

Galaxy Distances & Mixed Fractions



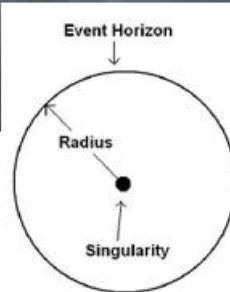
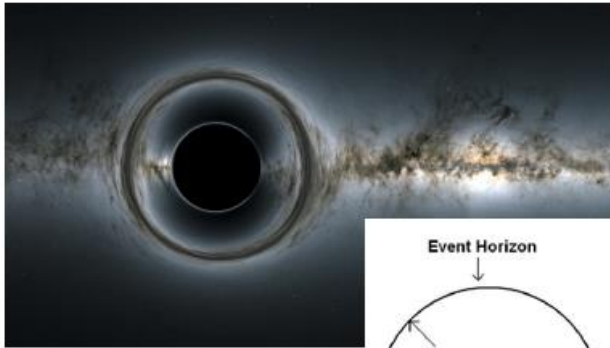
Problem 1 - The Andromeda Galaxy is $3/4$ mpc from the Milky Way, while the Sombrero Galaxy is 12 mpc from the Milky Way. How much further is the Sombrero Galaxy from the Milky Way?

Problem 2 - The Pinwheel Galaxy is $3 \frac{4}{5}$ mpc from the Milky Way. How far is it from the Sombrero Galaxy?

Problem 3 - The Virgo Galaxy Cluster is 19 mpc from the Milky Way. About how far is it from the Pinwheel Galaxy?

One "megaparsec" (mpc) is about $3 \frac{1}{4}$ million light years.

The Event Horizon



Problem 1 - Calculate the Schwarzschild radius (in cm) for Earth.

Problem 2 - Calculate the Schwarzschild radius (in km) for the sun.

$$M_{\text{earth}} = 5.7 \times 10^{27} \text{ grams}$$

$$M_{\text{sun}} = 1.98 \times 10^{33} \text{ grams.}$$

$$\text{Radius} = 1.48 \times 10^{-28} \text{ M centimeters}$$

Exploring Black Holes



Radius = 1.48×10^{-28} **M** centimeters

Suppose we could turn our planets and moons into black holes! How big would they be?

On a piece of paper, use a ruler and a compass to make circles that are as large as the black holes for each planet in our solar system. Also include the Sun, Moon and Pluto in your calculations.

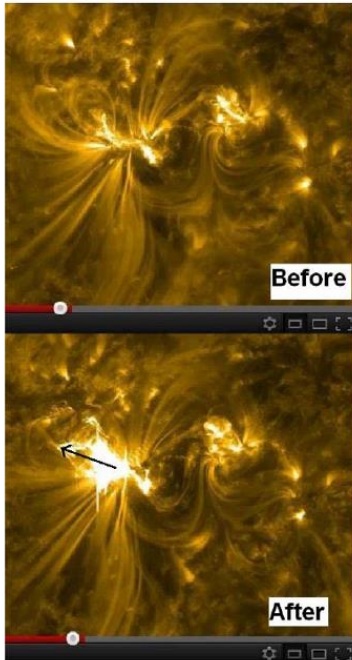
Use this [Solar System Model](#) to determine how far apart you would need to place each of these (set the sun scale to 10 mm if you'd like it all to fit in under 140 feet).



Click here for the [Solar System Model](#) link mentioned above.

Mass of Objects:

- Mercury 3.3011 E26 grams
- Venus 4.86732 E27 grams
- Moon 7.34767 E25 grams
- Mars 6.41693 E26 grams
- Pluto 1.30900 E25 grams
- Jupiter 1.898 E 30 grams
- Saturn 5.68319 E29 grams
- Uranus 8.68103 E28 grams
- Neptune 1.0241 E29 grams



