Synthetic observables with VLTI of dust asymmetries in the inner parts of circumbinary discs

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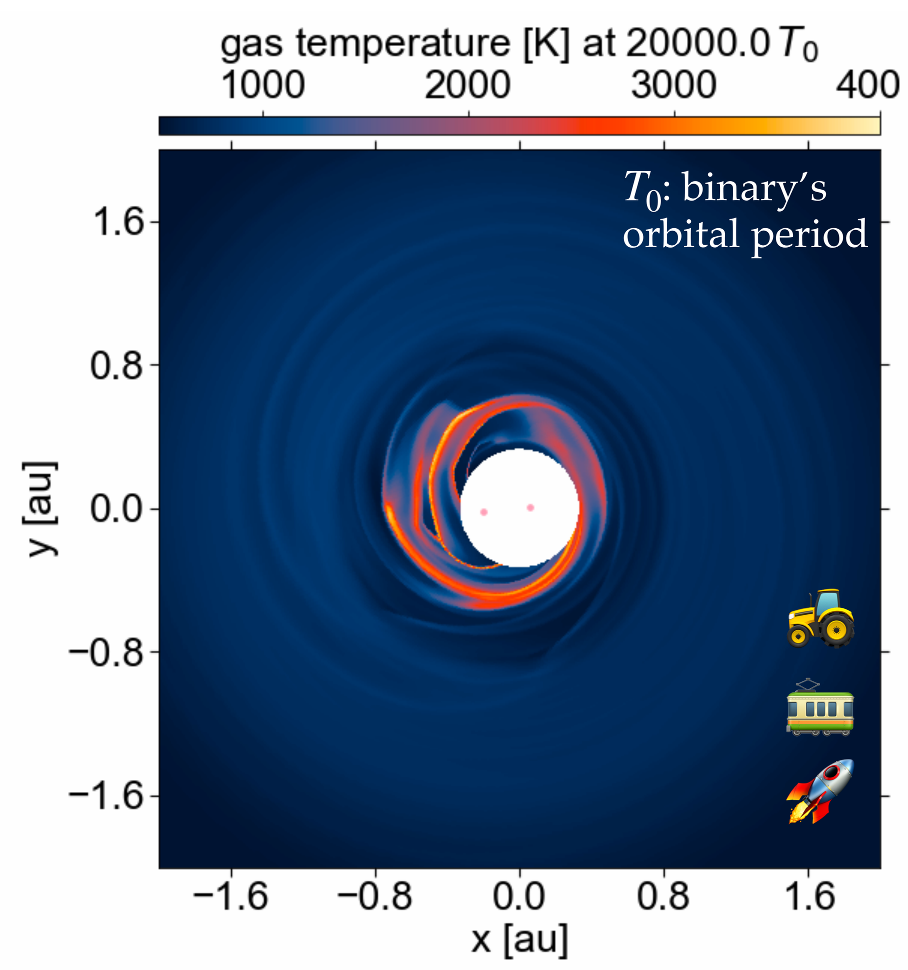
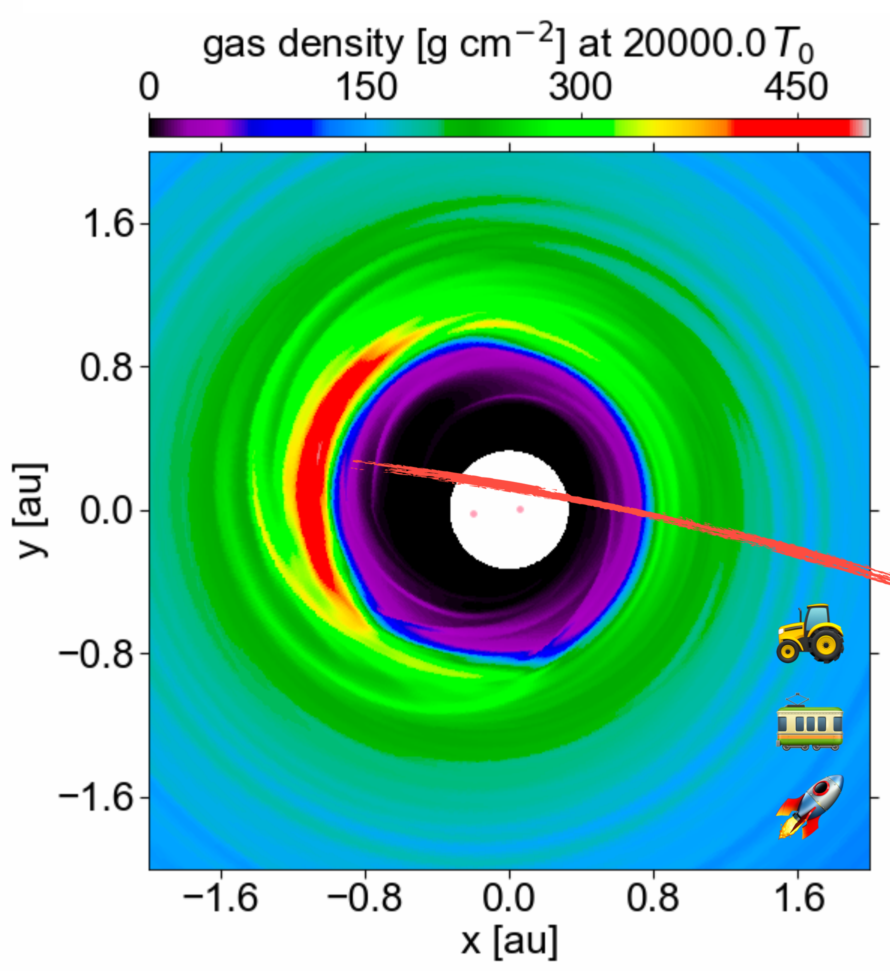
Summary: A dozen discs observed with GRAVITY or MATISSE at the VLTI exhibit **high closure phases**, suggesting an **asymmetric** spatial distribution of **dust** on a scale of a few tenths of an astronomical unit. We are currently exploring various possible **origins** for this asymmetry, including a dust-trapping **vortex**★ in a disc around a **single** star, and an **eccentric disc** around a **binary** star. This poster focuses on the latter scenario. It presents synthetic **interferometric observations** obtained from **hydrodynamical simulations** results post-processed by **dust radiative transfer calculations**, to show what dust structures in circumbinary discs would look like if observed by the VLTI, and more specifically what their **time variability** would be.

