Modelling the solar wind forced Martian environment

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Star Planet Interaction Module

We adapt the Star Planet Interaction Module (CESSI-SPIM) developed at CESSI, IISER Kolkata [Das et al. (2019), *ApJ*] for a Mars-like planet.

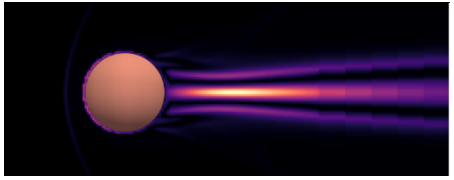
Planet: The non-magnetized planet lies at the origin of a Cartesian box.

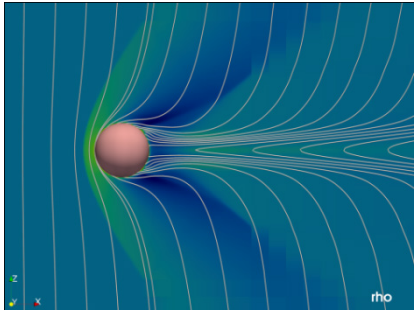
Atmosphere: A very thin gravitationally stratified atmosphere surrounds the planet, replicating present-day Mars.

Ambient medium: The ambient medium is initially devoid of magnetic field and has a density of 36 protons/cc.

Stellar wind: The stellar wind mimics slow solar wind properties at 1 AU and is given as a boundary condition satisfying the Rankine Hugoniot magnetized shock equations.

3D compressible magnetohydrodynamic (MHD) simulations are carried out.





Model results

A steady-state imposed magnetosphere is formed around the planet due to draping of stellar wind magnetic field lines.

The bow shock forms at a distance of 1.5 Rm (radius of Mars) while the stand-off location for the magnetopause occurs at about 1.1 Rm.

Three strong current sheets are found in the magnetotail region which form due to highly kinked field lines and magnetic field of opposite polarities.

The relevant results have recently been published [Basak & Nandy (2021), *MNRAS*].

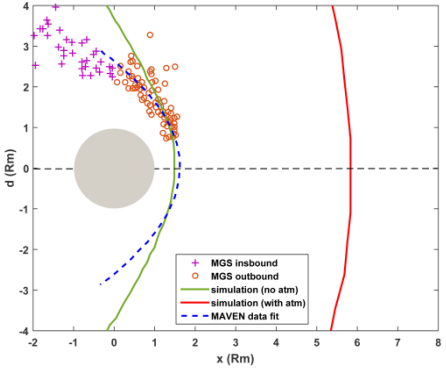
Linking to observations

The bow shock and magnetopause stand-off distances agree with observations.

The global trend of magnetic field compares well with data along specific spacecraft orbits of MGS and MAVEN. Crustal fields are ignored in our model, and thus, cannot be captured.

The results are expected to complement data from upcoming Mars missions.

The study is important for the exploration and detection of habitable planets in exoplanetary systems.



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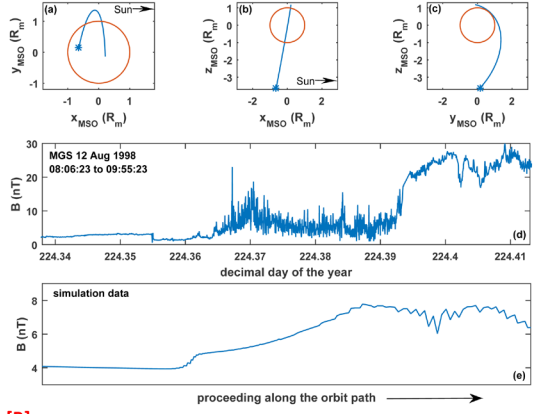

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