

Magnetic games in compact exo-planetary systems

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Abstract

Close-in planets generally orbit in a sub-alfvénic stellar wind. The effective magnetic connection between a close-in planet and its host takes the form of two Alfvén wings. The stellar global magnetic field is at the heart of star-planet magnetic interaction: its strength sets the magnetic energy available for the interaction, its shape determines the connection path between the star and the planet, and its temporal modulation (e.g. magnetic cycles) is at the source of an on/off behavior of the magnetic interaction. The magnetic coupling between the planet and its star establishes a current system that can affect the planetary magnetosphere, ionosphere, as well as the atmospheric escape of the close-in planet.

I will briefly give an overview of our understanding of star-planet magnetic interactions and present estimates for their amplitude. I will then present a specific study of the 3D star-planet magnetic interactions in the Kepler-78 system. Kepler-78 is a late G-type star around which a 1.86 Earth-mass planet orbit with an ultra-short period of 0.36 days. Based on this test case study, I will show that the detection of star-planet magnetic interactions generally requires a detailed knowledge of the stellar magnetic topology and amplitude. I will show that for favorable star-planet systems, the detection of star-planet magnetic interaction is theoretically possible with present telescope capabilities. I will finally present a new tool currently under development: SWiPy. SWiPy is a python package that leverages magnetic fields observed with Zeeman-Doppler-Imaging (ZDI) to predict the amplitude and detailed timing of star-planet magnetic interactions. Such a tool can be used at very low computational cost to predict the most favorable orbital and rotational phases for the detection of magnetic interactions in a given star-planet system. It can also be used to disentangle the effects of star-planet interaction from the intrinsic

variability of the star and therefore could provide an important asset in the exoplanet hunt era of CHEOPS, PLATO and ARIEL.