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Imaging Microburst Precipitation with Atmospheric X-ray emissions (IMPAX) CubeSat Mission

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The Imaging Microburst Precipitation with Atmospheric X-ray emissions (IMPAX) CubeSat was recently selected by NASA's H-FORT program, with a planned launch date of late 2027. The overarching goal of IMPAX is to quantify relativistic electron microburst precipitation as a radiation belt loss mechanism. The degree to which microbursts deplete the outer radiation belt is a major outstanding question in radiation belt physics, that has significant implications for manned space flight and space-borne instrumentation including GPS technology, as well as dramatically affecting atmospheric chemistry. Microbursts are precipitation events of keV-MeV electrons lasting 10s to 100s of ms, observed on magnetic field lines mapping to the outer radiation belt, most often during geomagnetic storms. They are known to be a significant loss mechanism for outer belt electrons, but the importance of microburst precipitation relative to other radiation belt loss processes has not been established. This mission will allow us to make this critical quantification by answering the following Science Questions:

1. **What is the energy distribution (flux and spectrum) of electron microburst precipitation into the Earth's atmosphere?**
2. **Where are relativistic electron microbursts that precipitate into the Earth's atmosphere generated?**

The answers to these questions will enable us to quantify this loss process to a much greater extent than previous measurements have allowed. The energy distribution will provide the flux of electrons at different energies precipitating within individual microbursts, trains of microbursts, and over the full precipitation region, as well as how this flux varies temporally (storms/substorms) and spatially (L/MLT). Identifying the generation location of microbursts will significantly constrain the spatial and temporal scale of microburst precipitation. Combining the measured energy distribution of precipitating electrons with the spatial and temporal scale of the precipitation region will determine how long it would take for microburst loss to deplete the outer radiation belt. This timescale will then be compared to the observed energy-dependent outer belt decay, which will quantify the loss that can be accounted for by microburst precipitation and thus its relative importance as a radiation belt loss process.

To answer these questions IMPAX will take the novel approach of **combining high resolution direct measurement of electrons within or near the loss cone and the first ever imaging in low-earth-orbit (LEO) of bremsstrahlung X-rays created when the precipitating electrons hit the atmosphere**. The combination of these instruments allows a precise measurement of bounce loss cone electron flux and spectrum that is not possible with only direct electron measurements at LEO, or short-duration balloon measurements of X-rays at low altitude. **The ultra-high energy resolution particle measurements will also show the energy-time dispersion that will allow identification of the microburst generation location**.

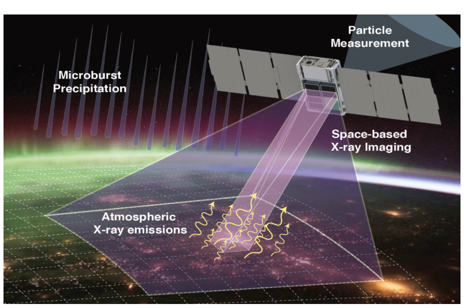

Figure 1. *IMPAX will measure microburst precipitation both by directly measuring the electrons and by imaging X-rays produced by bremsstrahlung in the upper atmosphere due to the precipitation. The direct measurement of the precipitating electrons will provide the spectra of the precipitation and the energy dispersion to determine the source location, while the X-rays provide measurements of the energy deposited by the precipitation and the size of the precipitation region.*