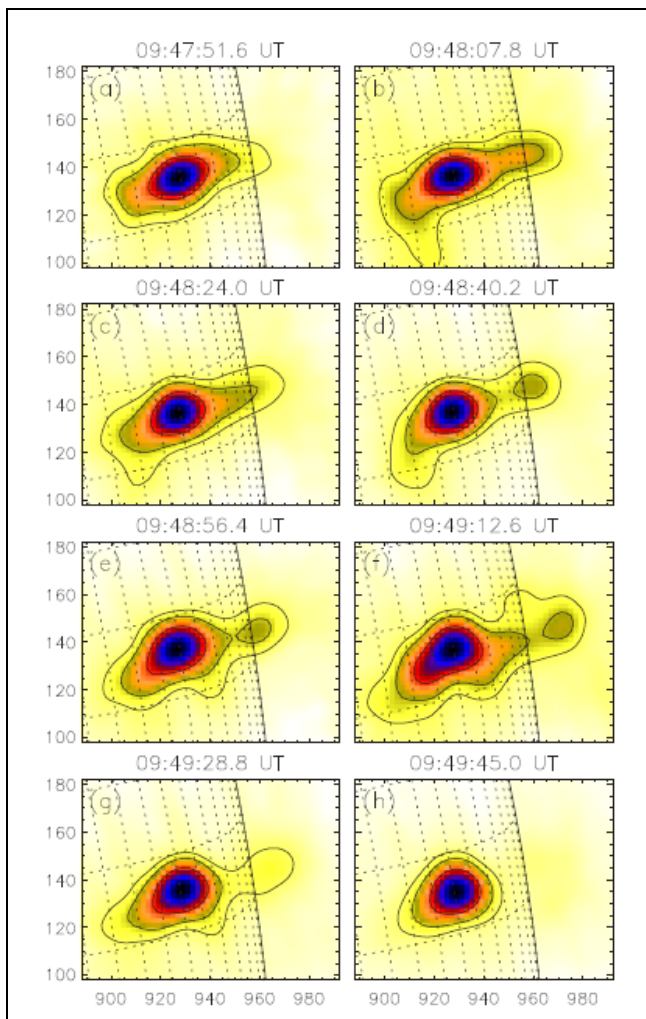# Super-fast solar flares !



NASA's Ramaty High Energy Solar Spectroscopic Imager (RHESSI) satellite has been studying solar flares since 2002. The sequence of figures to the left shows a flaring region observed on November 3, 2003. This flare was rated as 'X3.9' making it an extremely powerful event.   A detailed study of this flare by astronomer  Dr. Astrid Veronig and her colleagues at the Institute of Physics of the University of Graz in Austria allowed scientists to determine the physical properties of this event.

During the 4-minute flaring event, gas temperatures of over 45 million degrees Kelvin were reached in a plasma with a density of  400 billion atoms/cc.

The figures each have a field of view of 80 second of arc x 100 seconds of arc. The diameter of the sun in these angular units is 1950 seconds of arc, and its physical diameter is 1,392,000 kilometers.

Each image shows the main flare region (blue) and Images D ,E and F show a second 'blob' being ejected by the flaring region.

*"X-ray sources and magnetic reconnection in the X3.9 flare of 2003 November 3" A. Veronig et al., Astronomy and Astrophysics, 2005 vol. 446, p.675.*

Problem 1 - From the information in the text, what is the size of each box in kilometers?

Problem 2 - What is the scale of each image in kilometers per millimeter?

Problem 3 - Between Image D and Image F, how much time elapsed?

Problem 4 - Between Image D and Image F, how far did the plasma Blob travel in kilometers?

Problem 5 - Between Image D and Image F, what was the average speed of the Blob in
        kilometers per second?

Problem 6 - The SR-71 Blackbird holds the official Air Speed Record for a manned airbreathing jet
        aircraft with a speed of 3,529.56 km/h (2,188 mph). It was capable of taking off and
        landing unassisted on conventional runways. The record was set on July 28, 1976 by
        Eldon W. Joersz near Beale Air Force Base in California. Would the SR-71 have been
        able to out-run the plasma blob?

Answer Key:

Problem 1 - From the information in the text, what is the size of each box in kilometers?

Answer:   (100 arc-sec/1950-arcsec) x 1,392,000 km = 71,400 km.
      (80 arcsec/1950 arcsec0 x 1,392,000 km = 57,100 km.
    The boxes are 71,400 x 57,100 km in size.


Problem 2 - What is the scale of each image in kilometers per millimeter?
Answer:   The 100-arcsec edge of a box measures  34 millimeters, so the scale is (71,400 km/34 mm) = 2,100 km/mm


Problem 3 - Between Image D and Image F, how much time elapsed?
Answer:     09:49:12.6 UT - 09: 48: 40.2 UT  =    72.6 - 40.2 =  30.4 seconds.


Problem 4 - Between Image D and Image F, how far did the plasma Blob travel in kilometers?
Answer: In Image D it was  12 millimeters from the flare center. In Image F it was 15 millimeters from the flare center, for a net change of 3 millimeters or   3 mm x 2,100 km/mm =  6,300 kilometers.


Problem 5 - Between Image D and Image F ,what was the average speed of the Blob in kilometers per second?
Answer: The speed was   6,300 kilometers/30.4 seconds or    207 kilometers/sec.


Problem 6 - The SR-71 Blackbird holds the official Air Speed Record for a manned air-breathing jet aircraft with a speed of 3,529.56 km/h (2,188 mph). It was capable of taking off and landing unassisted on conventional runways. The record was set on July 28, 1976 by Eldon W. Joersz near Beale Air Force Base in California. Would the SR-71 have been able to out-run the plasma Blob?

Answer: The SR-71 traveled at a speed of 3,530 km/hour. There are 3,600 seconds in an hour, so the speed was  3,530 km/hr x  1 hr/3600 sec =  0.98 kilometers/sec. The solar flare blob was traveling at 207 kilometers per second or nearly 210 times faster!   The Blob Wins!!!