TESTING DISK EVOLUTION THROUGH MASS ACCRETION RATES AND ITS VARIABILITY: THE CASE OF XX CHA

RIK CLAES

Carlo Manara, Justyn Campbell-White, Antonio Frasca, R. Garcia-Lopez, A. Natta, M. Fang, Z. P. Fockter, P. Ábrahám and Many more

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PENELLOPE [Manara+ 2021]

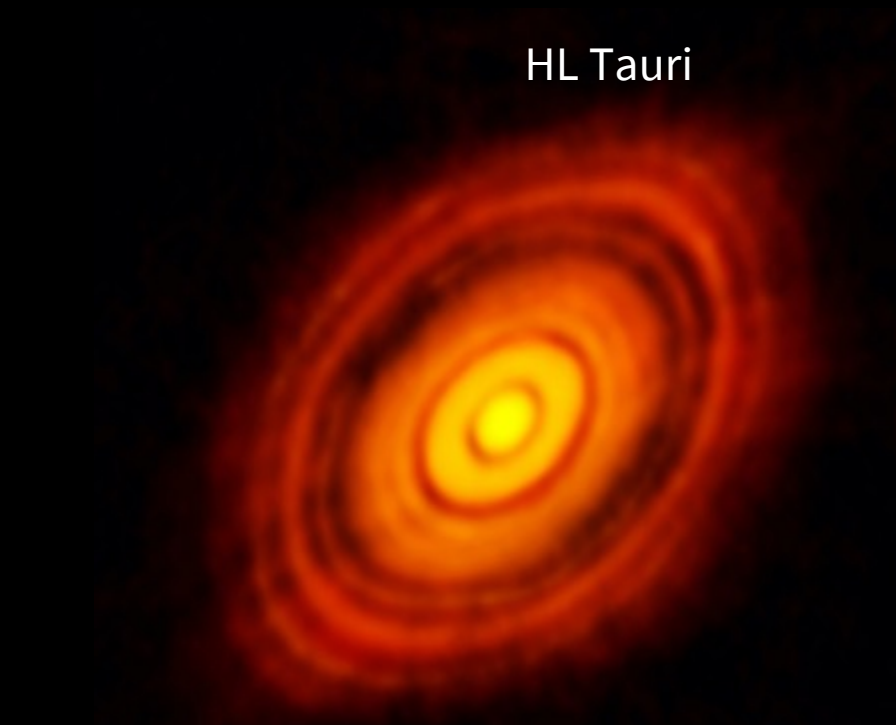
Who am I?

- Born and rased in Duffel
- Bachelors and Masters @ KU Leuven
- Now: 2nd year IMPRS PhD. Student @ ESO in Garching

Protoplanetary disks

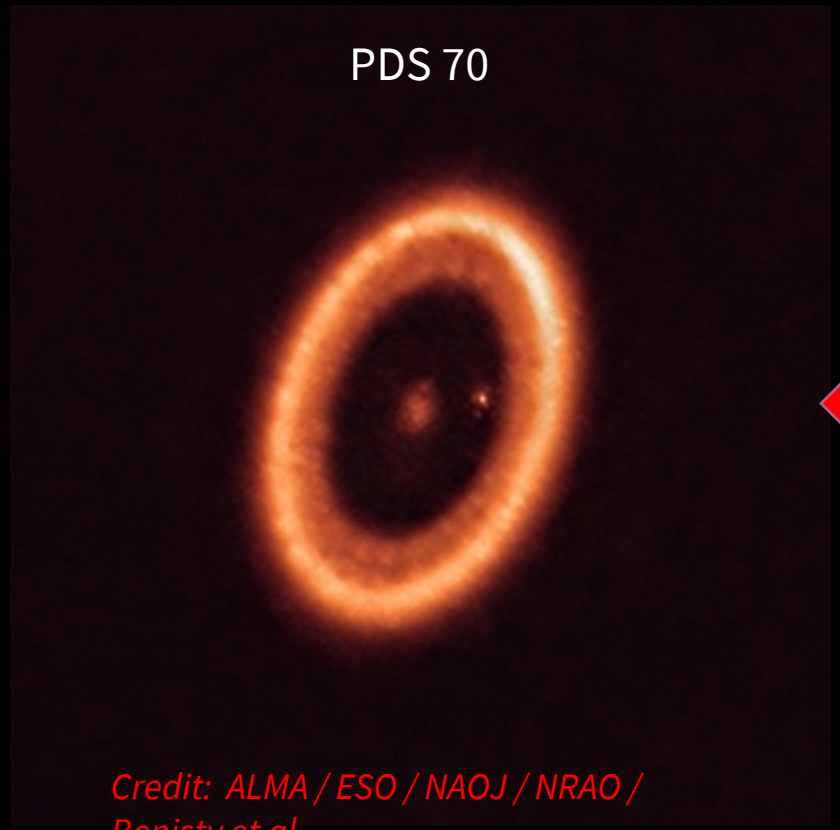
- Stage of star formation
- Planets are expected to form here
- How remains uncertain

