Space weather effects on a solar telescope

‘Space weather’ effects are caused by types of solar activity known as solar flares and Coronal Mass Ejections (CMEs), which produce sudden bursts of very fast-moving charged particles. These high-energy bursts cause problems for communications systems in several ways. For example, high energy particles directly affect the sensitive electronic equipment on satellites, corrupting data. In this activity, you will look at the effect of high-energy particles on some satellite images.

The effect on a solar telescope, the Solar and Heliospheric Observatory (SoHO)

Solar flares can severely affect sensitive instruments in space and corrupt the data that they produce.

On July 14, 2000, the Sun produced a powerful X-class flare, which was captured by instruments on board the Solar and Heliospheric Observatory (SoHO). The EUV Imaging Telescope (EIT) operating at a wavelength of 195 Angstroms (19.5 x 10^-9 m) showed a brilliant flash of light (left image). This wavelength is in the ultraviolet, which we cannot see, so the green image you see is a false-colour image: the colour could be anything, the astronomers just happened to choose green. The bright patches on the image show up where the gas in the solar atmosphere is particularly hot. During a solar flare the temperature can be as high as 10 million degrees Celsius.

When the high energy particles from the solar flare arrived at the SoHO satellite some time later, they caused the imaging equipment to develop ‘snow’ as the individual particles streaked through the sensitive electronic equipment. SoHO is in an unusual orbit, going around the Sun with the Earth, at a distance from Earth which is 1/100th of the way from the Earth to the Sun.

The images below were taken by SoHO LASCO (Large Angle Spectroscopic COronagraph). These images were taken in ‘white light’, that is the visible wavelength range. The Sun is blocked out by a disk (in a similar way to when the Moon blocks out the solar disk during a total eclipse). The size of the Sun is shown as the white circle inside the disk. We can see material streaming out from the Sun. The images show what happened to the LASCO instrument when a shower of fast particles from the solar flare arrived at the SoHO spacecraft. The date and time information (year/month/day hr : min) is given in the lower left corner of each image.
Effect on a solar telescope

Questions

1. Use the SoHO/EIT image to find out at what time the solar flare first erupted on the Sun.
2. At about what time did the LASCO imagers begin to show significant signs of the particles having arrived (‘snow’ effect)?
3. If the SOHO satellite is located approximately 148 million kilometres from the Sun, what was the approximate speed of the arriving particles?
4. If the speed of light is 300,000 km/sec, what is the speed of the particles as a percentage of the speed of light?
5. Suggest why it can be difficult to protect sensitive equipment on board space telescopes from damage caused by very high energy particles ejected from the Sun.

Image credits
EUV Telescope image:
Sequence of images from SoHO /LASCO: