



Introduction

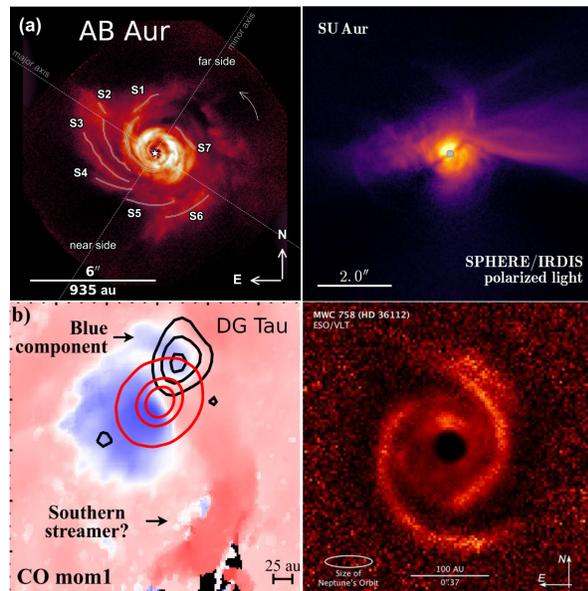
- Observations of Taurus reveal that **~30% of Class II disks are undergoing infall** [1]
- Treating planet formation in an isolated environment is being challenged
- Supply of new material and impact on disk kinematics has strong implications for planet formation
- Environmental interactions are evident as **streamers**
- Prominent examples: AB Aur [2], SU Aur [3], DG Tau [4], and many more

What is the nature of late infall streamers?

- Single accretion event with clear origin (“cloudlet”)?
- Well-defined mass reservoir?
- How to reconcile with large abundance of streamers?
- Continuous interaction with environment with turbulence-induced torque?
- Steady supply of material through **Bondi-Hoyle-Lyttleton accretion**

Can late infall cause spiral structures?

- Disks with environment interactions often show **spirals** with flocculent shape (SU Aur), and origin of clear $m=2$ arms debated (MWC 758 [5])
- Are the spirals a **direct consequence of the infall**?



About me



<https://leonhuehn.de>

Career status:

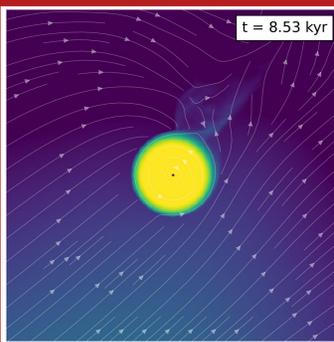
3rd year PhD student

Research interests:

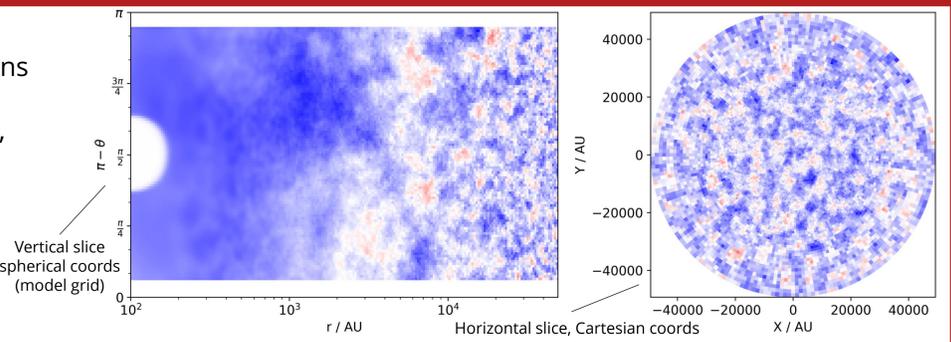
- Simulations of PPDs, especially infall
 - Radiative transfer modeling
 - (1D) dust transport
- Looking for postdoc opportunities!

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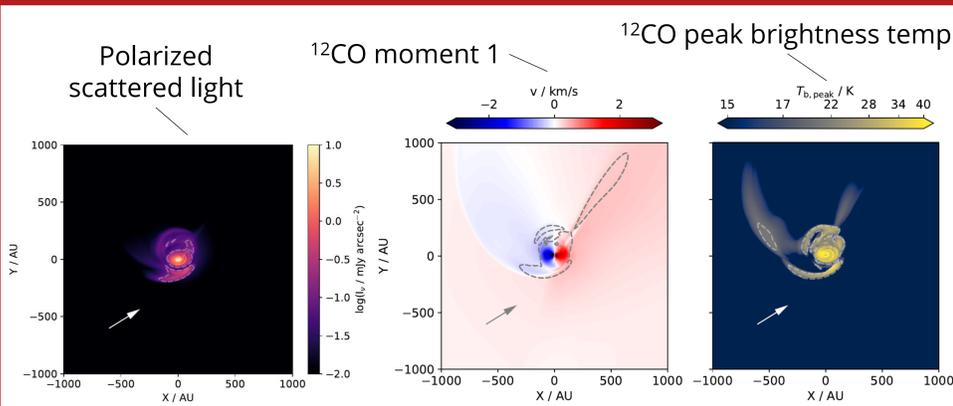
Methods



