
Modeling magnetized star-planet interactions

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Abstract

The diversity of discovered exoplanets in terms of mass, orbit and distance to their host stars promoted a renewed effort of the scientific community on better understanding star-planet interactions (SPI). Close-in planets provide a very interesting natural case of SPI in that their close orbit makes them more exposed to stellar ejecta. Also, they are in some cases likely to orbit inside the stellar wind Alfvén radius and thus be able to impact their host star global properties (e.g., stellar rotational and/or magnetism evolution history). Among the numerous SPI models which have been developed over the past years, specific magneto-hydrodynamic (MHD) simulations have been performed by a few different research groups in order to combine "state of the art" stellar wind numerical models with simplified models of planetary magnetospheres. Because those models are global, they are able to assess both the planetary evolution trends as well as the potential influence of close planets on their host stars self-consistently.

We present here a parametric study of global magnetic SPI using the PLUTO code. We distinguish the cases of magnetized and unmagnetized planets, which produce significantly different results, as expected. We characterize the potential influence of close-in planets on their host star properties, depending on their orbital position in the stellar wind. Thanks to the versatility of the PLUTO code, we put a particular emphasis on the influence of various numerical parameters (ideal vs diffusive MHD approaches, boundary conditions choices, numerical methods, magnetic topologies) on the numerical simulations predictions. Finally, we discuss how to use such global models for studying short time-scale phenomena, such as coronal mass ejections (CME)-planet interactions and planetary magnetospheric response.

Keywords: stellar wind, close in planets, magnetized interactions, MHD

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