



Indian Institute of Space Science and Technology
Valiamala, Thiruvananthapuram - 695 547, Kerala

PUNCHing Through the Heliosphere with Polarized Light

A Seminar by
Dr. Ritesh Patel

Research Scientist at the Southwest
Research Institute, Boulder, USA



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The Polarimeter to UNify the Corona and Heliosphere (PUNCH) is NASA's upcoming Small Explorer mission, launched in . PUNCH will obtain white-light polarimetric observations of the outer solar corona and inner heliosphere across an unprecedented 90° field of view, using four coordinated small satellites. By exploiting the physics of Thomson scattering, PUNCH aims to reconstruct the three-dimensional structure of the solar corona and its dynamic connection to the heliosphere. A key challenge lies in combining polarized observations taken at -60° , 0° , and $+60^\circ$ from multiple spacecraft, each moving in distinct and continuously varying reference frames. These conditions require modified treatment of Stokes parameters and careful correction for wide-field projection

effects. Accurate measurement of linear polarization is essential for the mission's scientific objectives. Projection-induced deviations of a few degrees in the effective polarizer angles—termed the “IMAX Effect”, by analogy with polarization distortions in wide-format 3D cinema—can significantly affect polarized brightness (pB) retrievals. To address these challenges, we present solpolpy, an open-source Python package for precise solar polarization analysis. The package enables robust conversion among multiple polarization representations—including total brightness (B), polarized brightness (pB), Stokes parameters, and radial/tangential components (Br/Bt)—and supports data from NASA and ESA's Heliophysics missions such as SOHO/LASCO, STEREO/SECCHI, MLSO, Solar Orbiter/Metis, PUNCH, and PROBA-3/ASPIICS. Recent updates include IMAX Effect correction, distortion handling via FITS-based lookup tables, RGB polarization visualization, SunPy map integration, and four-angle polarimetry support. By providing consistent, high-precision polarization processing across rotating reference frames, solpolpy strengthens the analytical foundation for PUNCH and future polarimetric missions. Dr. Ritesh Patel, Research Scientist at the Southwest Research Institute, Boulder, USA will be the speaker of the talk. This talk will outline the mission's science goals, discuss the challenges of wide-field polarimetry, demonstrate the role of solpolpy in achieving accurate 3D reconstructions, and highlight potential synergies between PUNCH and India's Aditya-L1 mission in advancing our understanding of the coupled corona-heliosphere system.