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Complete 3D-global kinetic simulations of interaction of solar wind with the Earth-Moon like exoplanetary systems

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The high energetic magnetized wind from a host star plays a crucial role in determining the magnetic configuration of the planets it harbours. The dynamics of such systems are essentially governed by the nonlinear Magnetohydrodynamics (MHD) equations [1]. But MHD essentially neglects the kinetic aspects and treats the wind & the ambient medium as conducting fluids characterized by macroscopic parameters viz. density, velocity, magnetic field and temperature. But, the interactions of high energetic charged particles, present in the wind, with the magnetic field of the planet exhibit fascinating events under certain conditions and often control the space weather near the planet and also in the vicinity of natural satellite of the planet.

By using implicit Particle-in-Cell simulations method [2] in three dimension a global kinetic model for Earth-Moon like planetary systems [3], in a single domain, has been developed. At the outset, this model has been benchmarked by comparing the outcomes with existing theoretical results. Next the electromagnetic field distribution and essential plasma characteristics have been measured at a certain altitude above the lunar surface for the following two configurations : (a) Moon is in the Geotail (downstream/full Moon configuration) and (b) Moon is facing undisturbed solar wind (upstream/new Moon configuration).

Moreover, by analysing the particle data, the particle precipitation rate on the lunar surface along the orbit of the Moon has been calculated [4]. The location of the Moon in its orbit where the population of non-thermal particles (electrons and ions) near the lunar surface is richest has been figured out.

A qualitative comparison of our simulation results with recent observations has also been made.

References:

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