EPSC Abstracts
Vol. 5, EPSC2010-327, 2010
European Planetary Science Congress 2010

High solar wind reflection from Phobos

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Abstract

During the Mars Express (MEX) closest approach to Phobos on July 23, 2008, the ASPERA-3/IMA (Ion Mass Analyser) sensor on board MEX carried out ion observations. IMA observations indicate that the solar wind protons are strongly backscattered from Phobos. Since the Moon of the Earth also backscatters the solar wind protons similarly, the backscattering of the solar wind protons is a common feature of the regolith in space, in contrarily from the classical argument that the regolith is a complete absorber of the solar wind protons.

Introduction

During the Mars Express (MEX) closest approach to Phobos on July 23, 2008, the ASPERA-3/IMA (Ion Mass Analyser) sensor on board MEX carried out ion observations. The approach was in the upstream solar wind, and IMA detected unusual signatures of the proton fluxes close to Phobos apart from the commonly seen bow shock signatures and the solar wind protons. In this presentation, we will discuss the source of the observed proton flux to investigate the Phobos interaction with the solar wind.

Analysis and discussion

During the close fly by of the MEX to Phobos (closest approach ~90 km), IMA detected distinct flux of the protons together with the well-known solar wind protons and the bow shock related protons. 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, we conducted careful analysis, and concluded that the source is Phobos. The reasons are: 1. The observed mass spectra clearly shows the flux is proton. The mass spectra cannot be explained by the solar UV or random background counts which are significant sources of the noises. 2. We conducted test particle backtracing assuming that the protons originate from Phobos under various magnetic field conditions. A consistent solution of the magnetic field for all independent observations was found. 3. We looked through all the IMA data observed in the undisturbed solar wind, and found that the strong signals were only observed during the Phobos flyby.

Summary

These analyses indicate that Phobos is the most probable source of the observed protons during the flyby. Even though the generation mechanism is not fully understood, by taking Kaguya [1] and Chandrayaan-1 [2] observation close to Moon as an analogy, the observed protons close to Phobos are most probably solar wind protons backscattered from Phobos. The process of backscattering of impinging keV particles has never been considered for Phobos 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.

References

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[2] Homström, M., et al: Dynamics of solar wind protons reflected by the Moon, J. Geophys. Res., in Press, 2010.