HL Tauri

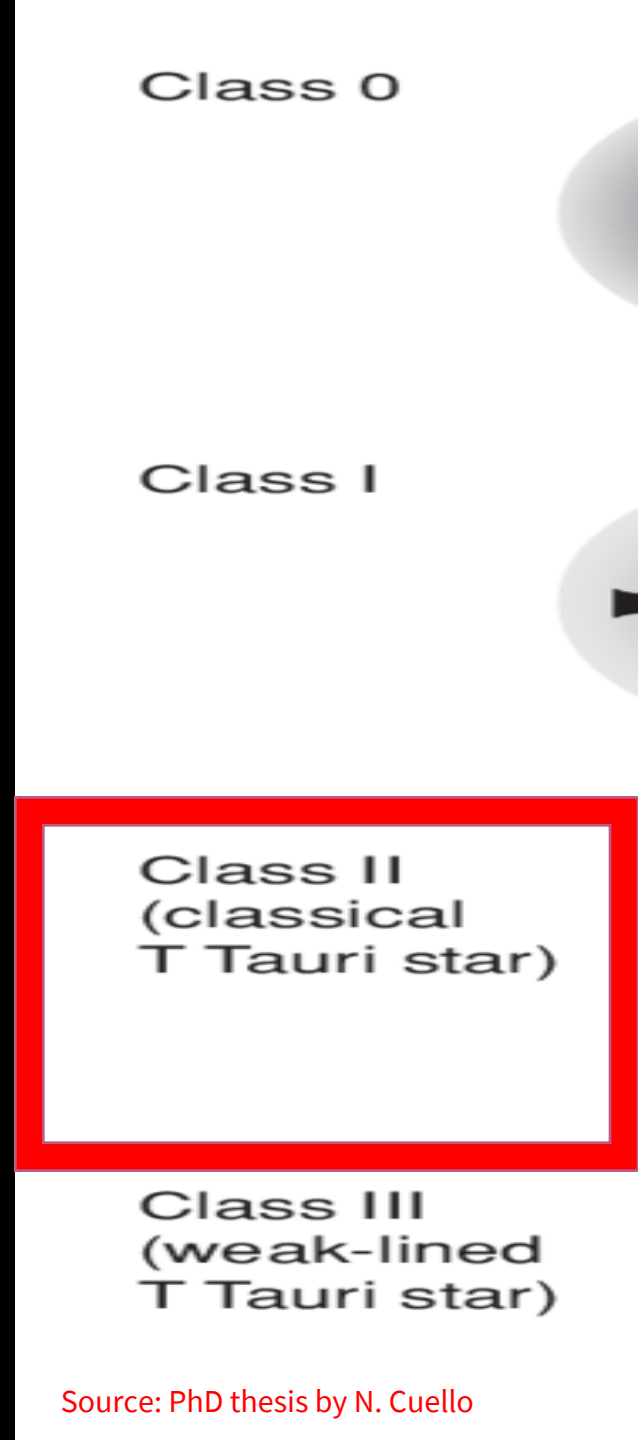


Credit: ALMA (NRAO/ESO/NAOJ);
C. Brogan, B. Saxton (NRAO/AUI/NSF)

PDS 70



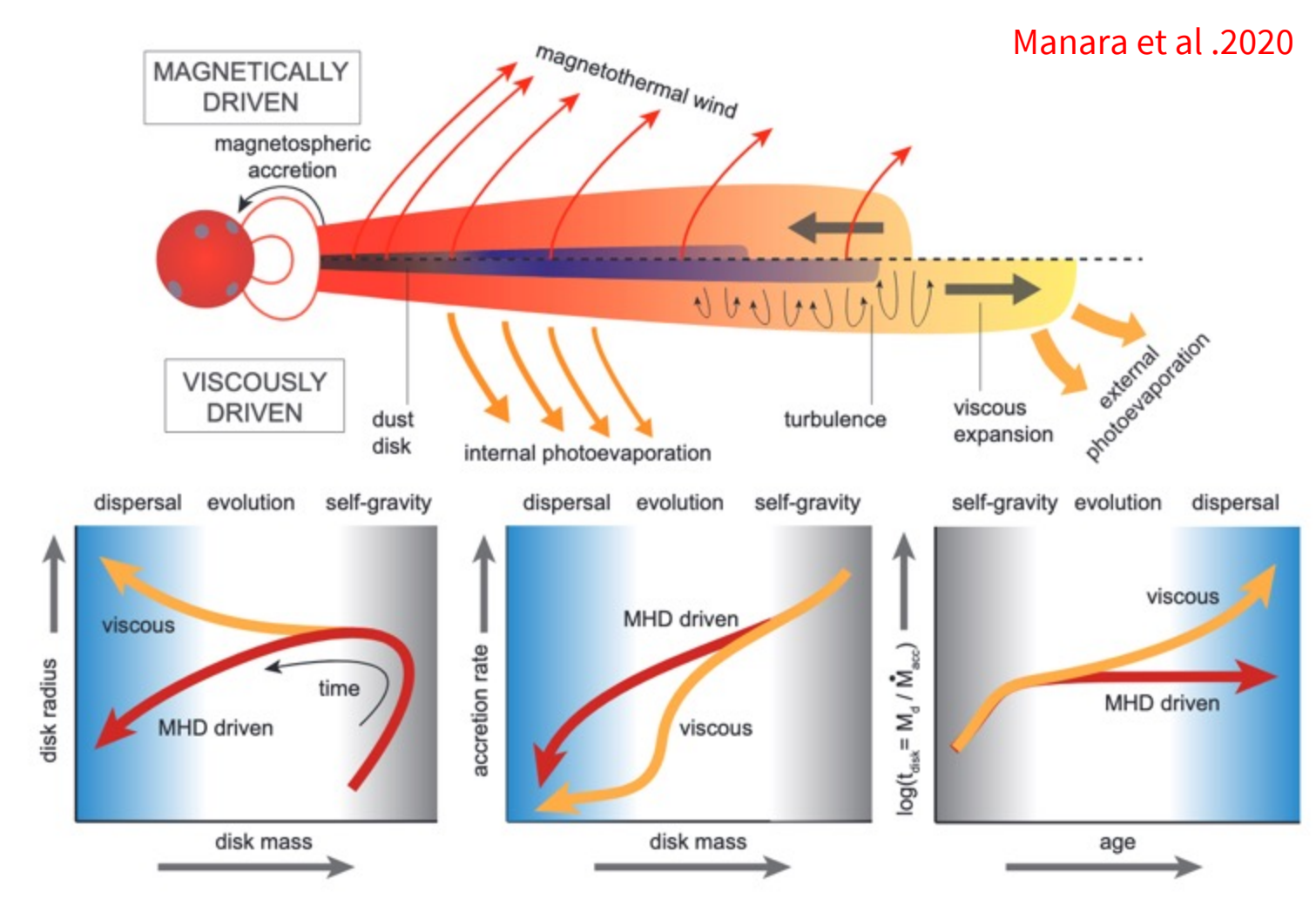
Credit: ALMA / ESO / NAOJ / NRAO / Benisty et al.



