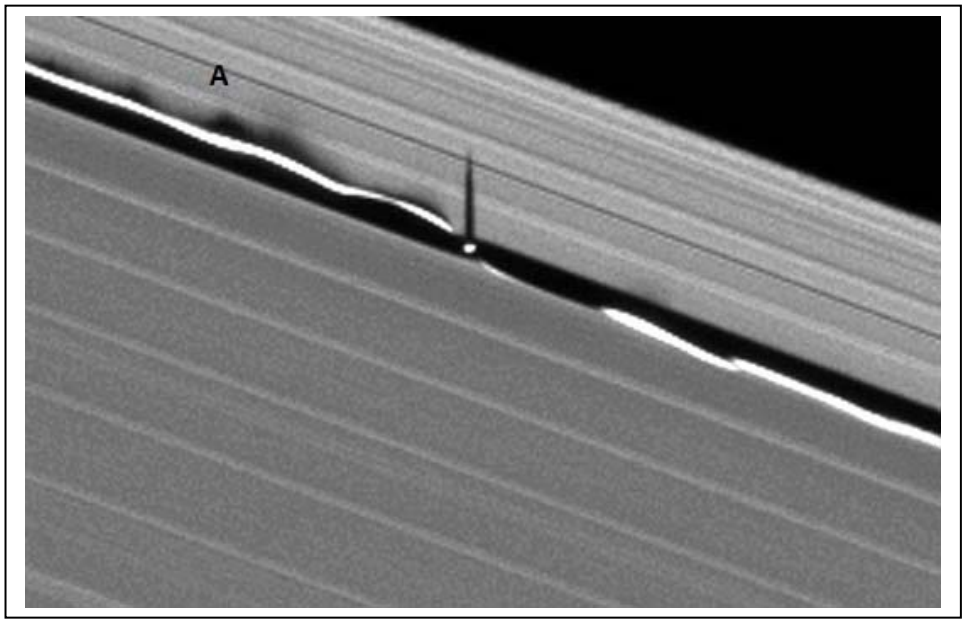

Never-before-seen looming vertical structures, created by the tiny moon Daphnis, cast long shadows across Saturn's A Ring in this startling image taken by the Cassin spacecraft. The 8-kilometre-wide moon Daphnis orbits within the 42-kilometre-wide Keeler Gap in Saturn's outer A Ring, and its gravitational pull perturbs the orbits of the particles forming the gap's edges. The Keeler Gap is foreshortened and appears only about 30 km wide because the image was taken at an angle of about 45 degrees to the ring plane.

Problem 1 – If the apparent perpendicular width of the Keeler Gap is 30 km, what is the length of the shadow of Daphnis in this image?

Problem 2 – Rounded to the nearest kilometer, what is the length of Shadow A to the left from Daphnis?

Problem 3 – Create a scaled model of this ring area and its 45 degree inclination, and using right triangles, estimate the elevation angle of the sun above the ring plane.

Problem 4 – From your scaled model, what is the height of the feature that is casting Shadow A on the ring plane?

Problem 1 – If the apparent (foreshortened) perpendicular width of the Keeler Gap is 30 km, what is the corresponding foreshortened length of the shadow of Daphnis in this image?

Answer: After printing this page on standard 8 ½ x 11 paper, the perpendicular width of the Keeler Gap is about 4 millimeters, which corresponds to 30 km, so the scale is 30 km/4mm = 7.5 km/mm. The length of the moonlets shadow is 12 mm, so its projected length is 12 x 7.5 = **90 km**.

Problem 2 – Rounded to the nearest kilometer, what is the length of Shadow A to the left from Daphnis?

Answer: Students may obtain 5 mm if they measure from the inner edge of the white band, or 3 mm if they measure from the outer edge of the white band. These measurements correspond to **23 km or 38 km**.

Problem 3 – Create a scaled model of this ring area and its 45 degree inclination, and using right triangles, estimate the elevation angle of the sun above the ring plane.

Answer: For the shadow of Daphnis, the true shadow length is the hypotenuse of a 45-45-90 right triangle ABD, and its shadow length in the image is the horizontal side along segment BC of this triangle, so the hyponenuse (segment AB) length is 90 km x $(2)^{\mathbf{1/2}}$ = 127 km. The diameter of the moon is 8 km, so the sun angle for the shadow on the ring plane is a triangle whose sides are AC=8 km and BC = 127 km. The angle to the sun ABC can be measured with a protractor and is Tan(Theta) = 8km/127km so to the nearest degree, **Theta = 4 degrees**.

Problem 4 – From your scaled model, what is the height of the feature that is casting Shadow A on the ring plane?

Answer: The projected height of the shadow is 23 or 38 km. The true shadow length is then
23 x $(2)^{\mathbf{1/2}}$ = 33 km or
38 x $(2)^{1/2}$ = 54 km.

The sun angle above the ring plane is 4 degrees, so if the right triangle ABC has side BC = 33 km then the height of segment AC can be measured with a protractor as about 33xTan(4) = **2.3 km**, or using the second shadow measurement 54xtan(4) = **3.8 km**.

Note: Astronomers find it amazing that even though the A ring has a thickness of about 10 meters, the wave produced by this small moon rises over 200 times higher above the ring plane than the thickness of the rings themselves!