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Solar wind interaction with Phobos: Observation of a new type of interaction

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Abstract

During the closest ever Phobos encounter of Mars Express on July 23, 2008, the ASPERA-3/IMA (Ion Mass Analyser) sensor on board carried out ion observations. The flyby occurred in the upstream solar wind far away from the Martian bow shock where no interference from the Martian plasma environment is expected. In the vicinity of Phobos, IMA detected unusual signatures in the proton fluxes. Because MEX has no magnetometer on board it is not possible to directly back trace the trajectories of the observed protons. Thus, it was not easy to confirm if those protons came from Phobos. However, after a careful analysis, we conclude that the origin of these protons is indeed Phobos. The reasons are: 1. The energy of the observed protons is slightly less than the solar wind proton energy, and the energy spectrum have a low-energy tail. The protons behave as backscattered solar wind protons which was reported by the Japanese Kaguya mission at the Moon. 2. We conducted test particle backtracing assuming that the protons originate from Phobos under various magnetic field conditions. A consistent solution for all independent observations was found. 3. We looked through all the ASPERA data observed in the undisturbed solar wind, and found that the strong signals were only observed during the Phobos flyby. This indicates that Phobos is the most probable source of the observed protons during the flyby. Considering those results, we conclude that the observed protons are solar wind protons backscattered from Phobos. The process of backscattering of impinging keV particles has never been considered because most of the particles have been assumed to be absorbed at the very rough surface of the regolith. However, these investigations suggest that the backscattering of the solar wind protons are a general feature of the atmosphereless body covered by regolith, which would be applicable to Mercury, meteorite, and moons of giant planets.