Source: PhD thesis by N. Cuello

Disk evolution

- Protoplanetary disks are poorly understood
- Dissipation over time
- Currently: viscous evolution vs MHD wind driven evolution



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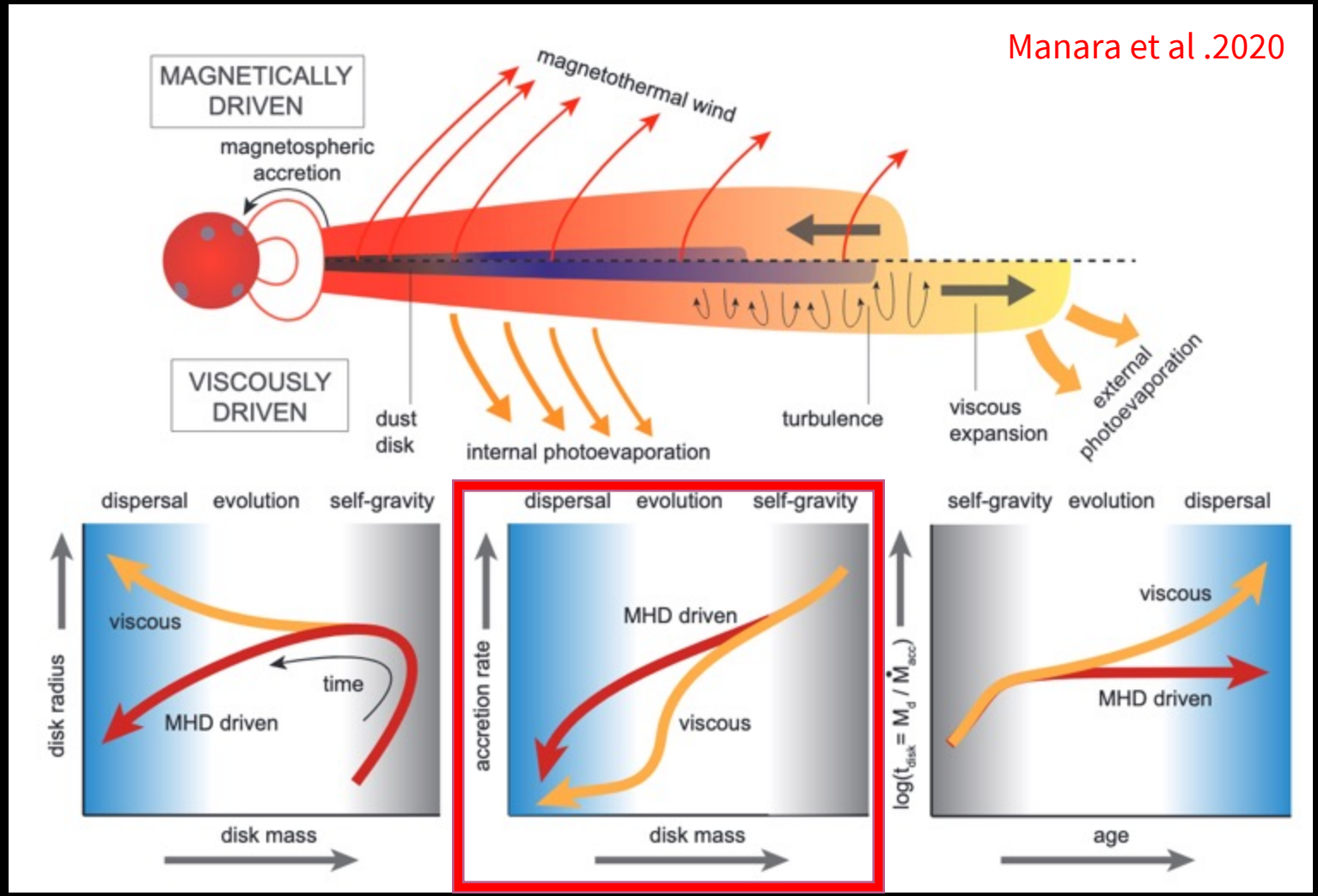
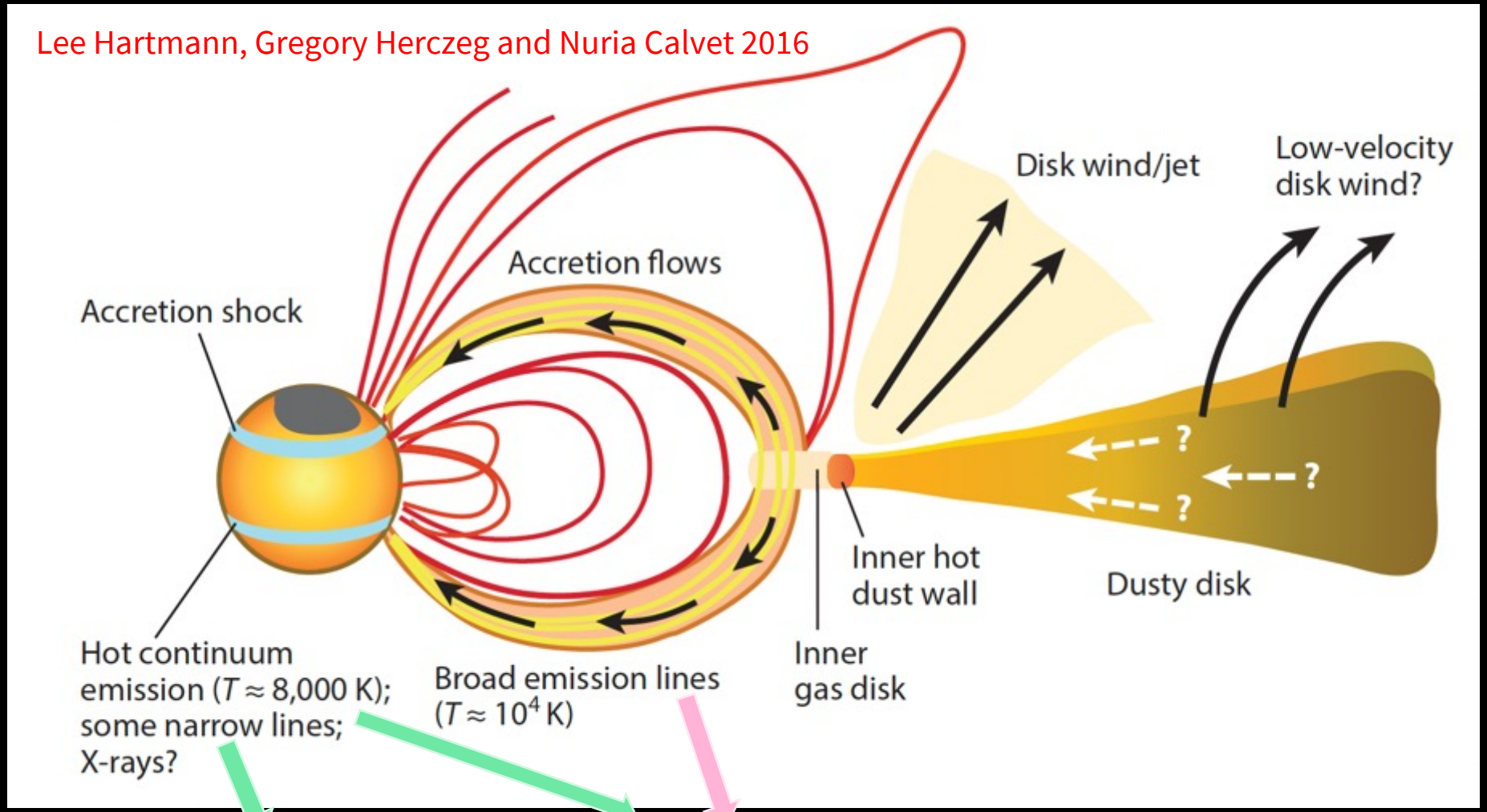
Manara et al .2020



