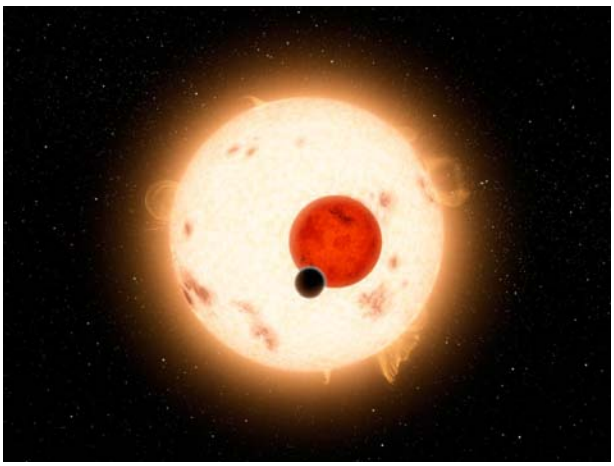

NASA's Kepler mission has discovered a world where two suns set over the horizon instead of just one. The planet, called Kepler-16b, is the most "Tatooine-like" planet yet found in our galaxy. Tatooine is the name of Luke Skywalker's home world in the science fiction movie *Star Wars*. In this case, the planet it not thought to be habitable. It is a cold world, with a gaseous surface, but like Tatooine, it circles two stars.

The planet orbits two stars, Kepler 16A and Kepler-16B located 200 light years from Earth. (Image credit: NASA/JPL-Caltech/R. Hurt)

The Saturn-sized planet Kepler-16b, orbits Kepler-16A at a distance of 0.7 Astronomical Units or 105 million kilometers. Its orbit is nearly a perfect circle. The smaller star Kepler-16B orbits its more massive companion at a distance of 0.2 Astronomical Units or 30 million kilometers. The diameters of the two stars are 890,000 kilometers and 300,000 kilometers respectively.

Problem 1 – Suppose you were standing on the surface of ‘Tatooine’ and watching (safely!) these two stars in the sky, perhaps much like Luke Skywalker was watching his twin suns near sunset. In terms of angular degrees, and by using the definition of the tangent of an angle, what would be the greatest separation between these two stars as they orbited one another to the nearest degree?

Problem 2 - At the time the stars are farthest apart in the sky, what would be the angular diameters of each star as viewed from Tatooine?

Problem 1 – Suppose you were standing on the surface of 'Tatooine' and watching (safely!) these two stars in the sky, perhaps much like Luke Skywalker was watching his twin suns near sunset. In terms of angular degrees, and by using the definition of the tangent of an angle, what would be the greatest separation between these two stars as they orbited one another to the nearest degree?

Answer: The geometry of this viewing triangle is that the adjacent side is the distance of Tatooine from Kepler-16A, which is 105 million kilometers, and the opposite side is the distance between Kepler-16A and 16B, which is 30 million kilometers.

The maximum separation angle is then

Tan(θ) = 30/105
= 0.286, so arctangent(0.286) = **16 degrees**.

Problem 2 - At the time the stars are farthest apart in the sky, what would be the angular diameters of each star as viewed from Tatooine?

Answer: The distance to **Kepler-16A** is just 105 million kilometers. Its diameter is 890,000 km, then

Tan(θ) = 0.89/105
= 0.00848 and arcTan(0.00848) = **0.49 degrees**.

For **Kepler-16B**, the problem is a bit tricky because the distance from Tatooine to Kepler-16B is now the hypothenuse of the triangle in Problem 1, which is $d^2 = (105)^2 + (30)^2$ so d = 109 million km. Then the angular diameter of Kepler-16B is just

Tan(θ) = 0.3/109
= 0.00275 so arcTan(0.00275) = **0.16 degrees**.

As seen from Earth, our sun (and moon) have angular diameters of 0.5 degrees by comparison.

Note, as a preliminary activity, have students sketch the two stars in the afternoon sky at what they think might be their sizes as seen from Tatooine. After completing these two problems, students may sketch the same scene in which the two stars are located in the sky at their proper angular scales, and compare with their first guesses.

For more details read the Press Release on September 15, 2011:

NASA's Kepler Mission Discovers a World Orbiting Two Stars

http://www.nasa.gov/mission_pages/kepler/news/kepler-16b.html