★see Siméo Evelain's talk in S03 session!

2D gas-only hydrodynamical simulations (code FARGO-3D)

- Fixed, **Kepler-16**-like **binary star** (a_{bin} = 0.22 au, e_{bin} = 0.16, q_{bin} = 0.28)
- A **jump** in the **turbulent viscosity** of the disc helps form and maintain a **cavity** around the binary star (α increases from 10^{-3} outside the cavity to 0.05 inside)
- Energy equation with **relaxation** towards **initial temperature** profile, cooling timescale computed via Rosseland opacities, initial temperature ~700K at the cavity edge. Inside the cavity, the temperature exceeds that required to drive MRI-driven turbulence

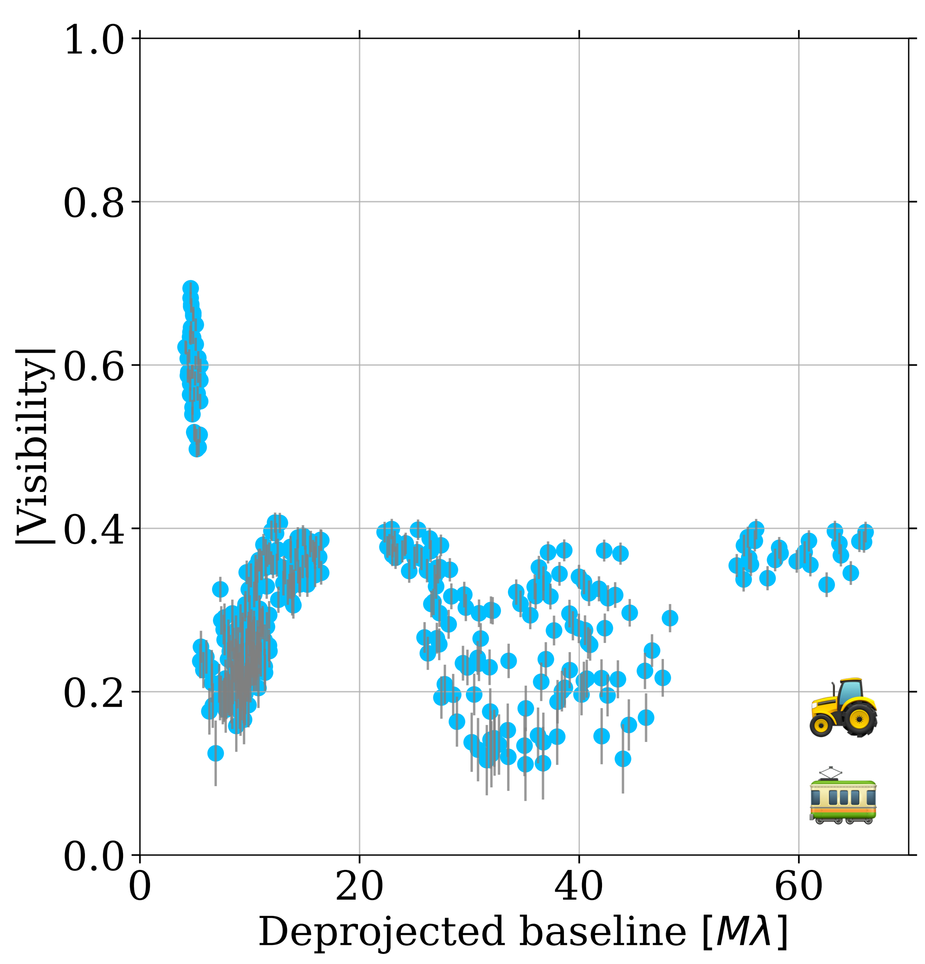




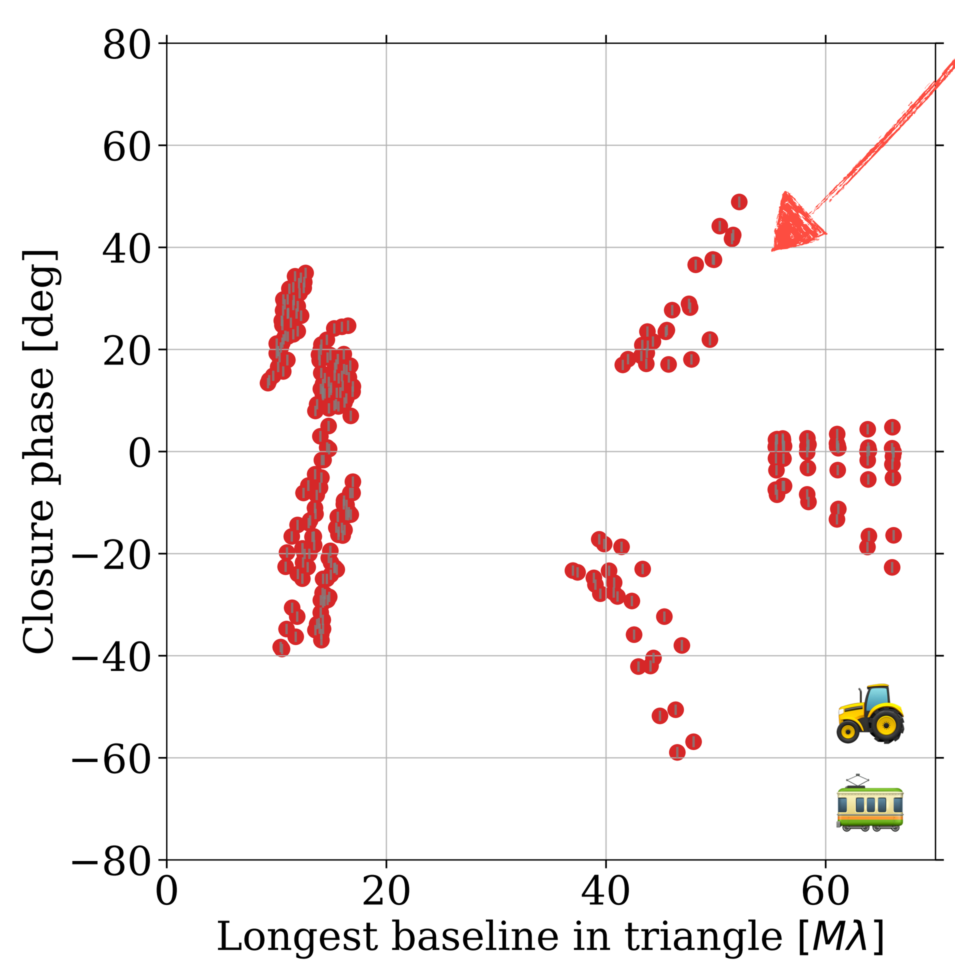
→ the cavity gets **warm** enough to **sublimate dust**

→ a large-scale time-periodic **asymmetry** forms in the gas **density** at the **cavity edge** due to the disc **eccentricity** (sort of *traffic jam*)

Synthetic GRAVITY observables (code ASPRO2)