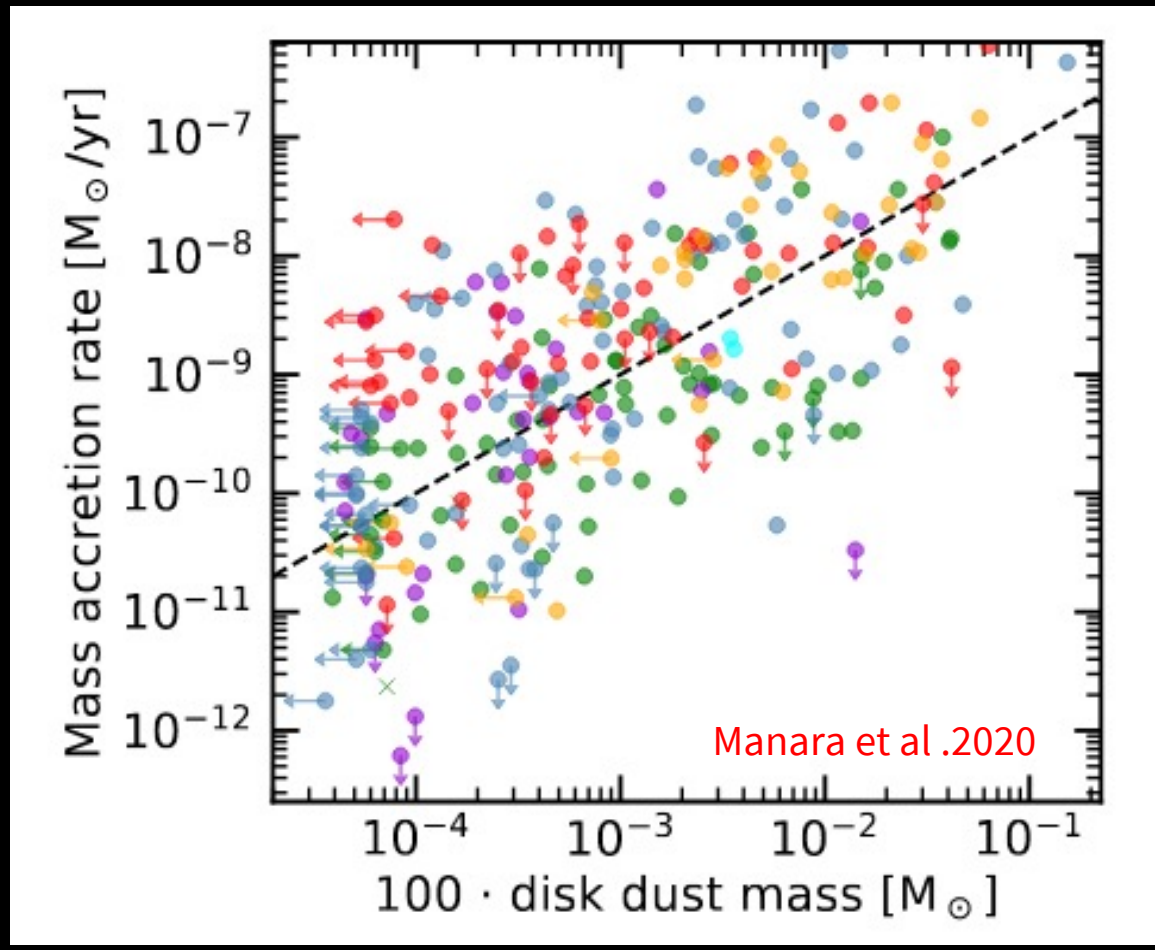
Magnetospheric accretion onto the star



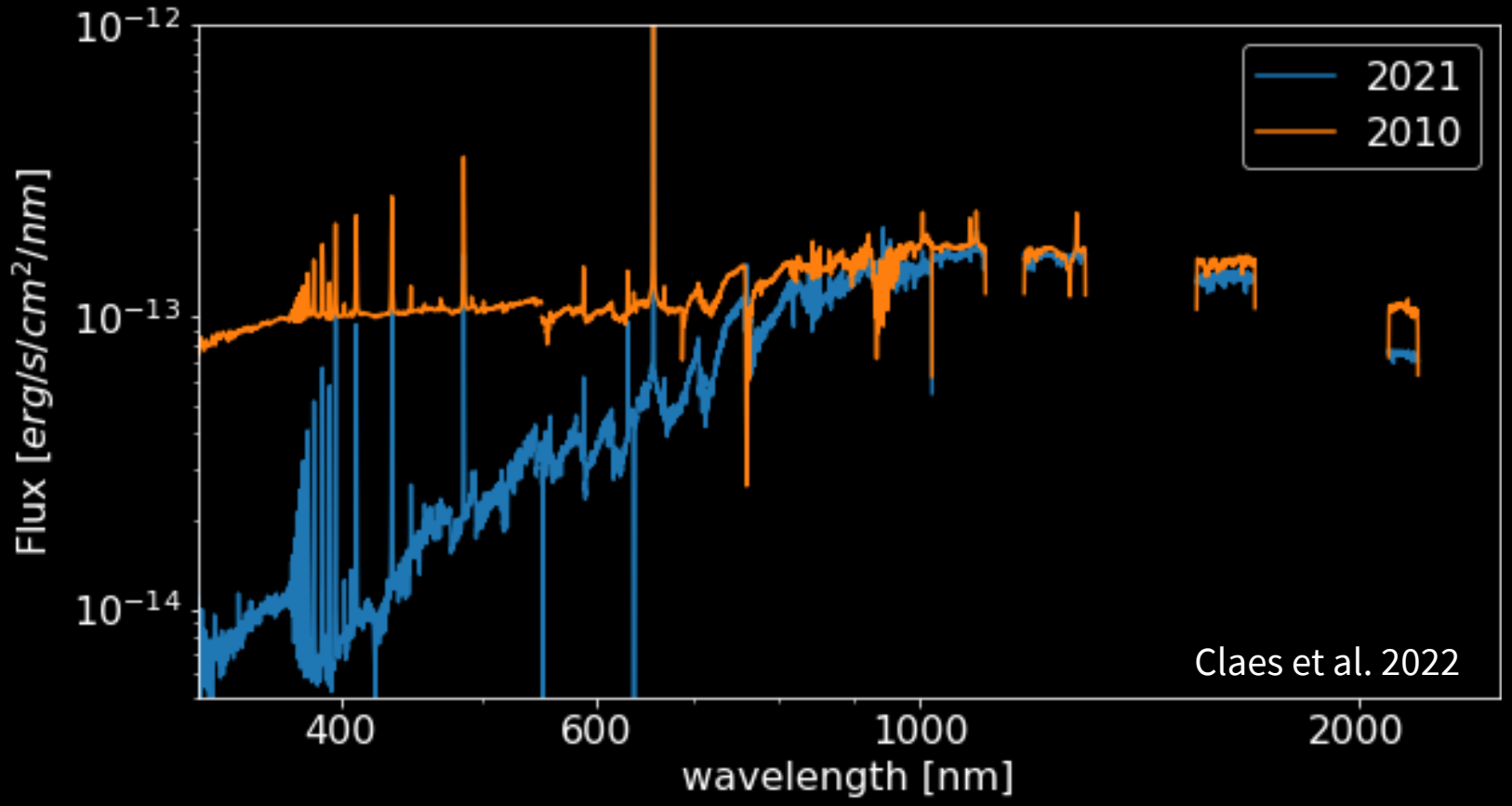
Two Main observables: UV continuum exess and Emission lines

