



# “Coronal Mass Ejection”

## Flip Book

14 July 2000

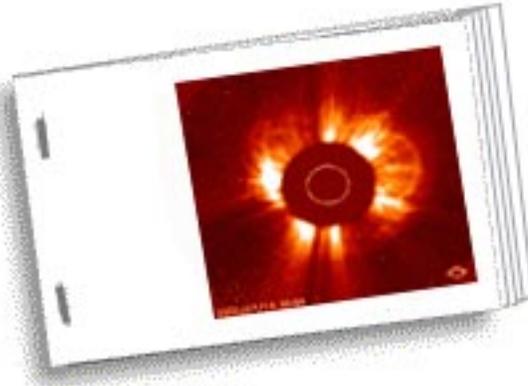


Image Credit: The SOHO-LASCO Consortium: SOHO is an ESA-NASA program of international cooperation..

### Basic Facts About CMEs

- Perhaps the most important solar event for the people on Earth is a coronal mass ejection (CME) because it can produce spectacular space weather events at Earth.
- Periodically, the sun violently expells a huge bubble of gas (called a coronal mass ejection) from its outer atmosphere into space. During the course of such an event on average, several billion tons of gas are blown toward Earth. This is equivalent to the mass contained in a small lake but vaporized and traveling at millions of miles an hour (thousands of km/s).
- The total energy contained in these massive electrified clouds during a large event is roughly the same as a large solar flare (approximately equivalent to the total energy of 100 hurricanes) but expelled over a longer time period than a solar flare (many hours as compared to tens of minutes).
- This high speed gas bubble expands rapidly into space rivalry the sun in size in just a matter of hours. It plows into the slower solar wind streaming outward from the sun creating shock waves. In these shock waves, a fraction of the particles are accelerated to dangerously high energies before they encounter the Earth.

### Effects of CMEs at Earth

CMEs, since they are bubbles in the interplanetary magnetic field, oftentimes contain southward directed magnetic fields. Magnetic fields with this orientation are capable of directly joining with magnetic fields attached to the Earth. This connection allows enhanced penetration of solar wind energy and particles into the Earth’s magnetosphere. The Earth’s radiation belts build up, magnetic substorms become frequent and intense, million-ampere currents are shunted through the ionosphere at far

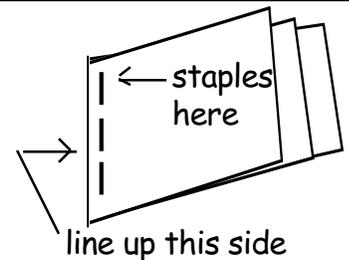
northern latitudes, breathtaking aurora appears at relatively low latitudes. Satellites in geosynchronous orbit may find themselves outside of the Earth’s magnetic shield. Enhanced levels of energetic particles produce single-event upsets in spacecraft electronics, and pose a danger for astronauts.

### About the 14 July 2000 Flare

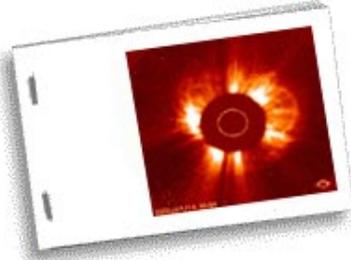
An X-class flare which erupted on 14 July 2000, was accompanied by a CME that lifted off the Sun at speeds near 1775 kilometers per second (about 4 million miles an hour). The CME plowed through the solar wind, moving toward Earth at 1300 to 1600 km/s (2.9 to 3.6 million mph), creating an interplanetary shock wave. The arrival at Earth of this massive electrified gas cloud at the end of the day on 15 July produced a G5 magnetic storm — the most severe possible and an S3 radiation storm in space. The high energy solar particles expelled by the flare produce streaks and spots on the flip-book images as the crash into

### Assembly Instructions

Print the following 3 pages. It works best if you can use stiff paper but standard printer paper is fine. Cut out each of the pages for the flip book along the solid line. All of the pages will be slightly different lengths. This makes it easier to flip through the book when it is finished. Arrange them in order according to the number in the upper left corner of each image. Line up all the pages by the edge that has a broken line marking the staples. Staple the left edge along the broken line. Your flip book is ready.



