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Solar wind, Pickup, Suprathermal, and Energetic Ion Composition Measurement Requirements for the Interstellar Probe Mission

Eric R. Christian (1), Mihir I. Desai (2), Eberhard Moebius (3), and Nathan A. Schwadron (3)
(1) NASA Goddard Space Flight Center Code 672, Greenbelt, Maryland, USA (eric.r.christian@nasa.gov), (2) Southwest Research Institute, San Antonio, Texas, USA, (3) University of New Hampshire, Durham, New Hampshire, USA

Abstract

There has been a tremendous increase in the understanding of the interaction between the heliosphere and the galaxy recently, due to the in situ measurements of the two Voyager spacecraft and remote sensing from the Interstellar Boundary Explorer (IBEX). A follow on to IBEX is already in work. The Interstellar Mapping and Acceleration Probe (IMAP) will launch in 2024 and greatly improve on the sensitivity of the IBEX ENA maps that have given us so much information about the interface region. But the Voyager mission will not last forever, and its instruments were designed for planetary encounters, not the rarified space of the distant heliosphere. Any spacecraft will require decades to travel to the outer heliosphere to make new in situ measurements. Therefore, starting the planning for these new observations immediately is key to the next step in our understanding of the outer heliosphere and beyond.

An Interstellar Probe must carry state-of-the-art instrumentation that unravels the currently unmeasured properties of critical populations. These include 1) 3-dimensional velocity distribution functions (VDFs) and composition of thermal solar wind ions; 2) 3D VDFs and relative composition of the interstellar pickup ions; and 3) energy spectra, composition, and arrival direction of suprathermal-through-energetic ions and electrons. In this presentation, we discuss the science rationale for these measurements and describe a novel instrument design concept that requires low mass, has a compact and fully optimized form-factor, and simultaneously provides high quality solar wind plasma, pickup, and suprathermal-through-energetic ion distributions and composition over 6 decades in ion energy in a wide variety of space plasma environments, including the solar wind, inner and outer heliosheaths, as well as the local interstellar medium.