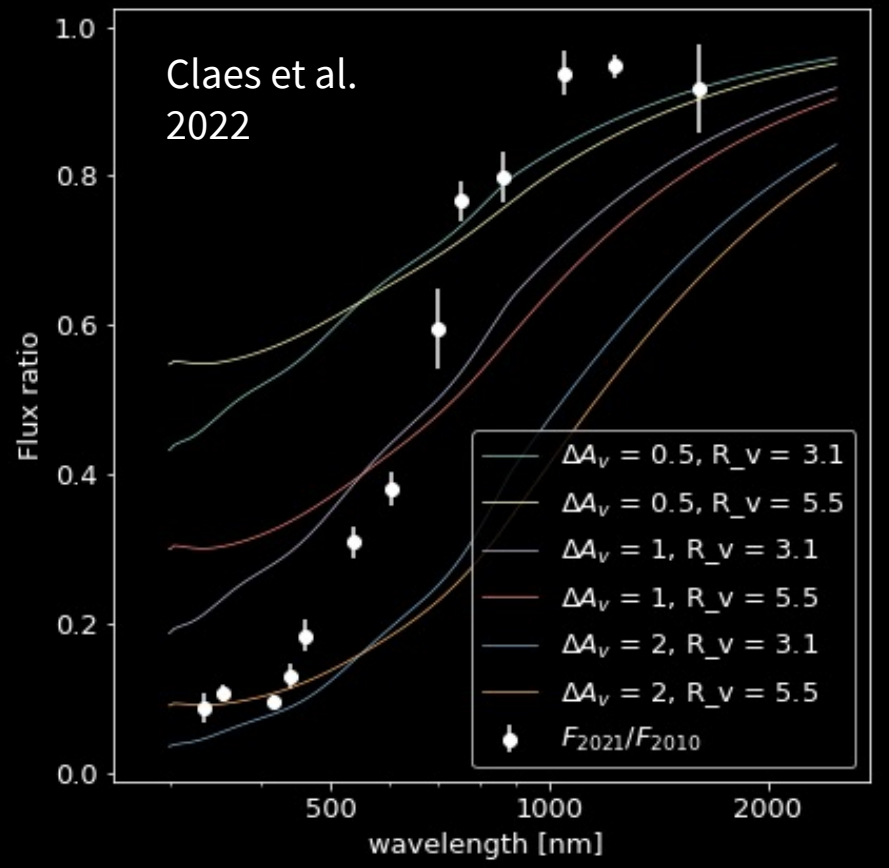
Mass accretion rates as a constraint on disk evolution

- Tight correlation between $\dot{M}_{\mathrm{acc}}$-M_{disk} is expected from viscous theory (Lodato 2017, Rosotti 2017, Mulders 2017)
- In MHD wind case the existance of a correlation is dependent on the initial conditions (Tabone et al 2021.)
- Correlation is observed, but with a large spread!
- What could contribute to this spread?



