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Strofio: Exospheric Sampling of Mercury's Surface Composition

STEFANO LIVI[1], GEORGE HO[1], DENNIS HAGGERTY[1]

[1] *The Johns Hopkins University Applied Physics Laboratory, Laruel, MD 20723, USA*

ESA's BepiColombo mission to the planetary Mercury includes a comprehensive set of advanced instruments. Strofio, one of the instruments on the SERENA neutral and ionizing particle suite on the Mercury Planet Orbit (MPO), is a high mass resolution, time-of-flight system for low energy neutral particles. Stemming from ancient Greek, the word Strofio means rotor or to rotate, and indeed, a rotating field is used to enable extremely high mass resolution observations. Strofio can measure the chemical composition of low-pressure gases, the relative abundance of different species, and (albeit at low accuracy) the particle flow direction and velocity. Incoming neutral gas if first ionized by a continuous, open source. Following ionization, the start times are "encoded" into the particle trajectories by a radiofrequency (RF) electric field. Once the particles leave the dispersing region they move on a constant trajectory to the 2D MCP detector system where the time of flight is measured, from which the mass/charge can be calculated. The time of flight and the spatial position of an ion uniquely determine its mass/charge. The combination of a highly efficient source and the use of position-sensitive detection promises to significantly improve the sensitivity and mass resolution of truly miniature low-energy neutral particle instruments. The design of the Strofio sensor is driven by the attempt to achieve both isotopic resolving capability (goal is a cross talk of 10-5 or better between two adjacent masses at the 50% level) and temporal resolution (a full-range spectrum can be collected in as short as 100 ms) within very limited resources (goal is 1.5 kg, 1.5W, 1, 000 cm3). Laboratory tests on an available prototype show that these goals are within reasonable reach. This instrument is currently been developed as integral part of the SERENA/BepiColombo project, but could be readily adapted to a number of future missions, including missions to study planetary atmospheres and exospheres, cometary missions, and fast flybys.