

Screaming CMEs Warn of Radiation Storms

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A CME (Coronal Mass Ejection) is a solar body slam to our high-tech civilization. CMEs begin when the sun launches a billion tons of electrically conducting gas (plasma) into space at millions of miles per hour. A CME cloud is laced with magnetic fields, and CMEs directed our way smash into Earth's magnetic field. If the CME magnetic fields have the correct orientation, they dump energy into Earth's magnetic field, causing magnetic storms. These storms can cause widespread blackouts by overloading power line equipment with extra electric current. But wait; there's more.

Some CMEs also bring intense radiation storms that can disable satellites or cause cancer in unprotected astronauts. As the CME blasts through space, it plows into a slower stream of plasma blown constantly from the sun in all directions, called the solar wind. The CME causes a shock wave in the solar wind. If the shock is strong enough, it accelerates electrically charged particles that make up the solar wind to high speeds, forming the radiation storm.

"Some CMEs produce radiation storms, and some don't, or at least the level of radiation is significantly lower," said Dr. Natchimuthuk Gopalswamy of NASA's Goddard Space Flight Center in Greenbelt, Md. "The trick is to identify the ones that can produce dangerous radiation, so we can warn astronauts and satellite operators."

Gopalswamy and his team may have found a way to do just that. Like a pro wrestler roaring before an attack, CMEs with powerful shocks capable of causing radiation storms "scream" in radio waves as they slam

through the solar wind, according to the team.

They made the connection by analyzing observations of CMEs from the SOHO (Solar and Heliospheric Observatory) and Wind spacecraft. SOHO has an instrument that can see CMEs (the Large Angle and Spectrometric Coronagraph), and an instrument that detects their radiation (the Energetic and Relativistic Nucleon and Electron experiment). Wind has an instrument that can pick up a CME's radio signal (The Radio and Plasma Wave experiment). The team compared observations from both spacecraft and looked at 472 CMEs between 1996 and 2005 that were fast and covered a large area of the sky.

They discovered that those CMEs which generated a radio signal also produced radiation storms, but CMEs without a radio signal did not.

Strong CME shocks accelerate electrons (the particles that carry electricity) in the solar wind, which produce the radio signal. The same strong shock must also accelerate atomic nuclei (the central part of atoms) in the solar wind, which produce the radiation storm, according to the team.

"Since the radio signal moves at the speed of light while the particles follow behind, we can use a CME's radio noise to give warning that it is generating a radiation storm that will hit us soon," said Gopalswamy.

"This will give astronauts and satellite operators anywhere between a few tens of minutes to a couple hours to prepare, depending on how fast the particles are moving."

The team also noticed that most radio-loud CMEs came from parts of the sun in line with Earth (areas near the solar equator), while radio-quiet CMEs mostly came from the edges of the sun. Since all the CMEs studied were fast and could have produced strong shocks, detecting radio noise and radiation from some but not others might simply be due to

geometry. CMEs near the edge of the sun only present a small section of their shock surface towards us as they expand through space, and therefore tend to be radio-quiet and radiation-free from our point of view, according to the team. However, it means that explorers on other worlds in our solar system, like Mars, will need a spacecraft positioned between them and the sun to take advantage of the radio warning.

"Radio is one of the strongest indicators of an impending radiation storm, so if astronauts are out at Mars off the edge of the Sun, our radio telescopes at or near Earth won't do much to protect them," said Dr. Bill Wagner of NASA Headquarters, Washington.

The research was funded by NASA and will be presented at the American Astronomical Society's 210th Meeting during 27-31 May 2007 in Honolulu, Hawaii. The team includes researchers from Goddard, the Catholic University of America, Washington, the Naval Research Laboratory, Washington, and the Observatory of Paris. SOHO is a cooperative project between the European Space Agency and NASA. NASA's Wind spacecraft was launched on November 1, 1994, and is operated from Goddard. The spacecraft is maintained at a position approximately one million miles from Earth along the Earth-sun line to measure the solar wind without any contamination from Earth's magnetic field.

Source: NASA/Goddard Space Flight Center

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