# Coronal Mass Ejection

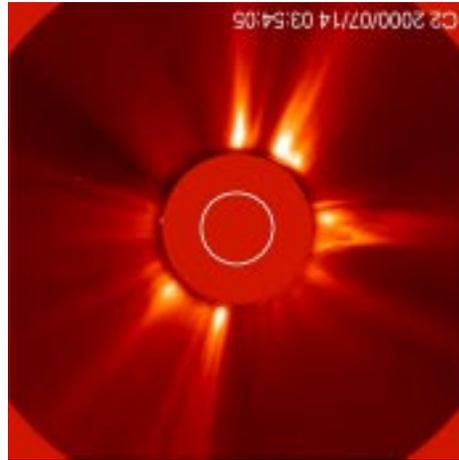


Flip Book

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Images courtesy of the SOHO-LASCO Consortium: SOHO is an ESA-NASA program of international cooperation

Developed in partnership with: 

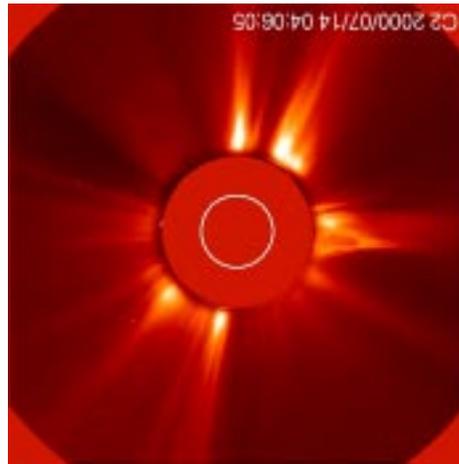


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## Flip Book Facts

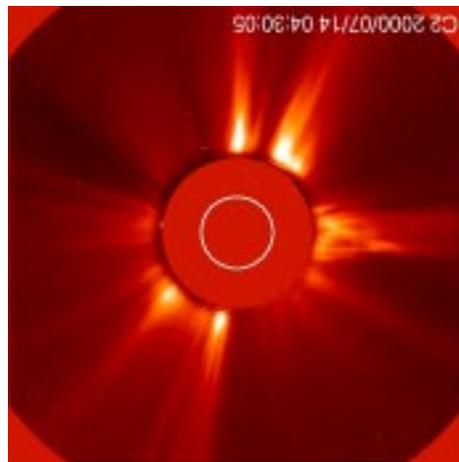
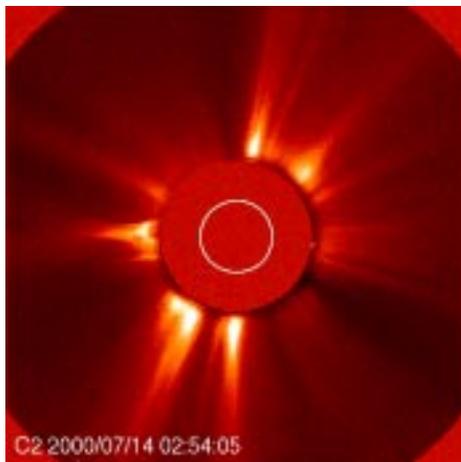
**What are CMEs?** Periodically the sun violently expels a huge bubble of gas (called a coronal mass ejection) from its outer atmosphere into space. This electrified gas cloud can contain several million tons of gas (equivalent to a small lake) and be moving directly towards Earth at millions of miles/hr.

**The flip book shows** a spectacular CME lifting off the sun on 14 July 2000 at speeds near 4 million miles/hr (1775 km/s). This gas cloud hit the Earth on 15 July at the end of the day and produced a G5 magnetic storm -- the most severe possible. In the images the sun is blocked out so that the faint corona can be observed. When the images become engulfed by white streaks and spots, high energy particles from the sun are hitting the LASCO camera.



