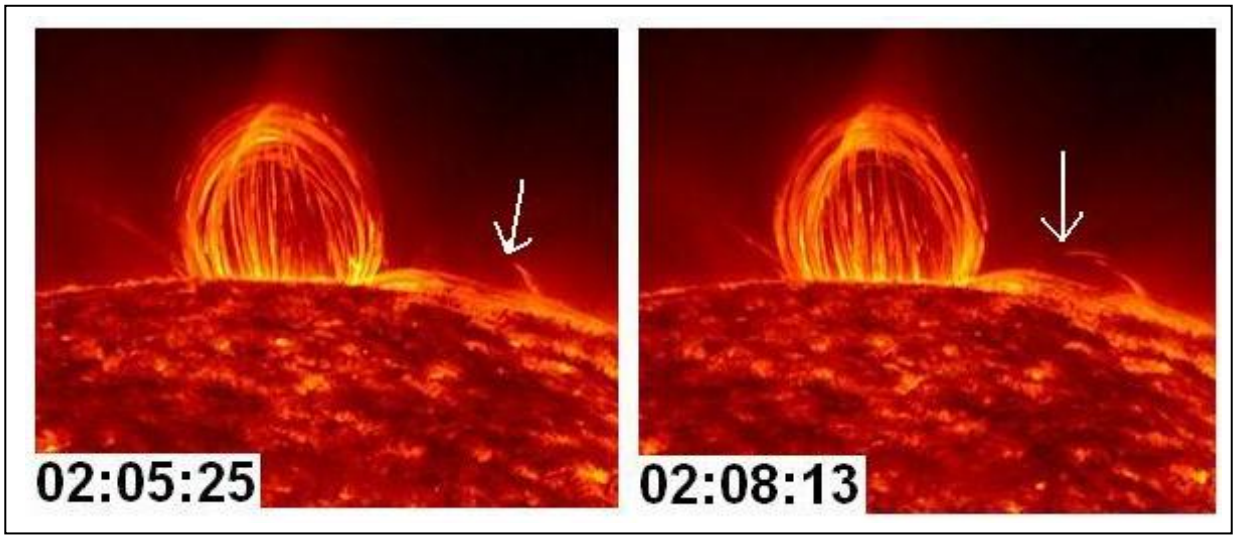

On February 20, 2013, NASA's Solar Dynamics Observatory released a stunning video of a dome-shaped coronal rain event. The footage in this video covers the time between 12:30 a.m. EDT to 10:00 p.m. EDT on July 19, 2012. The width of each image corresponds to 360,000 kilometers near the sun!

These two still images were taken from the SDO video at the time codes indicated above, which are given in terms of playtime beginning at 2 minutes, 5.25 seconds (left image) and ending at 2 minutes, 8.13 seconds (right image). SDO collected one frame every 12 seconds, and the movie plays at 30 frames per second, so each second in this video corresponds to six minutes of real time.

The arrow points to a streamer of plasma ejected from the solar surface, and traveling in an arc from right to left in the 2-dimensional plane of the photograph. Because we don't know how fast the streamer is moving along the line-of-sight in the 3rd dimension, our speed estimate below will be a bit slower than the actual speed of the streamer.

Problem 1 - Astronomers would like to know how fast the heated gas in the streamer is traveling. From the clues in the images and the information in the essay, how fast was the gas traveling in kilometers/sec?

Problem 2 - The Space Shuttle traveled at a speed of 29,000 km/h in its orbit around Earth. Could the astronauts in the Space Shuttle have outraced the gas in the streamer?

Problem 3 - How big would the Earth be at the scale of these images if its diameter is 12,700 kilometers?

February 20, 2013.
NASA's SDO Shows A Little Rain On the Sun
http://www.nasa.gov/mission_pages/sdo/news/coronal-rain.html

Problem 1 - Astronomers would like to know how fast the heated gas in the streamer is traveling. From the clues in the images and the information in the essay, how fast was the gas traveling in kilometers/sec?

Answer: The time between the still images is 8.13seconds – 5.25 seconds = 2.88 seconds in 'movie time' but the essay says that 1 second in movie time equals 6 minutes (360 seconds) in real time, so the time interval between the images is 2.88 x 360 = 1037 seconds. To get the distance traveled in kilometers, students may use a millimeter ruler to measure the width of the image, which is 360000 kilometers. Typical measurements should get 76 millimeters, so the scale of the image is 360000/76 = 4700 km/mm. Carefully comparing the distance traveled between the two arrows will get a measurement of about 8 millimeters, so the physical distance is 4700 x 8 = 37,600 km. The speed of this streamer is then 37,600 km/1037 seconds **= 36.3 km/s**.

Problem 2 - The Space Shuttle traveled at a speed of 29,000 km/h in its orbit around Earth. Could the astronauts in the Space Shuttle have outraced the gas in the streamer?

Answer: We need to convert the shuttle speed to km/s. 29,000 km/h x (1 h/3600 sec) = 8.0 km/s. This is much slower than the streamer speed of 36.3 km/s so the shuttle **could not outrun the streamer**.

Problem 3 - How big would the Earth be at the scale of these images if its diameter is 12,700 kilometers?

Answer: The image scale is 4700 km/mm, and from the proportion 12700/4700 = X/1 mm we get X = **2.7 millimeters in diameter**.