Solar Scientists Use New Instruments And New Perspectives To Discover Physical Mechanism Behind Sympathetic Flares

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PALO ALTO, Calif., Dec. 13, 2010 /PRNewswire/ -- A serendipitous alignment of high-powered spaceborne solar instruments–designed and built by Lockheed Martin (NYSE: LMT)–has finally provided the data allowing scientists to uncover the physical mechanism behind so-called "sympathetic flares" on the Sun. For over 75 years, solar physicists have been observing near-synchronous explosions in the solar atmosphere, and have wondered whether they were somehow related, but hard evidence for connection has been elusive.

Then, on August 1st of this year, nearly the entire Earth-facing side of the Sun erupted in a tumult of activity, comprising a large solar flare, a solar tsunami, multiple filaments of magnetism lifting off the solar surface, radio bursts and half a dozen coronal mass ejections (CMEs). At the same time, three NASA spacecraft–the Solar Dynamics Observatory (SDO) and the twin Solar Terrestrial Relations Observatory (STEREO) spacecraft–were ideally positioned to capture both the action on the Earth-facing side of the Sun, and most activity around the backside, leaving a wedge of only 30 degrees of the solar surface unobserved.

"The high-quality simultaneous data we received from SDO and the STEREO spacecraft, and our subsequent analysis, enable us to present unambiguous evidence that solar regions up to 160 degrees away are involved in defining the large-scale coronal field topology for flares and CMEs," said Dr. Carolus Schrijver, of the Solar and Astrophysics Lab at the Lockheed Martin Advanced Technology Center in Palo Alto, and lead author of a paper presented today at the American Geophysical Union Winter Meeting in San Francisco. "Moreover, as far as we are aware, this is the first well-documented case that is highly suggestive that the evolution of that distant field, i.e. the flux emergence in one or more of the three active regions behind the eastern limb of the Sun as seen from Earth and SDO, plays an important role in the destabilization of the magnetic field involved in a series of CMEs aimed for Earth."

The SDO Atmospheric Imaging Assembly (AIA) provides a major advance in the ability of physicists to observe the solar corona: full-Sun 4096 x 4096 images with 0.6 arcsec pixels, in temperatures ranging from chromospheric around 10,000 K up to about 10 million K, with images every 12 seconds, without interruption. The instrument design enables the tracing of perturbations over long distances, even if short-lived or occurring at, or changing across, widely different temperatures. At the time of the August 1st observations, the STEREO spacecraft were each approaching quadrature relative to the Sun-Earth line, thus providing perspectives on activity on most of the eastern and western hemispheres relative to Sun-Earth line. Moreover, the SDO Helioseismic and Magnetic Imager (HMI), combined with a computational model of full-sphere flux-transport on the Sun, and global coronal field modeling, revealed the long-distance magnetic connections with fair fidelity.

"We've reached a turning point in our ability to forecast space weather," said Dr.Alan Title of the ATC, and co-author of the paper presented today. "We now have evidence that multiple events can be triggered by other events that occur in regions that cannot be observed from Earth orbit. This gives us a new appreciation of why solar flare and CME predictions have been less than perfect. As we seek to understand the causes of eruptive and explosive events that will improve our ability to forecast space weather, it is clear that we must be able to analyze most of the evolving global solar field, if not all of it."

The events that took place on the Sun onAugust 1st propagated outward into the solar system and eventually reached Earth on August 5th and 6th. The Rutherford-Appleton Laboratories in the UK designed and built the Heliospheric Imagers on STEREO that can image and follow the material ejected by the Sun all the way to the Earth. The coronagraphs on STEREO were designed and built by the Naval Research Laboratory, and the EUV Imagers were built by Lockheed Martin. Working together, an international team is now putting into place the many pieces of this very interesting puzzle.

It was not chance, however, that brought together the spacecraft and instruments that teased understanding from the tumultuous events of early August 2010, but rather a decades-long NASA science plan to place instruments throughout the heliosphere called the Heliospheric System Observatory, with the goal of understanding and predicting space weather. While the Sun makes life possible on the Earth, our technological society is increasingly vulnerable to infrequent but high-impact phenomena that can result from space storms.

Large-scale electrical systems and space-based technology are susceptible to solar-driven space weather events that couple into the Earth's geomagnetic field and from there down to ground systems. Satellite failures and power-grid problems occur with some regularity whenever large solar storms occur, and observations of stars like our Sun suggest that some such storms may be much larger than those experienced in recent history. Thus, there is a growing need to better understand the climate of space, both in terms of its day-to-day fluctuations and its most extreme conditions. Advancing knowledge of our space environment and its potential impacts is essential to national and international economic, as well as military, security.

The Solar and Astrophysics Laboratory at the ATC conducts basic research into understanding and predicting space weather and the behavior of our Sun including its impacts on Earth and climate. It has a 47-year-long heritage of spaceborne solar instruments. The ATC is the research and development organization of Lockheed Martin Space Systems Company (LMSSC). LMSSC, a major operating unit of Lockheed Martin Corporation, designs and develops, tests, manufactures and operates a full spectrum of advanced-technology systems for national security and military, civil government and commercial customers. Chief products include human space flight systems; a full range of remote sensing, navigation, meteorological and communications satellites and instruments; space observatories and interplanetary spacecraft; laser radar; ballistic missiles; missile defense systems; and nanotechnology research and development.

Headquartered in Bethesda, Md., Lockheed Martin is a global security company that employs about 133,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. The Corporation's 2009 sales from continuing operations were $44.0 billion.

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