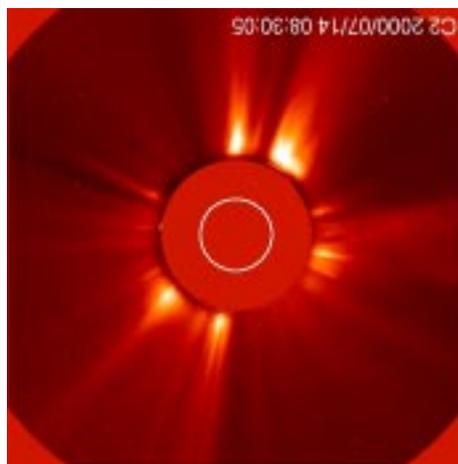
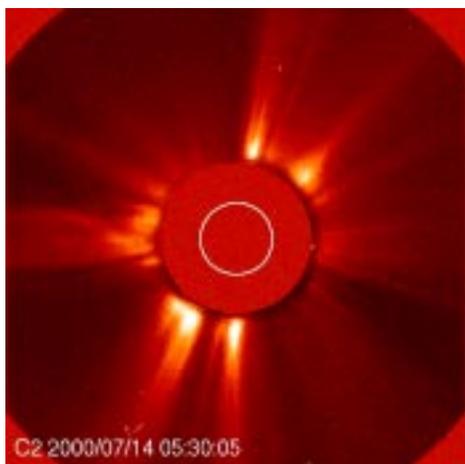
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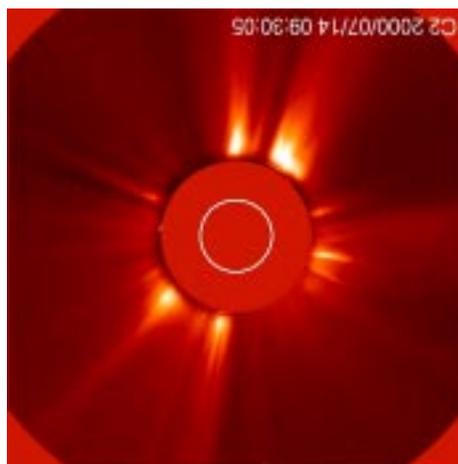
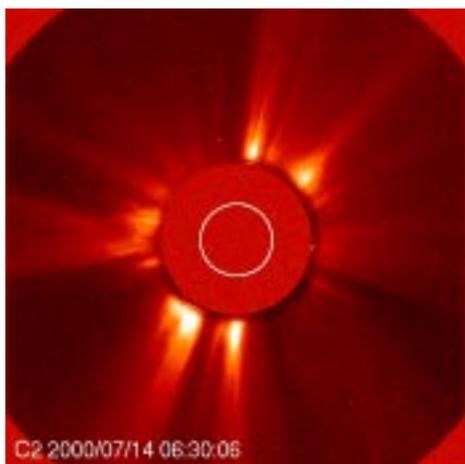
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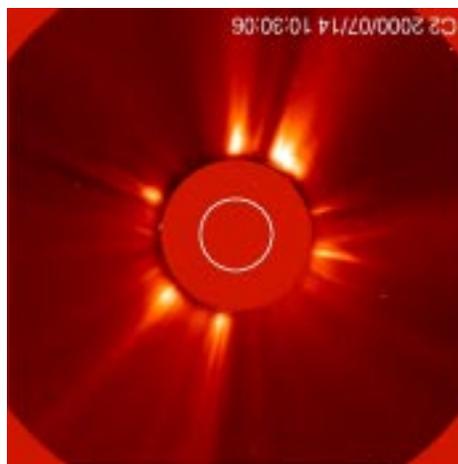
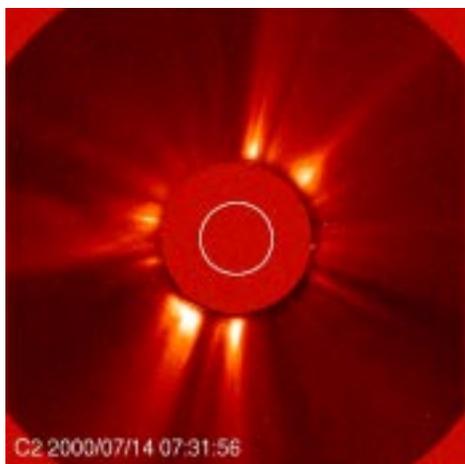
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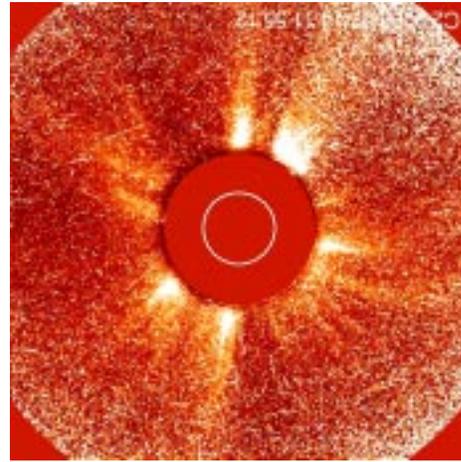