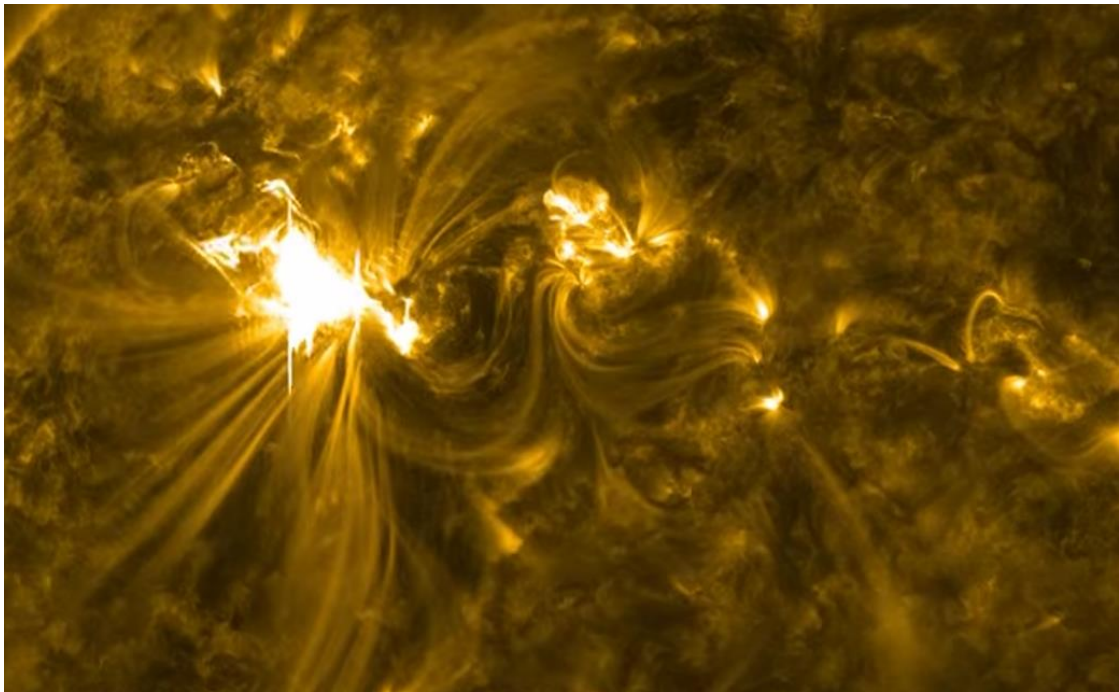
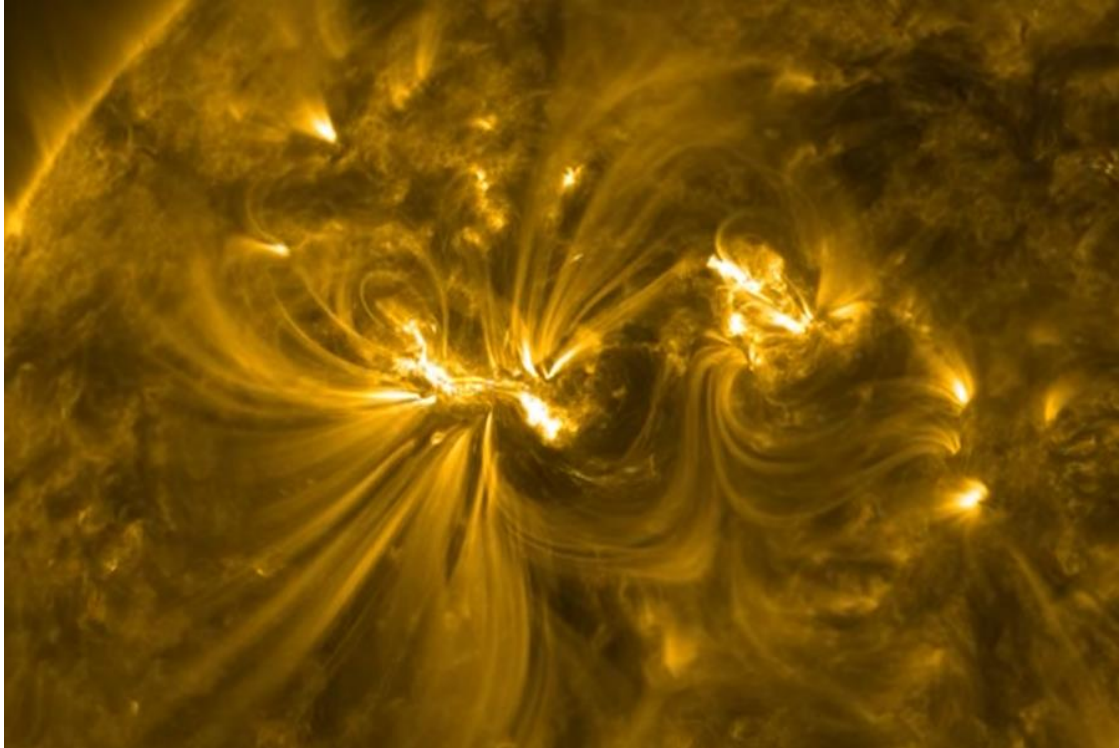
Magnetic Field Speeds on the Sun

On March 6, 2012 Active Region 1429 produced a spectacular X5.4 solar flare shown in the pair of images taken by the NASA Solar Dynamics Observatory. The time between the two images is 2 seconds, and the width of each image is 318,000 kilometers.

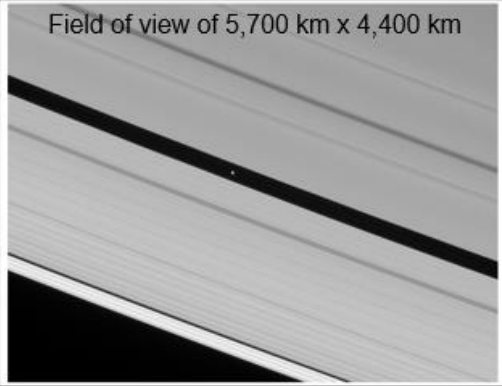
Problem 1 - The arrowed line indicates how far the million-degree gas produced by the flare traveled in the time interval between the images. What was the speed of the gas, called a plasma, in kilometers/sec?

Problem 2 - By carefully looking at the two images, what other features can you find that changed their position in the time between the images?

Click to watch the original video of the [Massive Solar Flare](#).



