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THE SOLAR POLARIZATION AND DIRECTIVITY X-RAY EXPERIMENT (PADRE) CUBESAT MISSION

Abstract

The Polarization and Directivity X-Ray Experiment (PADRE) is a groundbreaking NASA cubesat mission aimed at unraveling the enigmatic secrets of the Sun. A collaborative effort between the Space Sciences Laboratory at the University of California Berkeley (SSL/UCB), Goddard Space Flight Center (GSFC), SouthWest Research Institute (SWRI), University of Applied Sciences and Arts Northwestern Switzerland (FHNW), the Saclay Nuclear Research Centre of the Commissariat à l'énergie atomique (CEA-Saclay),and EnduroSat, PADRE seeks to advance our understanding of solar phenomena. The primary focus of PADRE revolves around two sophisticated instruments: the Solar HARd X-ray Polarimeter (SHARP) and the Measuring Directivity to Determine Electron Anisotropy (MeDDEA). SHARP is designed to determine the degree of polarization (MDP) of solar flare non-thermal X-rays during the impulsive phase. It achieves this by quantifying the azimuthal distribution of scattered Hard X-rays (HXRs) using a cylindrical beryllium scatterer surrounded by photon counting detectors with Timepix3 ASICs. By deciphering the polarization along magnetic field lines, SHARP provides new insights into the acceleration of flare-induced electrons, addressing the crucial question of their directional characteristics. Complementing SHARP, MeDDEA employs existing SO/STIX flight-spare detectors provided by CEA-Saclay to measure solar flare electron anisotropy through X-ray directivity. Unlike STIX, MeDDEA does not utilize grids or perform imaging of HXRs, focusing instead on stereoscopic observations from two distinct viewpoints. This innovative approach allows unambiguous measurements of electron anisotropy, providing essential data on the energy spectrum, spatial distribution, and propagation characteristics of energetic electrons in solar flares. The collaborative efforts of the participating institutions underscore the significance of PADRE in advancing solar physics. The mission's objectives go beyond conventional observations, offering a deeper understanding of fundamental solar processes. The results obtained from SHARP and MeDDEA will contribute valuable constraints to flare acceleration models, shedding light on previously unexplored aspects of solar activity. In conclusion, PADRE represents a crucial step forward in solar exploration, leveraging state-of-the-art technology and collaborative expertise to unlock the mysteries of the Sun. Through the meticulous study of polarization and directivity in solar X-rays, PADRE promises to revolutionize our understanding of solar flares and their impact on the dynamic behavior of our closest star.