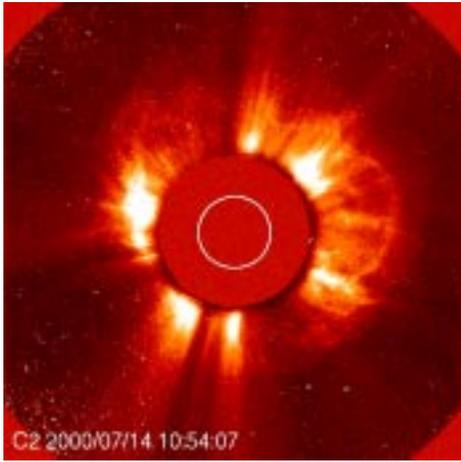
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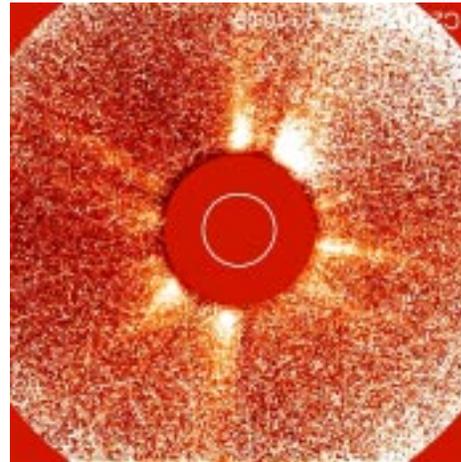
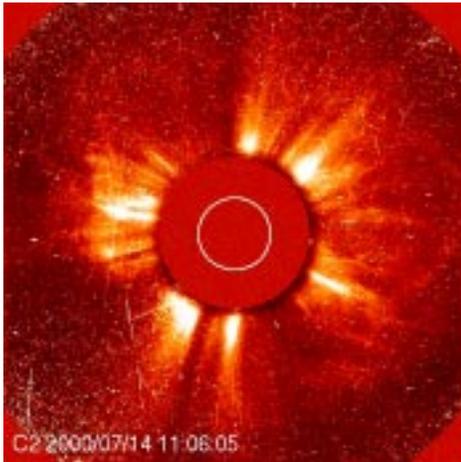
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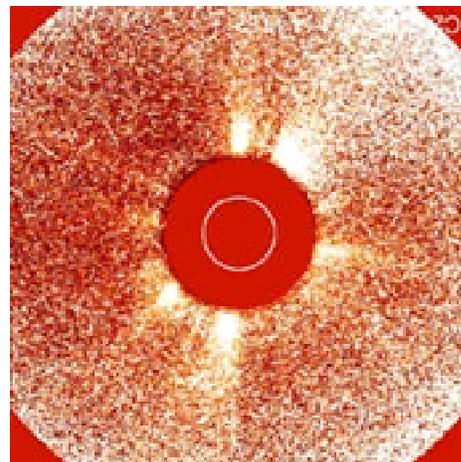
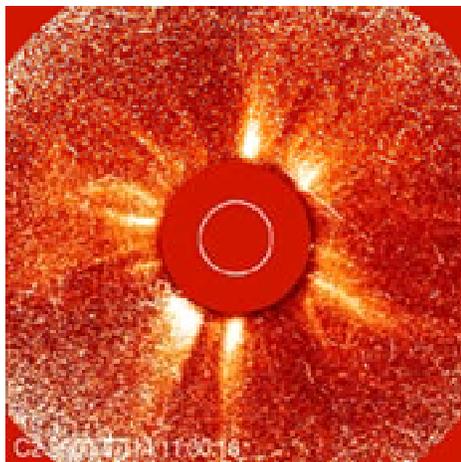
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