

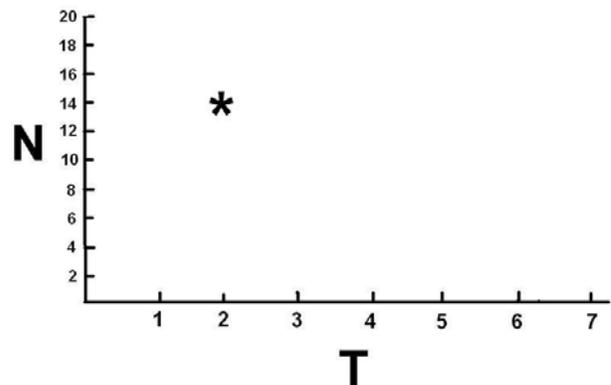
Space Math

NASA's Kepler spacecraft recently announced the discovery of five new planets orbiting distant stars. The satellite measures the dimming of the light from these stars as planets pass across the face of the star as viewed from Earth. To see how this works, let's look at a simple model.

In the Bizarro Universe, stars and planets are cubical, hot spherical. Bizarro astronomers search for distant planets around other stars by watching planets pass across the face of the stars and cause the light to dim.

Problem 1 - The sequence of figures shows the transit of one such planet, Osiris (black). Complete the 'light curve' for this star by counting the number of exposed 'star squares' not shaded by the planet. At each time, T , create a graph of the number of star brightness squares. The panel for $T=2$ has been completed and plotted on the graph below.

Problem 2 - If you knew that the width of the star was 1 million kilometers, how could you use the data in the figure to estimate the width of the planet?



Problem 1 - The sequence of figures shows the transit of one such planet, Osiris (black). Complete the 'light curve' for this star by counting the number of exposed 'star squares' not shaded by the planet. At each time, T , create a graph of the number of star brightness squares. The panel for $T=2$ has been completed and plotted on the graph below.

Answer: Count the number of yellow squares in the star and plot these for each value of T in the graph as shown below. Note, for $T=3$ and 5 , the black square of the planet occupies 2 full squares and 2 half squares for a total of $2 + 1/2 + 1/2 = 3$ squares covered, so there are $16 - 3 = 13$ squares remaining that are yellow.

Problem 2 - If you knew that the width of the star was 1 million kilometers, how could you use the data in the figure to estimate the width of the planet?

Answer: The light curve shows that the planet caused the light from the star to decrease from 16 units to 12 units because the planet blocked $16 - 12 = 4$ units of the stars surface area. That means that the planet squares occupy $4/16$ of the stars area as seen by the astronomers. The area of the star is just the area of a square, so the area of the square planet is $4/16$ of the stars area or $A_p = 4/16 \times A_{star}$. Since the star has a width of $W_{star} = 1$ million kilometers, the planet will have a width of $W_p = W_{star} \sqrt{\frac{4}{16}}$ or **500,000 kilometers**.

The amount of star light dimming is proportional to the ratio of the area of the planet and the star facing the observer. The Kepler satellite can detect changes by as little as 0.0001 in the light from a star, so the smallest planets it can detect have diameters about 1/100 the size of the stars that they orbit. For a star with a diameter of the sun, 1.4 million kilometers, the smallest planet detectable by the Transit Method has a diameter about equal to 14,000 kilometers or about the size of Earth.