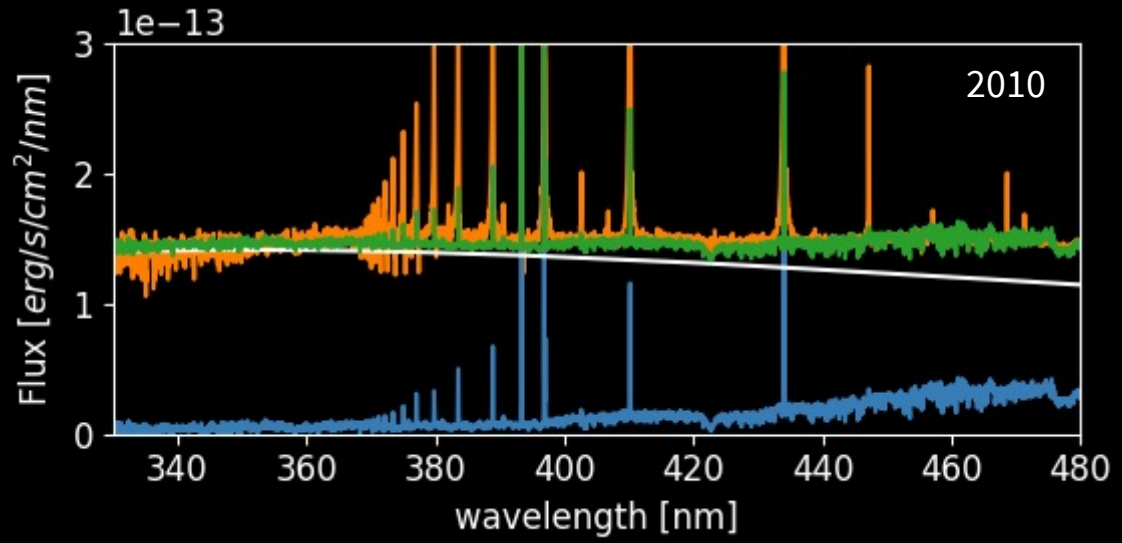
XX Cha: Extreme accretion variability

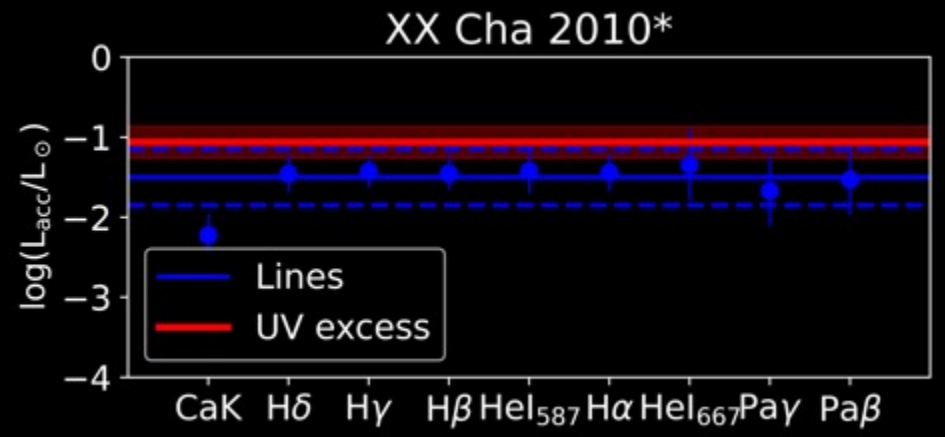


