Challenges and Solutions for PUNCH Polarimetry

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The PUNCH mission science requires exquisite linear polarimetry at the 1E-5 level compared to the background: while the science requirements only specify roughly 2% polarimetry to locate features in 3D, that is relative to the K signal from the corona (or solar wind) itself. The solar wind is observed against a background that is roughly 1,000 times brighter than the signal of intrest. The background, in turn, comprises three separate primary sources (instrument stray light, F corona, and the starfield) which are themselves polarized in different reference frames all in motion relative to one another. This challenge in background characterization and subtraction, together with the need to merge polarimetric data from four separate platforms with different, and changing, orientations in space, required rethinking the way we represent and manipulate the linear polarization state of light. Building on prior work with tri-polarizer systems, we developed the "MZP" system of virtual polarizer triplet channels as a useful representation of polarimetry. This representation allows us to apply conventional background-estimation methods that are inaccessible with the Stokes "IQU" system. It also highlights an analogy between systems of polarimetry and systems to represent color. We will present an overview of the MZP system and how we applied it to removing three separate polarized backgrounds to extract the polarization of the visible solar wind.