



Earth's orbit is not a perfect circle centered on the sun, but an ellipse! Because of this, in January, Earth is slightly closer to the sun than in July. This means that the sun will actually appear to have a bigger disk in the sky in January than in July...but the difference is impossible to see with the eye, even if you could do so safely!

The figure above shows the sun's disk taken by the SOHO satellite. The left side shows the disk on January 4 and the right side shows the disk on July 4, 2009. As you can see, the diameter of the sun appears to change slightly between these two months.

Problem 1 - What is the average diameter of the Sun, in millimeters, in this figure?

Problem 2 - By what percentage did the diameter of the Sun change between January and July compared to its average diameter?

Problem 3 - If the average distance to the Sun from Earth is 149,600,000 kilometers, how much closer is Earth to the Sun in July compared to January?

Problem 1 - What is the average diameter of the Sun, in millimeters, in this figure?

Answer: Using a millimeter ruler, and measuring vertically along the join between the two images, the left-hand, January, image is 72 millimeters in diameter, while the right-hand image is 69 millimeters in diameter. The average of these two is $(72 + 69)/2 = 70.5$ millimeters.

Problem 2 - By what percentage did the diameter of the Sun change between January and July compared to its average diameter?

Answer: In January the moon was larger than the average diameter by $100\% \times (72 - 70.5)/70.5 = 2.1\%$. In July it was smaller than the average diameter by $100\% \times (70.5 - 69)/70.5 = 2.1\%$.

Problem 3 - If the average distance to the Sun from Earth is 149,600,000 kilometers, how much closer is Earth to the Sun in July compared to January?

Answer: The diameter of the sun appeared to change by $2.1\% + 2.1\% = 4.2\%$ between January and July. Because the apparent size of an object is inversely related to its distance (i.e. the farther away it is the smaller it appears), this 4.2% change in apparent size occurred because of a 4.2% change in the distance between Earth and the Sun, so since $0.042 \times 149,600,000 \text{ km} = 6,280,000$ kilometers, the change in the Sun's apparent diameter reflects the 6,280,000 kilometer change in earth's distance between January and July. The Earth is **6,280,000 kilometers closer to the Sun in July than in January.**