Probing the inner disk and magnetospheric accretion region of CI Tau with VLTI/GRAVITY

For a few million years after the gravitational collapse that led to their formation, young stellar systems (YSO) remain surrounded by a circumstellar disk from which planets form. Otegi et al. (2022) revealed that most planetary systems consist of super-Earths or mini-Neptunes orbiting close to their host star. It is crucial to explore the physics of the star-planet-inner disk interaction in young stars, not only for the role it plays in the early evolution of solar-type stars (e.g., accretion/ejection, angular momentum) but also to define the environmental conditions that prevail at the time of planetary formation. CI Tau is so far the only pre-main sequence star still accreting from its surrounding disk claimed to host a hot Jupiter planet. The most exciting aspect of CI Tau regards its extreme magnetic field (3.7 kG) that disrupts the inner gaseous disk and generates accretion funnel flows down to the stellar surface. We propose to present our investigation of the inner region of CI Tau, aiming at reconnecting the different spatial scales of the system down to a few stellar radii (≤0.1 AU). We investigated this puzzling system using the long-baseline interferometry technique at three different epochs (2021, 3 nights in 2022). Thanks to the high spectral resolution of VLTI/GRAVITY (R=4000), we are both sensitive to the emitting dusty part of the inner rim (K-band continuum), and the magnetosphere itself traced by the Brγ emission line (2.1661 μm). In the continuum, we characterize the disk's inner rim, which appeared disconnected from the outer disk with a significant misalignment in inclination and position angle (Soulain et al. 2023). We report an internal cavity at 0.20 ± 0.02 AU that could infer the presence of a planet carving the inner part of the disk, reinforced by a recent hydrodynamical simulation (Muley et al. 2021). Additionally, the strong asymmetry (inferred from the non-zero closure phase) seems to move between our epochs and could be caused by a moving material within the disk (vortices? planets?). In the Brγ line, we detect a compact emitting region of 0.05 ± 0.01 AU strongly supported by our accreting magnetosphere models (Tessore et al. 2023). Interestingly, the two-day baseline allowed us to trace this accretion phenomenon during the same orbit. We used the differential phases (sensitive to the photocentre of the system) to follow the funnel flows them-self. An asymmetric solid rotation of the magnetosphere should induce a variable photocentre displacement, and we propose to present these critical new results.