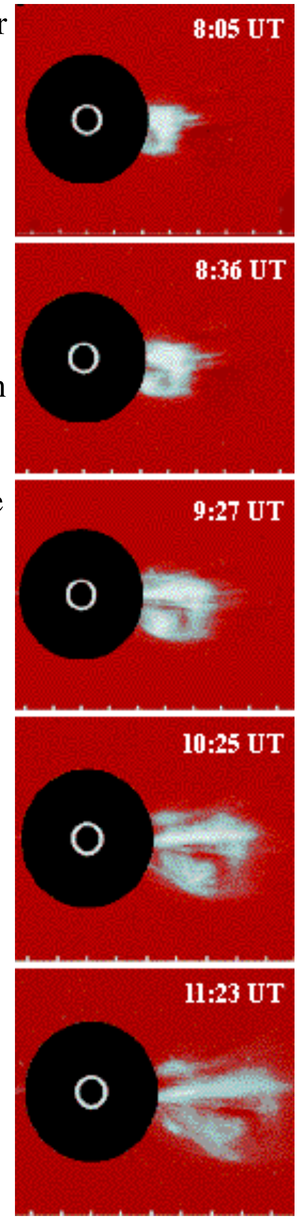
Measure the Motion of a Coronal Mass Ejection

Activity: Calculate the velocity and acceleration of a coronal mass ejection (CME) based on its position in a series of images from the Large-Angle Spectrometric Coronograph (LASCO) instrument on SOHO.

Materials: ruler, calculator, and a set of CME images from the LASCO instrument on SOHO. You can use the ones here or gather another set from http://sohowww.nascom.nasa.gov/gallery/LASCO/las001.gif.

Background: An important part of space weather research is to measure the velocity of CMEs and their acceleration as they leave the Sun. This is done by tracing features in the CME and measuring their positions at different times. In the sequence of images shown on the right, you can see a CME erupting from the Sun on the right side of the coronagraph disk. The white circle shows the size and location of the Sun. The black disk is the occulting disk that blocks the surface of the Sun and the inner corona. The lines along the bottom of the image mark off units of the Sunís diameter.



Procedure: Select a feature of the CME that you can see in all five images--for instance, the outermost extent of the cloud, or the inner edge. Measure its position in each image. Your measurements can be converted to kilometers using a simple ratio:

$$\frac{\text{acutal distance of feature from Sun}}{\text{diameter of the Sun (1.4 million km)}} = \frac{\text{position of feature as measured on image}}{\text{diameter of Sun as measured on image}}$$

Using the distance from the Sun and the time (listed on each image), you can calculate the average velocity. Velocity is defined as the rate of change of position. Using the changes in position and time, the velocity for the period can be calculated using the following equation: v = (s2 - s1) / (t2 - t1), where s2 is the position at time, t2; s1 is the position at time, t1. The acceleration equals the change in velocity over time; that is, a = (v2 - v1) / (t2 - t1), where v2 is the velocity at time t2; v1 is the velocity at time t1. You can record your results in a table.

Universal Time	Time Interval	Position	Avg. Velocity	Avg. Acceleration
8:05				
8:36				
9:27				
10:25				
11:23				

Further Questions and Activities

- Select another feature, trace it, and calculate the velocity and acceleration. Is it different from the velocity and acceleration of the other feature you measured? Scientists often look at a number of points in the CME to get an overall idea of what is happening.
- How does the size of the CME change with time? What kind of forces might be
acting on the CME? How would these account for your data?

Credit: This activity is based on "Sun-Centerd Physics,"
a set of lesson plans developed by Linda Knisely.

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