S07 Atelier calcul haute performance et simulations numériques

Unveiling Variability in T Tauri Disk Inner Rims: Insights from 3D Radiative MHD Simulations with IDEFIX

T Tauri disks are composed of gas and dust, but in their innermost regions—where temperatures exceed 1,000 K—the dust sublimates. The radius at which this occurs can be spatially resolved with the VLTI instrument GRAVITY, offering valuable observational constraints on the disk's inner structure. While this sublimation radius has traditionally been considered stable over time, recent 2D viscous radiative simulations challenge this view, revealing that it can vary dramatically—expanding by up to a factor of 20 over just a few decades. Such rapid changes would be detectable with GRAVITY and raise important questions about the underlying physical mechanisms. In this talk, I will present a series of 2D radiative viscous simulations showing that the variability of the sublimation radius is highly sensitive to the viscosity prescription, which should be physically controlled by the magneto-rotational instability (MRI). To robustly test this scenario, we have performed global 3D radiative non-ideal magneto-hydrodynamic (MHD) simulations, fully resolving the MRI across the transition between the inner MRI-active and outer MRI-dead zones. These simulations leverage the newly developed radiation module of the IDEFIX code, optimized for both CPU and GPU architectures. This high-performance implementation now makes such demanding simulations tractable. I will conclude by illustrating the broader range of astrophysical problems that can be tackled using this new module.