another equation relating v and e.

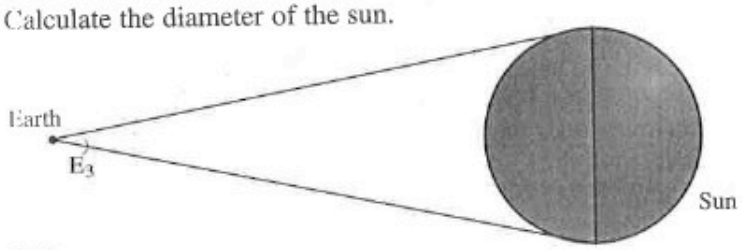
3. Combine the equations to obtain an equation involving v alone. Solve this equation to determine the distance from Earth to the sun.

LOOK AT THE IMPLICATIONS

When we know the distance to the sun, we can use it to determine other distances.

4. Calculate the distance from Venus to the sun.

5. Astronomers can measure $\angle E_3$ in this diagram. The result is approximately 0.532°. Use this information and the distance to the sun from exercise 3. Calculate the diameter of the sun.



REVISIT THE SITUATION

6. The radar signals astronomers use to calculate the distance to Venus travel at the speed of light, 3×10^5 km/s. In the diagrams on page 522, it took 5.90 min and 23.36 min, respectively, for the reflected signals to return to Earth. Use this information to confirm that the distances s_1 and s_2 are correct.

7. a) Calculate how far Earth travels in one year in its orbit around the sun.
   b) Calculate Earth's speed in kilometres per hour.

8. The orbits of Earth and Venus are so close to being circles that on the scale of the diagrams on page 522, you would not be able to tell they were not circles.
   a) Do you think the assumption that the orbits are circles has a significant effect on the results?
   b) Where in the calculations did we use the fact that the orbits are circles?