Camera developed by Stanford researchers launches from Cape Canaveral

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A United Launch Alliance Atlas V with NASA’s Solar Dynamics Observatory launches from Cape Canaveral on Thursday. One of the observatory's components is a camera, developed by researchers at Stanford and Lockheed Martin, that will photograph the sun.

(PhysOrg.com) -- An imager aboard a NASA satellite launched into Earth's orbit Thursday will photograph the sun's changing atmosphere and magnetic fields -- lending unprecedented insights into the dynamics of solar activity.

After years of design, assembly and testing, a space camera developed by researchers from Stanford University and Lockheed Martin roared through a snippet of a Florida rainbow into space Thursday morning, on a mission to reveal the sun's inner workings in unprecedented detail.

The Helioseismic and Magnetic Imager, or HMI, was propelled from Cape Canaveral into space aboard an Atlas V rocket at 10:23 a.m. Florida time, beginning a long-awaited mission to photograph the sun's atmosphere in continuous rapid sequence.

"It's up there; its antennas are out; its solar panels are out. It's stable and everything is going fine," said Stanford's Phil Scherrer, the chief scientist on the project, who was in Florida for the launch.

While orbiting Earth, the observatory will snap images of the sun every 0.75 seconds for the next five years, and possibly longer, providing almost 50 times more scientific data than any previous mission in NASA history - delivering 150 million bits of data per second (the equivalent of downloading a half-million songs each day).

Scientists hope the instrument's high-resolution images will lend unprecedented insights into the origins of solar variability, and eventually assist them in making short-term predictions of "space weather."

HMI is one of three components aboard a NASA satellite, the Solar Dynamics Observatory (SDO). The program's objective is to gather solar data that can be useful in coping with the sun's inevitable impact on human society and development.

"The raw data looks like images. It's like you had … a 16-megapixel camera and you took a picture of the sun through a very narrow-band filter," said Scherrer, a solar physicist and principal investigator for the HMI team at the W. W. Hansen Experimental Physics Laboratory and director of the Stanford Solar Observatories Group.

Images as data for research

"We don't actually look at those as pictures, we look at them as data, as brightness data. … We take a sequence of a dozen of them at different wavelengths and different polarizations, and combining those, we can make the map of velocity and the map of magnetic field."

HMI will record two important phenomena on the sun's surface. The first is seismic motion - sound waves of extremely low frequency that emanate from deep within and induce up-and-down oscillations in the sun's outer gas layer. Measurements of these surface motions can be used to make maps of solar surface velocity (called Dopplergrams), from which physical conditions such as temperature, composition and the interior magnetic field can be inferred.

HMI's second task is to record the magnetic field over the sun's entire visible surface, a 500-kilometer thick region known as the photosphere. This is accomplished by analyzing measurements taken in different polarizations. The shape and distribution of the corona (the atmospheric layer enveloping the chromosphere and photosphere) are largely influenced by the complex interactions of varying magnetic fields at its surface. These magnetic fields, generated by the churning motion of convective plasma within a star, cause solar storms - sunspots, solar flares and coronal mass ejections - which in turn cause the space weather that effects technological systems on Earth.

Scherrer and his team believe that a greater understanding of surface magnetic field activity will not only allow them to predict patterns of variability in the extended solar atmosphere (where Earth resides) but also help them to infer the sun's interior dynamics - including the movement of hot gases in its convection zone and the origin and evolution of sunspots.

"What we discovered is we can now measure local flows underneath active regions underneath sunspots," said Scherrer. "We needed a higher resolution image all the time - more of the sun, higher resolution, all of the time, is what we get with HMI.

"With the seismology we hope to be able to see what's going to happen, with the magnetic measurements we can see what is happening, and we can compute what might be happening in the corona, and we can compare that to measurements made by the Atmospheric Imaging Array [AIA] imaging instrument on SDO." AIA is HMI's sister investigation led and developed by the Lockheed Martin Solar and Astrophysics Lab in Palo Alto.

Eight years in development

The HMI investigation was first conceptualized in 1998 and went into development in 2002 when NASA officially inaugurated the SDO mission. Eight years and $100 million later, the instrument refined by Scherrer's team is a significant improvement on its predecessor, the Michelson Doppler Imager (MDI) instrument aboard the Solar and Heliospheric Observatory (SOHO, a joint project between the European Space Agency and NASA).

While the MDI can measure only the component of the magnetic field pointed toward the observer, HMI will observe the field in its entirety. "So that means we'll be able to track the field all the way across the disc," explained Scherrer.

What's more, because the sun's center is transparent to sound waves, the oscillations measured by HMI can be used to infer the location of sunspots on the far side of the sun - the side the telescope can't see directly. The instrument's inclined geosynchronous orbit also will allow it to track a solar feature for its entire 13-day passage across the face of the sun, before the sun's rotation takes it from view. SOHO's view was limited to two days.

"With the magnetic field at the surface we can then compute an estimate of the field up in the corona," Scherrer added. "It's interactions of fields in the atmosphere, in the corona … that cause the magnetic ejections or magnetic storms that matter for people. So the source of space weather is really solar magnetic activity."

Being able to predict space weather could one day help electrical companies prevent power grid failures and provide airlines with advance notice before GPS systems go haywire. Understanding radiation environments in space also will be critical in designing space transportation systems and ensuring that future interplanetary exploration will be safer for humans and robots. "We'd like to understand the solar cycle so we could forecast activity on a scale of years," Scherrer said.

Scientists hope SDO will record data for most of the current solar cycle; each cycle lasts about 11 years. In a break with tradition, NASA will make its data available as soon as it hits the ground in White Sands, N.M.

Provided by Stanford University

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