Field of view of 5,700 km x 4,400 km



Pan's Highway in Saturn's Rings

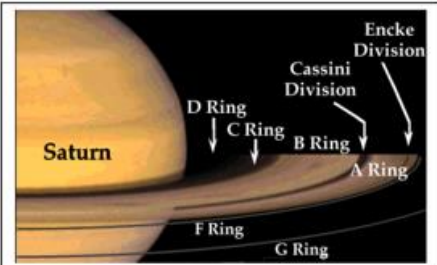
Problem 1 - This top image was taken by Cassini in 2007 and at the satellite's distance of 1 million kilometers.

With the help of a millimeter ruler, what is the scale of the image in kilometers per millimeter?

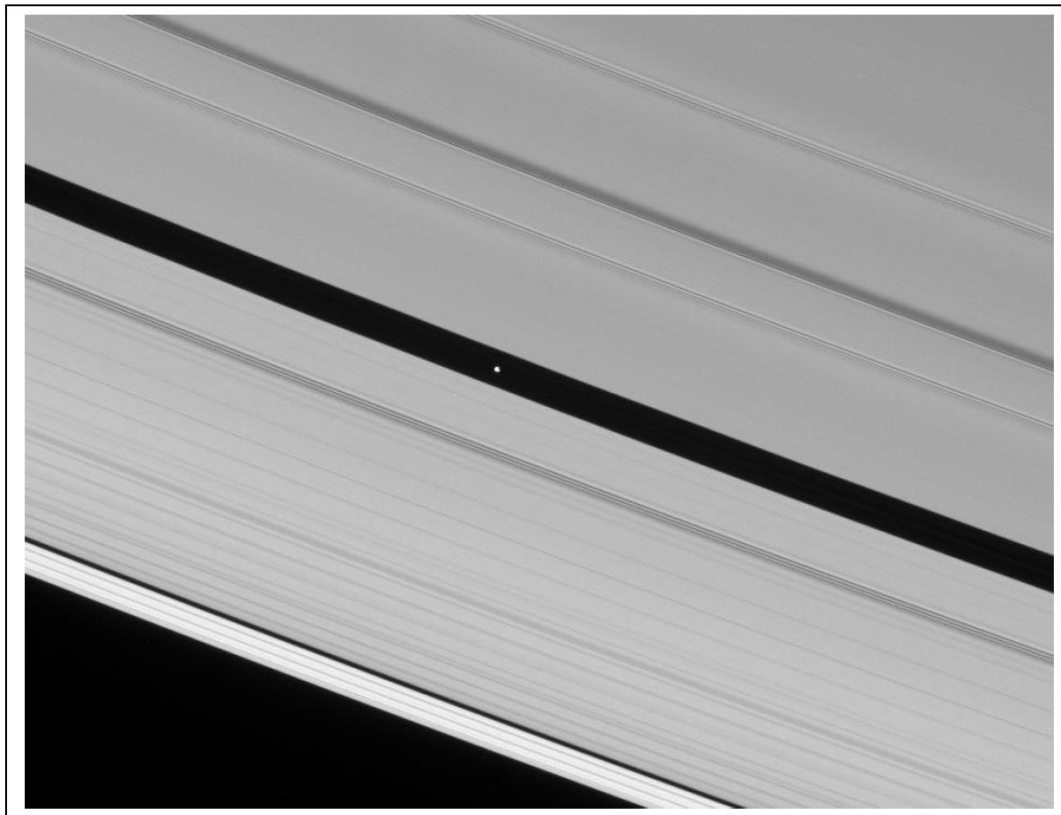
Problem 2 - Pan is that bright spot within the black zone of the Encke Gap in the top photo. How many kilometers in diameter is Pan?

Problem 3 - How wide is the Encke Gap in the top photo?

Problem 4 - What is the smallest feature in the top photo?



View the [original photo here](#) from NASA.



ANSWER KEY

Galaxy Distances & Mixed Fractions

1. $11 \frac{1}{4}$ mpc
2. $8 \frac{1}{5}$ mpc
3. $15 \frac{1}{5}$ mpc

The Event Horizon

1. 0.84 cm
2. 2.9 km

Exploring Black Holes

- Problem 1 - Mercury is a black hole with a radius of 0.5 millimeters.
- Problem 2 - Venus is a black hole with a radius of 7 millimeters
- Problem 3 - Earth is a black hole with a radius of 9 millimeters
- Problem 4 - The moon is a black hole with a radius of 0.1 millimeters
- Problem 5 - Mars is a black hole with a radius of 1.0 millimeter
- Problem 6 - Pluto is a black hole with a radius of 0.02 millimeters
- Problem 7 - Jupiter is a black hole with a radius of 280 centimeters
- Problem 8 - Saturn is a black hole with a radius of 83 centimeters
- Problem 9 - Uranus is a black hole with a radius of 13 centimeter
- Problem 10 - Neptune is a black hole with a radius of 15 centimeter

Magnetic Field Speeds on the Sun

1. 26,500 km/sec
2. Answers vary

Pan's Highway in Saturn's Rings

1. 38 km/mm
2. 38 km in diameter
3. 190 km
4. 4 km