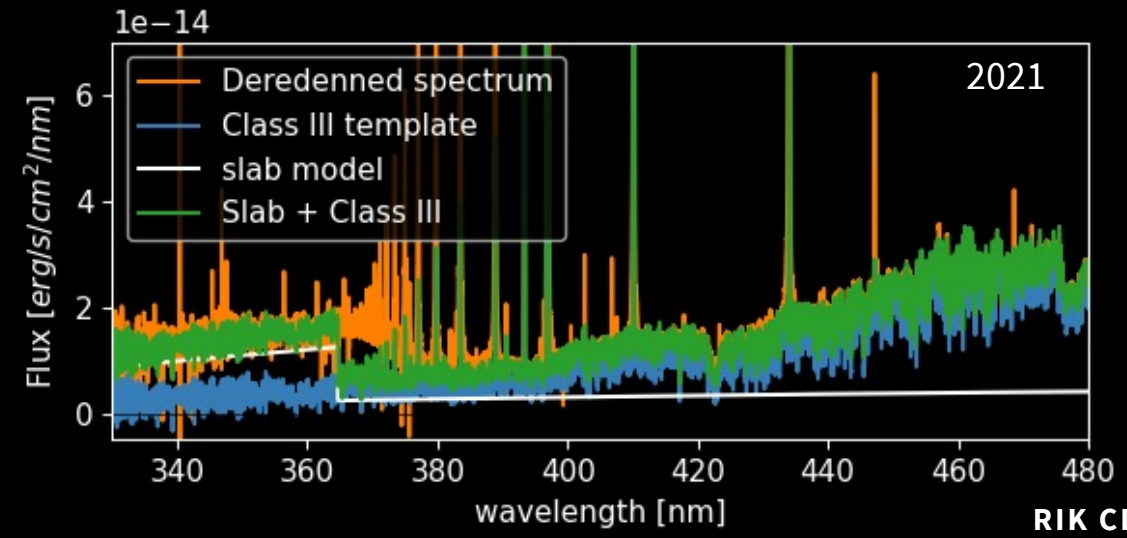


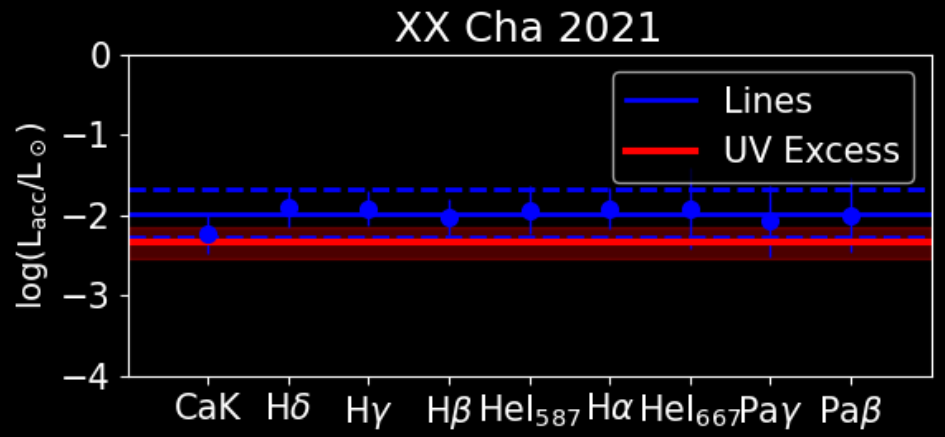
Determining the accretion rate

