Abstract SF2A

Title : Electric charging of dust grains -- Application to hot exozodiacal dust disks

Abstract :

The study of debris discs is becoming a growing research field, thanks to recent observational advances that allow us to refine our understanding of the spatial distribution, properties, origin and dynamics of the dust grains. However, current models struggle to reproduce the observational data self-consistently.
This includes the near- and mid-infrared interferometric observations (e.g. Absil et al. 2013 with CHARA/FLUOR, Ertel et al. 2014 with VLTI/PIONIER) that reveal hot and warm exozodiacal dust grains populating the inner regions of extra-solar planetary systems. A significant fraction of the nearby Main Sequence stars (15-20%) shows large concentrations of hot grains, accumulated near their sublimation zone, despite their short theoretical lifespan this close to the star. In both the near- and mid-IR, exozodis are more frequently detected around stars that have also a cold debris disk (Nuñez et al. 2017, Ertel et al. 2018, Absil et al. 2021).
Diverse explanations have been developed: some intense and regular restocking mechanisms such as dust migration by Poynting-Robertson drag or exo-comet evaporation, both requiring an external reservoir of material (Absil et al. 2006, Kral et al. 2017), and/or some trapping mechanisms extending the dust lifetime due to gas drag (Pearce et al. 2020) or due to the interaction with the stellar magnetic field (Krivov et al. 1998, Rieke et al. 2016). Still, no theoretical model has been able to fully explain the hot dust observations, yet.

In this study, we aim to re-explore the magnetic trapping scenario, for which earlier simulations led to contradictory results in the past years. The electric charge acquired by hot dust grains makes them sensitive to the stellar magnetic field, allowing the Lorentz force to affect their trajectory and potentially trap them at the right location.
To this end, we will lean on the dynamical code presented in Sezestre, Augereau & Thébault (2019) to compute grain trajectories with real-time sublimation, to which we implemented a well-understood electric charge model (inspired by Mukai et al. 1981 and Kimura et al. 2020) to robustly account for the Lorentz force. We expect this study to do a step forward in the explanation of the hot exozodi presence, and its connection with the cold debris disk and the cometary population.
The poster will present our electric charge study (model and main assumptions, charge results, limits, and sensibility to key parameters and model hypothesis) and some preliminary results about the electric charge impact on the dust grain dynamical evolution.