SpaceX launch puts UMass Lowell research into orbit

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An Air Force satellite launched into orbit this week via SpaceX's Falcon Heavy rocket carries an instrument built by UMass Lowell researchers to conduct experiments in space.

Space is a harsh and dangerous place. Aside from temperature extremes, high vacuum and bombardment of cosmic rays, there are also extremely high-energy particles—dubbed "killer electrons—that can pose a hazard to the health of astronauts and shorten the lifespan of orbiting satellites. These electrons are the subject of the research being conducted by UMass Lowell via the satellite.

"These electrons, traveling at nearly the speed of light, are capable of damaging the satellites' sensitive electronics and exposing astronauts to high doses of radiation," said UMass Lowell Physics Prof. Paul Song of the university's Space Science Lab.

To help understand how these harmful electrons are generated and, consequently, how they can be mitigated, the Air Force Research Laboratory (AFRL) awarded a three-year contract to a team of UMass Lowell researchers led by Song to support the Air Force's Demonstration and Science Experiments (DSX) mission to the Earth's radiation belts. The DSX's objective is to explore the role of "wave-particle interaction" in the dynamics of these killer electrons.

The project started more than a decade ago to investigate the possible physical processes involved with the electrons. The UMass Lowell team,

then under the leadership of Professor Emeritus Bodo Reinisch, designed and built a high-power space radio-wave transmitter as part of the DSX's Wave Particle Interaction Experiment. It is expected that the transmitted waves will interact with the killer electrons. The transmitter, which is one of the primary instruments aboard the DSX satellite, will send out Very Low Frequency (VLF) transmissions into space using a long dipole antenna that measures more than 260 feet when deployed.

During the mission, the UMass Lowell researchers will help operate the VLF transmitter and analyze the resulting data at the Space Science Lab on campus.

"Our goal is to better understand the wave-particle interaction process," said Song.

The DSX satellite launched from Cape Canaveral, Fla., using a SpaceX Falcon Heavy, the same rocket booster used by SpaceX CEO Elon Musk to send his Tesla Roadster and Starman mannequin into orbit in February of last year. This week's successful launch is among the most complicated and difficult in space, as it included 24 different satellites, of which DSX is the largest and was the last to deploy. With DSX now in its intended orbit, the deployment and testing of instruments, among which the UMass Lowell-built instrument is the largest, will take weeks.

In addition to Song, the other members of the UMass Lowell team include Research Prof. Ivan Galkin, who is a UMass Lowell graduate; Research Prof. Jiannan Tu; and physics major Brianna Croteau of Lowell, who is also an Air Force ROTC cadet at UMass Lowell.

"My role is to participate in the data analysis at the Space Science Lab for my capstone project," said Croteau, who will be commissioned as an Air Force officer after she graduates next year. "Being able to do real research and work on a real Air Force space mission while still being an

undergrad and a cadet is so amazing. It feels great knowing that I am doing real work to help the Air Force. It is a major stepping stone in my future military career and it is very humbling to work with and learn from the experts on this project. It is an incredible opportunity and I am so happy I could be a part of it."

How Good Electrons Go Bad

Since the 1960s, scientists have known that during a severe geomagnetic storm, the solar wind—a continuous high-speed stream of charged particles from the sun—impacts and compresses the daytime side of Earth's magnetosphere, the region around the planet controlled by its magnetic field. Some of these particles become highly energized in the nighttime side of the magnetosphere by processes that remain under investigation. Following a storm, electrons can be energized up to a million electron volts or more and accelerated up to 94 percent of the speed of light, more than 280,000 kilometers per second.

The DSX satellite is in an elliptical orbit that will take it to an altitude of 6,000 kilometers at its closest pass and 12,000 kilometers at its farthest. This will allow the satellite to fly through the inner and outer Van Allen radiation belts that surround Earth while collecting valuable data, according to Song. The DSX mission is expected to last for a year.

UMass Lowell's role in the DSX mission is built upon the success and engineering capability demonstrated by university researchers in an earlier space mission. UMass Lowell Space Science Lab scientists designed, built and operated the Radio Plasma Imager for NASA's IMAGE satellite, which was launched in 2000 and transmitted data for nearly six years before ground controllers suddenly lost contact with it in 2005. Last year, NASA was able to re-establish radio contact with IMAGE, albeit very weakly.

Provided by University of Massachusetts Lowell