How to measure interstellar dust in the Solar System

Ralf Srama[123], Veerle Sterken[12], Georg Moragas-Klostermeyer[12], Harald Krüger[4], Peter Strub[14], Rachel Soja[1], Nicolas Altobelli[5], Katherina Fiege[6], Frank Postberg[16], Jon K. Hillier[6], Eberhard Grün[2]

[1]University Stuttgart, Germany, [2]Max Planck Institute Nuclear Physics, Heidelberg, Germany, [3]Baylor University, Waco, USA, [4]Max Planck Institute Solar System Research, Katlenburg-Lindau, Germany, [5]ESA, Madrid, ESP, [6]University Heidelberg, Germany

The in-situ measurement of interstellar dust in the Solar System by Ulysses in 1993 was largely unexpected. Since then, further datasets have demonstrated clear evidence for interstellar material at various distances from the Sun. Today, interstellar grains have been identified between 0.6 AU and 9.5 AU by in-situ dust measurements. How successful were the interstellar dust campaigns of Stardust?

Here, we present an overview of current in-situ measurements and provide recommendations for future missions. Which time frames and mission trajectories are optimal for the measurement of interstellar dust populations? What are the instrument requirements with regard to the sensitive area and mass resolution? What are the advantages and limitations of sample return missions? Can we combine the measurement of interstellar dust with interplanetary dust measurements? What are the pointing, power and data rate requirements? Which magnetospheric parameters can be measured in conjunction with interstellar dust campaigns? The answer to these questions are relevant for the design of future missions that aim to investigate the seeds of our Solar System. As a detailed example, we describe the capabilities of Cassini dust instrument suite and the procedures to perform interstellar dust measurements.

Technical aspects are often underestimated when planning a scientific mission. The data required to fulfill the scientific goals of the mission can only be achieved if the mission design, spacecraft operations and instrument operations, project management, the spacecraft bus and the instrument capabilities are designed to optimise the success of the scientific tasks. Thus, the early planning of a pointing profile and limited spacecraft bus constraints (forbidden FOVs) is essential for a successful mission. New technologies allow for a low instrument mass and power while simultaneously increasing the scientific performance.

This paper describes the instrument methods required for a successful measurement in terms of operations and software design. If the mission trajectory is adjusted to the interstellar dust flow, an in-depth mapping of our cosmic dust environment is possible. Cassini represents only a first step that has sucessfully demonstrated the power of Dust Astronomy: we now have to prepare for the future with advanced instrument and mission concepts.