Watching space weather through the MAGIC of CubeSat CINEMA

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(PhysOrg.com) -- A trio of CubeSats that will study the effects of space weather on the Earth's radiation belts and magnetic field are being prepared for launch. TRIO-CINEMA is a collaboration between UC Berkeley, Kyung Hee University and Imperial College London. The first CINEMA CubeSat passed acceptance testing in January 2012 and will launch in mid-2012. Two more identical spacecraft will launch towards the end of the year. The mission will be presented by Professor Tim Horbury at the National Astronomy Meeting 2012 in Manchester on Tuesday 27th March.

CINEMA will carry two science instruments: the SupraThermal Electron, Ion and Neutral (STEIN) sensor, provided by UC Berkeley, and the MAGIC magnetometer provided by Imperial College London. Both sensors represent technological leaps in miniaturised instrumentation and could have applications in a wide variety of space and planetary physics missions.

"CINEMA is part of the first generation of CubeSats to do world-class science," said Professor Bob Lin of UC Berkeley, who leads the CINEMA mission.

With a mass of just 500 grams, the tiny STEIN sensor will measure fast-moving charged and neutral particles and monitor the effects of magnetic storms, substorms, and particle precipitation on the Earth's magnetic field, radiation belts and auroral zones. STEIN builds on technology developed for NASA's STEREO solar mission, but is able to differentiate between ions, electrons, and energetic neutral atoms (ENAs).

"These types of particle detectors have been used before but have been limited in energy and time resolution. STEIN will be unique in its capacity to make high sensitivity maps and movies of ENAs," said Horbury, of Imperial College London. "CINEMA will be in Low Earth Orbit at an altitude of a few hundred kilometres above the Earth's surface, so STEIN will look upwards at the radiation belts. This will allow us to make longitudinal measurements around the Earth, and particularly to look at the energised tail of the Earth on the opposite side to the Sun."

The solar wind from the Sun hits the Earth's magnetic field, causing it to vary. Magnetometers allow scientists to monitor these small variations, which can have large effects on near-Earth space, accelerating particles to high energies which can ultimately harm satellites. . The MAGIC

instruments developed at Imperial are a new breed of magnetometer sensor that use a property called ‘anisotropic magneto-resistance, in which the electrical resistance of a material depends on the angle between the electric current and the orientation of the magnetic field. From Low Earth Orbit, CINEMA will provide a crucial new measurement location between the magnetometers far from the Earth, such as those carried by the Cluster mission, and those on the ground. CINEMA will therefore provide an essential measurement to track the motion of these disturbances from the solar wind, through near-Earth space and to the ground, giving us the best ever picture of how they are formed, move and their effects on space around us.

"CINEMA will provide the first opportunity to use this technology in space science," said Horbury. "MAGIC works on a completely different system from the big magnetometers carried by missions such as Cluster, Cassini and Rosetta. Although the MAGIC instruments are less sensitive than traditional magnetometers, if you want to have a global picture of what's happening in the Earth’s magnetosphere, you need to have a lot of spacecraft providing measurements. The sensor head for MAGIC is incredibly tiny – smaller than a Euro coin – so it’s ideally suited to fly on constellations of CubeSats."

Kyung Hee University in South Korea, the third partner in CINEMA, is providing two more CubeSats identical to CINEMA. This CINEMA-TRIO mission will open up possibilities for stereoscopic imaging of neutral atoms and observations of the magnetic field in three dimensions.

"Additional funding has recently been secured from the NSF and the US Air Force to build a further CINEMA CubeSat, so in time there should be four in operation," said Horbury. "The satellites should remain in orbit for up to 20 years. However, as the electronics are off-the-shelf components rather than space grade components, it's uncertain how long

they will remain operational."

The STEIN instrument needs accurate pointing so, in a further innovation, CINEMA will be the first spin stabilised CubeSat. The team in Berkeley has developed a complete attitude control system for CINEMA.

"This has been a huge undertaking but should prove a good investment for the future," said Horbury.

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