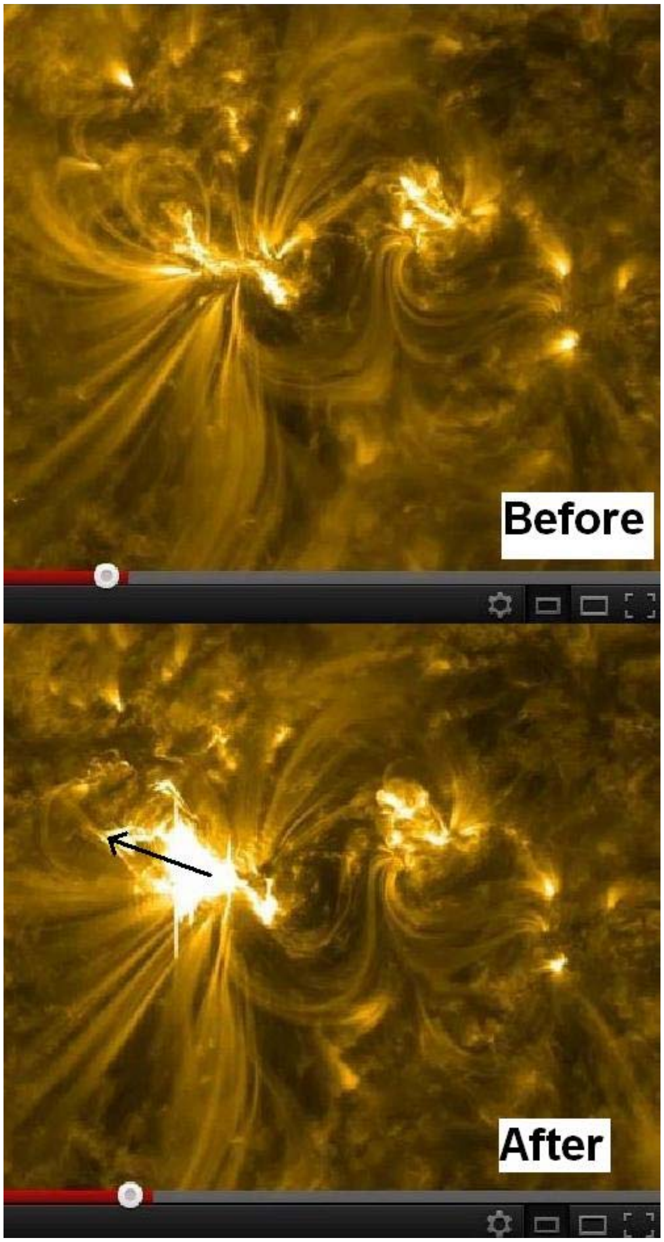
Estimating Magnetic Field Speeds on the Sun



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?

Problem 3 - What would you estimate the speeds to be for the features that you identified in Problem 2?

The explosion can be seen in the movie located on *YouTube* at
http://www.youtube.com/watch?v=4xKRBkBBEP0

The above 'high definition' images of the spectacular March 6 solar flare were taken by the NASA Solar Dynamics Observatory (SDO) located in geosynchronous orbit around Earth. Within a few minutes, this flare produced more energy than a thousand hydrogen bombs going off all at once. This energy caused gasses nearby to be heated to millions of degrees, and produced a blast-wave that traveled across the face of the sun at over 4 million km/hour. In the movie above, watch for magnetic loops and filaments to be disturbed by the explosion as the blast wave passes by them.

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?

Answer: Students should compare the length of the arrowed line to the width of the image and solve the proportion to get the physical distance that the plasma traveled. Example, for standard printing onto an 81/2 x 11 page, the line width is about 14 millimeters long, and the width of the image is about 84 millimeters so the proportion for the true length of the line in kilometers is just

$\frac{14}{84} = \frac{X}{318,000km}$ so X = 53,000 km

The speed of the flare is simply the distance traveled (53,000 km) divided by the time between the two images (2 seconds) so V = 53,000/2 = **26,500 km/sec**.

The actual speed of the plasma will be much less than this because some of the brightening you see in the second image is because gases trapped in the magnetic field loops were heated in place and brightened rapidly without much movement. As one region dims and another brightens we have the appearance of something moving between the two locations when in fact there was little of no actual movement.