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Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond (4)

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IN-SITU INVESTIGATION OF THE INTERSTELLAR MEDIUM

Abstract

After the exciting in-situ observations of the termination shock and the entry of the Voyager 1 spacecraft into the inner and possibly outer heliosheath, there is a growing awareness of the significance of the physics of the outer heliosphere. Its understanding helps to clarify the structure of our immediate interstellar neighborhood, contributes to the clarification of fundamental astrophysical processes like the acceleration of charged particles at a stellar wind termination shock and beyond, and also sheds light on the question to what extent interstellar–terrestrial relations are important for the environment of and on the Earth and of exoplanets. In order to explore the boundary region of the heliosphere, it is necessary to send a spacecraft to perform advanced in-situ measurements particularly in the heliosheath, i.e. the region between the solar wind termination shock, and the heliopause, as well as in the (very) local interstellar medium. Solar activity is decreasing to 'normal values' below those of the Grand Solar Maximum which was typical of the space age so far. This is likely to reduce the size of the heliosphere and allows us to study a 'normal' heliosphere by launching an Interstellar Probe (IP) which will also provide within a shorter time than previously believed the first comprehensive measurements of key parameters of the local interstellar environment such as its composition, state, and magnetic field. Together with an accurate determination of the state of the heliospheric plasma across the heliosphere, these quantities are crucial to our understanding of how the heliosphere, and, much more generally, astrospheres, are formed and how they react to varying interstellar environments.