Title: Realistic models of star-planet magnetic interactions in close-in exoplanets : implications for Ohmic heating

While many physical parameters of exoplanets are now well constrained, exoplanetary magnetic field remains largely unexplored, despite playing a key role in understanding dynamo processes in planets and in atmospheric retention. Star-planet magnetic interactions (SPMI) provide a promising pathway to probe this missing parameter. Existing analytical models (Saur et al. 2013; Lanza et al. 2013; Paul & Strugarek 2025) predict that the total SPMI power scales with the strength of the planetary magnetosphere. However, these approaches assume that the planet interacts with a homogeneous stellar wind along its orbit. This approximation breaks down in the presence of complex stellar magnetic topologies, such as during solar maximum, motivating the need for more realistic modelling.

We present a non-axisymmetric 3D MHD stellar wind model that, for the first time, explicitly includes an exoplanet and its magnetosphere. Our *ab-initio* simulations reveal how the excitation and transport of planetary-induced Alfvén waves can be modulated over the orbital phase. This modulation produces strong intra-orbit variations in any signal induced by star-planet magnetic interactions. Consequently, the magnetic coupling between the planet and its environment varies significantly along the orbit and depends sensitively on the assumed magnetospheric size. Such pronounced spatio-temporal variability in magnetic energy transport is expected to also directly influence the dissipation of electromagnetic energy in the planetary ionosphere, particularly through Ohmic heating of the upper atmosphere, which can easily reach power levels of 10^{16} to 10^{17} W. This process therefore emerges as an additional heat deposition mechanism that should be taken into account to assess atmospheric escape of close-in exoplanets.

Our results demonstrate that such modelling is required to move beyond order-of-magnitude estimates toward a quantitative characterisation of SPMI and address self-consistently the modulation of their associated signals for specific star-planet systems. Ultimately, this approach opens new prospects for constraining the magnetospheric sizes of close-in exoplanets and for improving our understanding of magnetic coupling between exoplanet magnetospheres and their upper atmospheres.