Mem. S.A.It. Vol. 90, 639

Memorie della

Comparative analysis of response of the near Mars plasma environment to ICMEs during a solar minimum and maximum

L. Neves-Amaral[1,2], P. Kajdič[3], B. Sánchez-Cano[4], C. G. Bernal[1], and D. Rojas-Castillo[5]

[1] Instituto de Matemática, Estatística e Física, Universidade Federal do Rio Grande, Campus Carreiros: Av. Itália km 8, Bairro Carreiros, Rio Grande do Sul, Brazil
[2] Instituto de Ciencias Nucleares, UNAM, Circuito Exterior s/n, C.U., Apartado Postal 70-543, 04510, CDMX, México, e-mail: laura.amaral@correo.nucleares.unam.mx
[3] Instituto de Geofísica, UNAM, Circuito Exterior s/n, C.U., 04510, CDMX, México
[4] Department of Physics and Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, UK
[5] Space Research Institute, Austrian Academy of Sciences, Schmiedlstrasse 6, 8042 Graz, Austria

Abstract. We present results of our study in which we compare the impacts of two interplanetary coronal mass ejections (ICME) on near Mars plasma environment. The two ICMEs exhibit similar characteristics at 1 au. The first ICME was observed by the ACE mission in November 2007, during the most recent minimum of the solar activity. The second was detected by ACE in March 2012 when the Sun was near its maximum. During these periods, Earth and Mars were almost aligned meaning that ICMEs that hit Earth also hit Mars. We use Mars Express (MEX) data in order to study the processes in the near Mars plasma environment. The motivation behind this study is that, during its maximum, the Sun emits more photoionizing light than during its minimum and the Martian ionosphere, which represent an obstacle that the SW cannot penetrate, is more ionized and therefore more rigid in this period.

Key words. Planetary Geophysics: Mars Plasma Environment – Heliophysics: Space Weather – Heliophysics: Interplanetary Coronal Mass Ejection – Heliophysics: Solar Cycle

1. Introduction

Unlike the Earth, Mars does not have its own global magnetic field (magnetosphere), instead its magnetosphere is induced due to the solar wind interaction with the planet's ionosphere (Acuña et al. 1998).

This means that solar transient events arriving to the planet interact more directly with the Mars atmosphere.

Meanwhile, the solar emission of EUV and X-ray radiation changes with the solar cycle (Lean 1991).

This means that the Mars' ionosphere exhibits higher degree of ionization during solar maxima than during solar minima.

Thereby, this study focuses on the comparison of the response of Mars plasma environment to the arrival of two interplanetary coronal mass ejection (ICME) in November

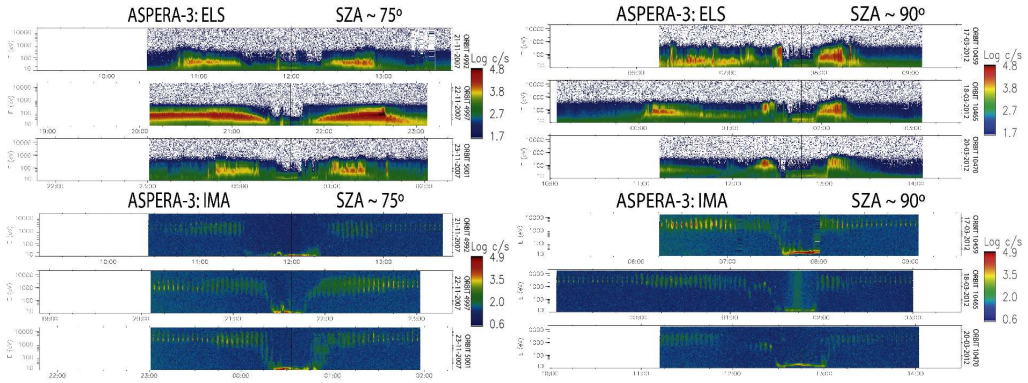

Fig. 1. Mars electron (ELS) and H^+ and O^+ (IMA) spectrograms during three consecutive orbits in November 2007 (left) and March 2012 (right) corresponding to periods when two ICMEs passed the planet. The central black line on all panels indicates the periapsis of MEX.

2007, which corresponds to the solar minimum 23/24, and March 2012, near the solar maximum.

2. Datasets

We choose our case studies from the data of the Advanced Composition Explorer (ACE) mission located at the L1 point between the Earth and the Sun. During the intervals of interest, ACE and Mars were practically aligned, so ACE serves as a solar wind monitor.

In order to study the ICME interactions with Mars, we make use of the Mars-Express (MEX) observations. We use the data from the Ion Mass Analyzer (IMA) and ELectron Spectrometer (ELS). During both time periods MEX had an elliptic orbit, with a periapsis of 250 km and an apoapsis of 10.142 km, orbital period of 6.75 h and orbit inclination of 86.35^o (quasi-polar) with the planet equator.

3. Results

Here we compare the behaviour of the Mars plasma environment during the passage of two ICMEs with similar properties. We look at the ionosphere compression and the particle counts in the induced magnetosheath.

The response of the Mars plasma system is more pronounced during the event of 2007 (similar to observations of another event studied by Sánchez-Cano et al. 2017), where the size of the magnetosheath and ionosphere and particle count inside this regions change more with the time, comparing with the 2012 event (see Figure 1), where the system is continuously perturbed.

Comparing the panels of IMA, we see that MEX stays less time inside the ionosphere in 2007 impact than in 2012. The continuous presence of suprathermal ions within the ionospheric cavity and magnetosheath, indicates that these regions presented higher ionization rate. The size of magnetosheath have an asymmetry because MEX orbit on 2012.

We also observe high count rates of ions with velocities above the Mars' escape velocity, indicating an enhanced atmospheric escape from Mars during both time periods under study.

Acknowledgements. I am grateful to Instituto de Ciencias Nucleares of Universidad Nacional Autónoma de México which allowed me to present some results on this conference. This study was partially financed by the Coordena£o de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

References

Acuña, M. H. 1998, Science, 279, 1676
Lean, J. 1991, Reviews of Geophysics, 29, 505
Sánchez-Cano, B. et al. 2017 , J. Geophys. Res. (Space Physics), 122, 6611