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# Reduction of ENA emission above the magnetic anomalies on Mars: MEX/ASPERA-3 result

X.-D. Wang, S. Barabash and Y. Futaana
Swedish Institute of Space Physics, Kiruna, Sweden (wang@irf.se)

## Abstract

We present the preliminary results of the effect of Martian magnetic anomalies (MAs) on the emission of energetic neutral atoms(ENAs) at Mars. It is demonstrated that the anomalies reduce ENA flux significantly. The explanation is that stronger magnetic field above the MAs elevates the induced magnetosphere boundary (IMB) so that only the higher and less dense part of Martian exosphere can interact with shocked solar wind. This is the first attempt to image Martian MAs with ENA remote sensing technique.

## 1. Introduction

Mars has no global dipole magnetic field, upstream solar wind ions (mainly protons) can reach very low altitude until they meet the induced magnetosphere boundary (IMB). As the ions approach the planet, they have greater and greater chance to react with the planet's neutral exosphere by charge exchange process, producing energetic neutral atoms (ENAs) [6]. ENAs do not feel electromagnetic field and almost do not feel gravity field, so they travel in straight lines. However, new born ENAs may also collide with exospheric particles and be scattered. Observations of these two populations, namely charge-exchange and backscattered ENAs, have been reported [4, 5, 7, 9, 8, 2]. ENAs can be used as a remote sensing medium to study the interaction between solar wind plasma and Martian exosphere. The generation of ENA is also a channel of atmospheric escape for unmagnetized bodies.

Although in lack of global magnetic field, Mars possesses localized crustal magnetic field, called magnetic anomalies (MAs) [1]. MAs greatly increase the complexity of Martian plasma environment and their role in the solar wind-planet interaction has not been totally understood. This study will focus on the effect of MAs in the generation of ENAs.

## 2. Data and Processing

We use the data of Neutral Particle Detector (NPD) from the Analyzer of Space Plasma and Energetic atoms(ASPERA-3) on Mars Express (MEX) spacecraft[4]. NPD consists of two identical ENA energy spectrometers with $9^\circ \times 180^\circ$ field of view (FOV) in all. Its data are ENA energy spectra listed by different observing directions and time. The angular and time resolutions are $5^\circ \times 40^\circ$ and 1 second, respectively. After necessary clean-ups of the data, we first calculated the directional flux by integrating the ENA energy spectrum over the range from 0.3 to 3 keV, in order to exclude possible contaminating electrons and potential oxygen atoms. Then we converted the position of spacecraft and viewing attitude vectors into Mars-Centered Geographic coordinate system in which the strongest MAs locate at $\sim$(180°E, 50°S). This is followed by the back-tracing of measured ENA flux to the source region at the altitude of Martian exobase. Then we got the spatial distribution of ENA flux at the source region. The result is shown in Figure 1.

## 3. Result and Discussion

The result shows good agreement between the reduced ENA emission region and the region of major MAs. Detected ENA flux is the integration of production rate from the instrument to the end of the line of sight. Since observation geometry did not change above the MAs, the reduction of ENA flux is caused by the reduction in production rate. The production rate is proportional to the product of solar wind flux and the neutral density. There is no evidence that Martian exosphere becomes tenuous above the MAs, whereas the elevation of IMB has been observed by MEX mission [3], which will cause a reduction of ion flux below the IMB, therefore the observed phenomenon can be explained.

Currently, the asymmetries in the exospheric density between northern and southern hemispheres are

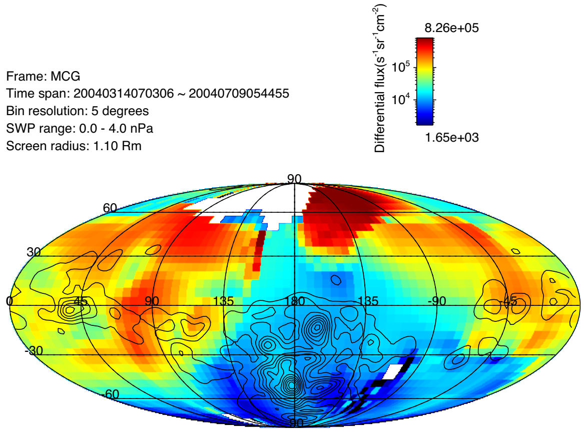


Figure 1: Distribution of back-traced ENA flux with respect to position in Mars-Centered Geographic coordinate system at an altitude of 0.1 Mars radii. Black contours show the morphology of magnetic anomalies.

not considered [10], and it might be responsible for the asymmetric background flux between hemispheres. Also, instead of averaged differential flux, radial flux per area as a function of location on the exobase should be calculated to give more accurate physical meanings.

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