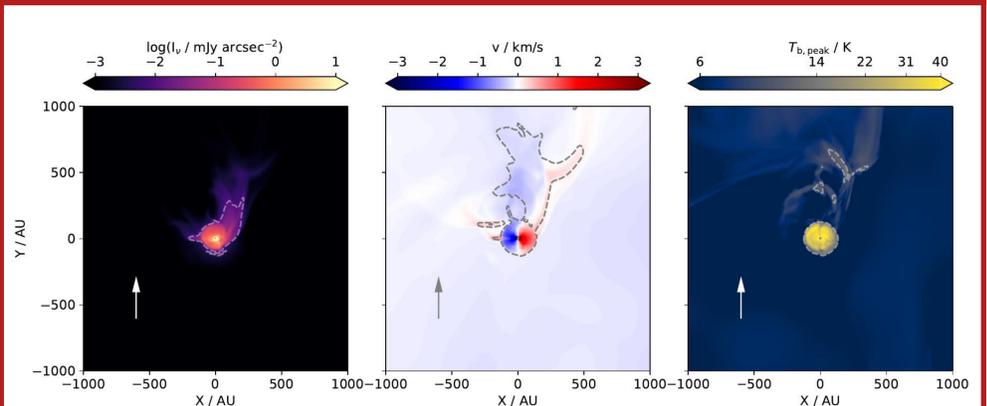
- **3D hydrodynamics** simulations using FARGO3D
- Post-processing with RADMC3D: synthetic observations
- Model 1: Capture of spherical gas cloudlet**
- Initialized on hyperbolic orbit, expands significantly, encounters disk by fully engulfing it (left)
- Parameters: Mass, distance, impact parameter, etc.
- Model 2: Disk moving through turbulent medium**
- No assumed initial overdensity, but compressible turbulence (Gaussian random field, right)
- Parameters: Power spectrum, systemic velocity, etc.



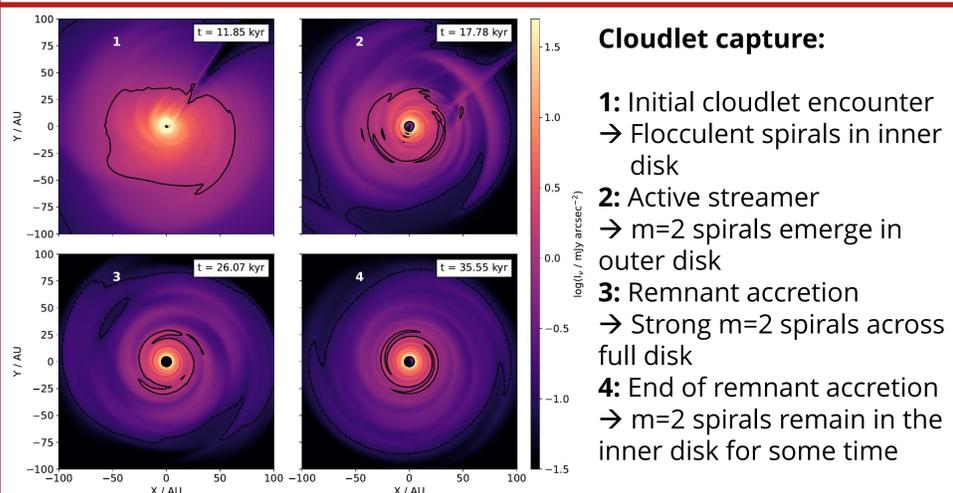
Results



Cloudlet capture: Singular, bright streamer, but **short-lived** (~10 kyr)

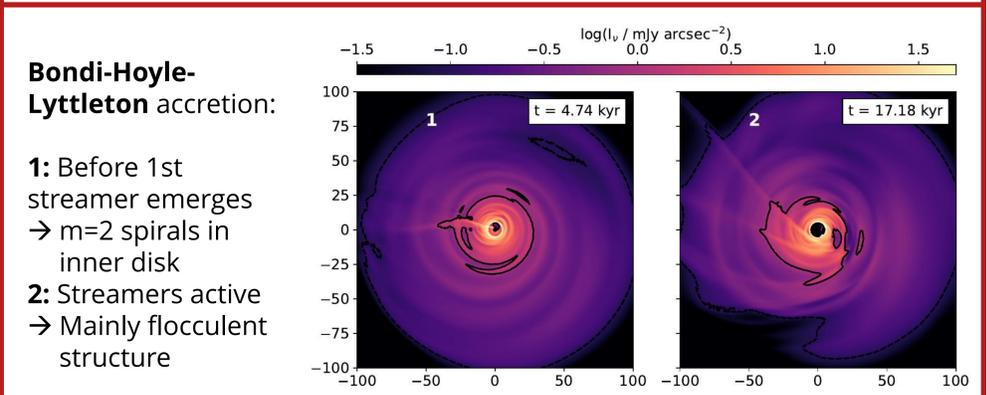


Bondi-Hoyle-Lyttleton accretion: Multiple, substructured **streamers**



Cloudlet capture:

- 1: Initial cloudlet encounter → Flocculent spirals in inner disk
- 2: Active streamer → $m=2$ spirals emerge in outer disk
- 3: Remnant accretion → Strong $m=2$ spirals across full disk
- 4: End of remnant accretion → $m=2$ spirals remain in the inner disk for some time



Bondi-Hoyle-Lyttleton accretion:

- 1: Before 1st streamer emerges → $m=2$ spirals in inner disk
- 2: Streamers active → Mainly flocculent structure

Infall-induced spirals are **surface-level only** and almost **stationary**

Conclusions

- Capture of a **cloudlet** of gas and **accretion in a turbulent medium** can both create **streamer** structures, but individual streamers are **short-lived** (~10 kyr)
- To explain the high observational abundance of streamers, streamers occurring in a **turbulent medium are more suitable**, as they re-emerge repeatedly
- Turbulent accretion streamers are **sensitive to turbulence level and scale**; their observed morphology can be used to infer environmental conditions
- Various **spiral structures** can be caused by late infall – structures reminiscent of different known systems arise in the same simulation at different times
- Late infall spirals are **surface-level only** and best visible in **scattered light**, not perturbing the disk midplane unless the infall-to-disk-mass ratio is very high