Modelling the interaction of Phobos' surface with the Solar Wind and Martian environment

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Introduction: Phobos' surface is subject to space weathering by Solar wind ions and micrometeorites bombardment. This results in ejection of surface material and production of dust and gas phases in the close moon environment. In particular the existence of a such tori has been postulated [12,3], but not confirmed by observations [4,5]. Additionally, recent observations from Mars/Express ASPERA indicate a population of protons backscattered by the surface, shading new light on the interaction between the Martian moon and the solar wind. The goal of this paper is to perform numerical simulation of the space weathering process at Phobos in order to determine a putative composition of the gas phase and compare the result with available data. This allows to propose some diagnostic of Phobos' surface.

Model:

We use a 3D Monte Carlo numerical code which simulates ejection due to sputtering by solar wind and magnetospheric ions, and bombardment by micrometeorites. Trajectories of the following neutral species : Fe, O, Mg, Na, and Ca, as well as backscattered protons, are followed within 4 martian radii from Mars center. We assume a surface composition based on observed similarity between Phobos IR surface spectra, spectra of D-type asteroids [6,7] and associated meteorites, resulting in the following main species distribution :

Element	Mass fraction
Fe	0.3700
Si	0.1300
O	0.4100
Mg	0.0800
Al	0.0170
Ca	0.0025
Na	0.0015

The Solar Wind parameters, electric and magnetic fields around Mars are ad hoc elements given at solar minimum conditions by a Hybrid simulation of the Solar Wind interaction with Mars [8]. We use micrometeoritic fluxes consistent with those derived form observations by [9] and previous estimations [10,11]. Ejected particles are followed until they are ionized by photons or by charge exchange with solar wind protons, impact the Martian surface, or escape the calculation space.

Results: We calculate the steady state density of Phobos ejecta in the Martian environment for each species, and provide estimates of corresponding solar scattering emission intensities.

Our preliminary results show no clear evidence of a gas torus forming around Mars at Phobos orbit. Due to the very small size and gravity of Phobos and velocity distributions condidered, ejected species basically escape and do not form a torus at Phobos orbit. We however show density distributions of putative surface elements ejected in the Martian environment and as well as a back-scattered proton population. Figure 1 below gives an example of the density distribution of Sodium atoms around Mars when Phobos is subsolar, while Figure 2 shows the density distribution for Fe atoms for the same Phobos position. The maximum densities of Sodium and Iron close to Phobos are 1.86×10^{-2} cm^{-3} and 4.0×10^{-1} cm^{-3}, respectively. For instance for Sodium we estimate a scattering emission intensity of the D2 line (5889.95 Å) no larger than 1.3×10^{-2} Rayleigh ($1R=10^6$ photons.s$^{-1}/4\pi$).

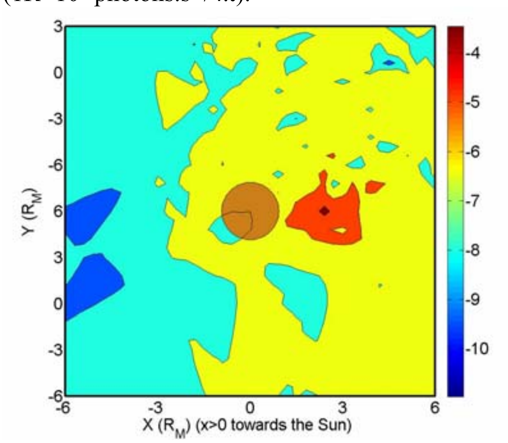

Fig 1 : Density distribution of Sodium atoms (in log (n) cm^{-3})

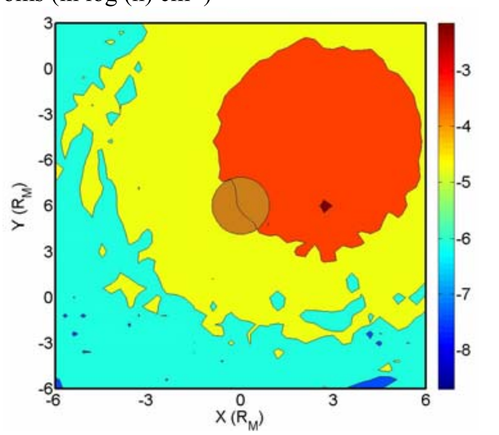

Fig 2 : Density distribution of Iron atoms (in log (n) cm^{-3})

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