↔ **radial distribution** of intensity



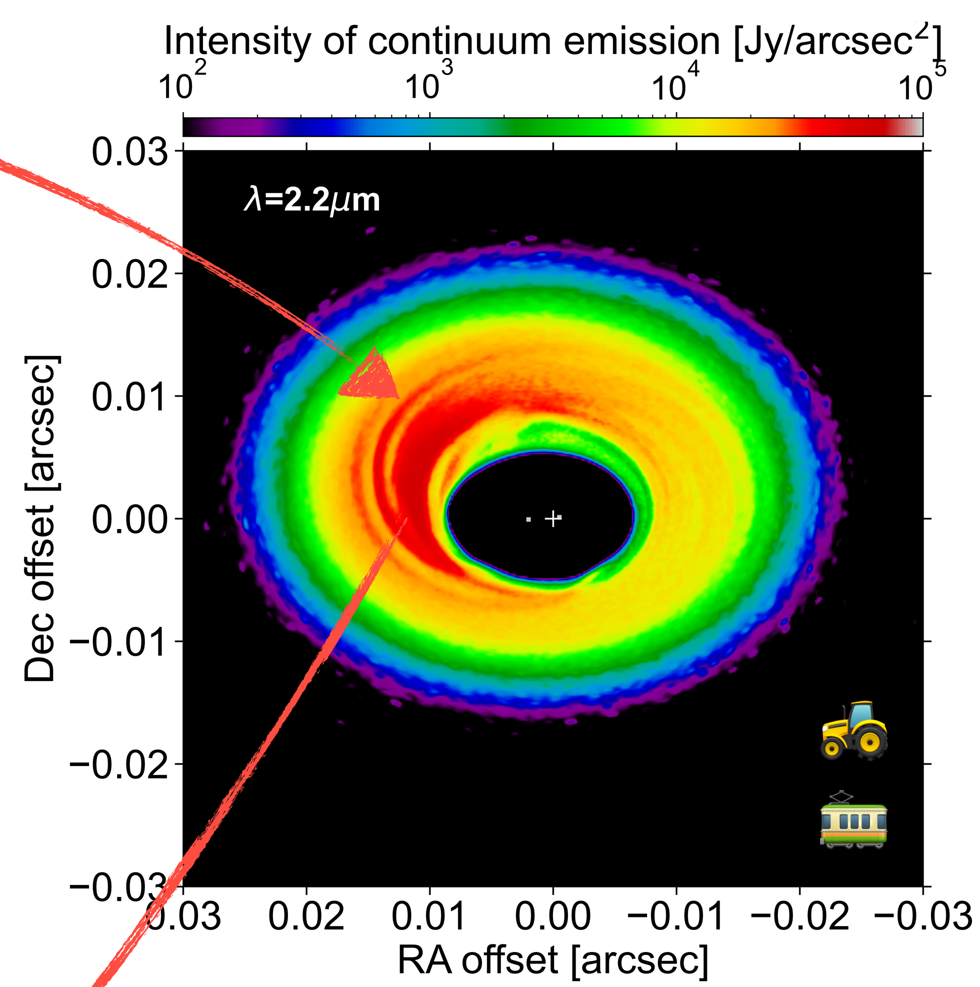
↔ **asymmetry** of intensity

Animations★	Timespan
🚜	one orbit of the binary (T_0 ~1 real month)
🚃	one orbit of the disc at the cavity edge (~8.5 T_0 ~0.7 real yr)
🚀	secular periodicity (~11,000 T_0 ~900 real yr)

★click on the symbols in the panels to watch online animations!

3D dust radiative transfer calculations (code RADMC-3D)

- Synthetic images of the **dust** continuum in the **K-** and **L-bands**
- Small dust between 1 and 10 μm, assumed fully **coupled** to the **gas**
  → dust **temperature** taken to be that in the hydro run
  → dust **density** derived from the surface density in the hydro run (small-dust-to-gas density ratio is 10^{-4}). A simple model for dust **sublimation** is included (dust density dropped where T ≳ 1000 K)



- Both **stars** included, their flux is rescaled so as to prescribe the total stars-to-disc flux ratio (60% in the K-band)
- disc at **100 pc**, inclined by **40°** w.r.t. sky-plane

→ large-scale variable **asymmetry** in the dust's specific **intensity** outside the cavity

- Synthetic interferometric observables in the **continuum** for **GRAVITY** (K-band, shown here) and for MATISSE (L-band, not shown here)
- **Input** = synthetic image of specific intensity computed by RADMC-3D, **outputs** = complex visibilities

→ **short** and **mid** baselines reflect the **eccentric disc** outside the cavity, **large** baselines the **binary**

→ **closure phases** from short to high baselines, and their **variability** over month- to year-timescales can help **distinguish** between mechanisms able to create an **asymmetric** continuum intensity (eccentric disc, vortex, unknown companion…)

- **Future**: comparison with VLTI-observed discs, observables in the gas