Claes et al. 2022



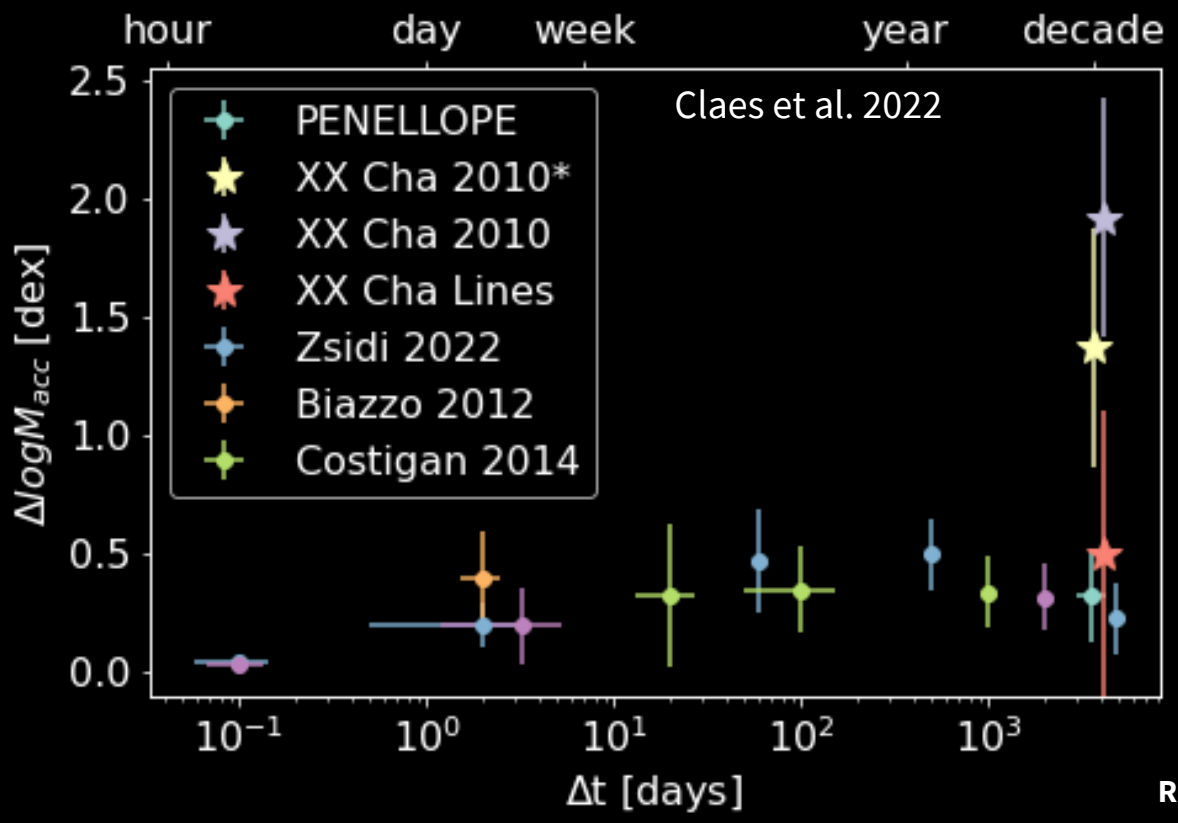


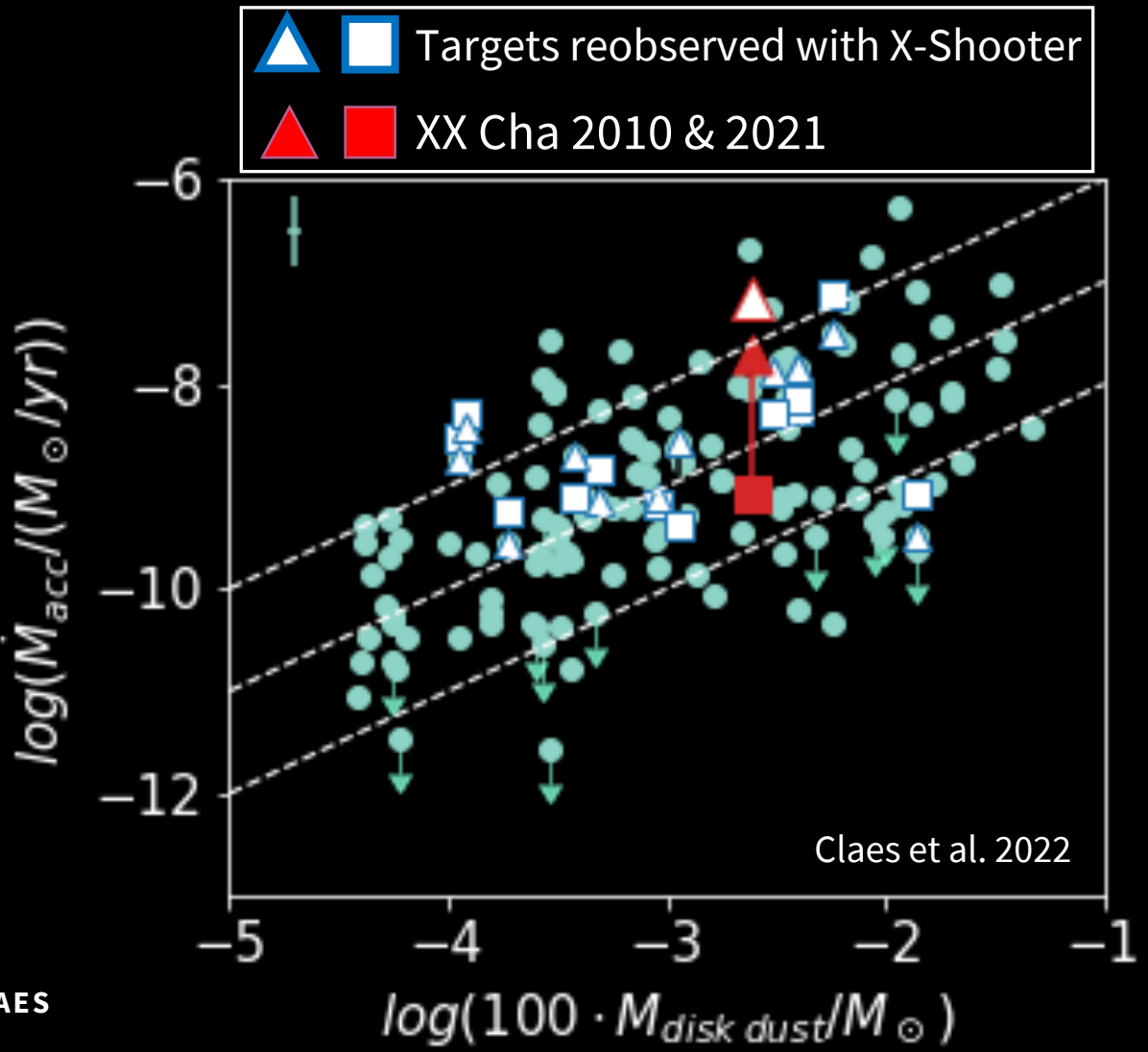




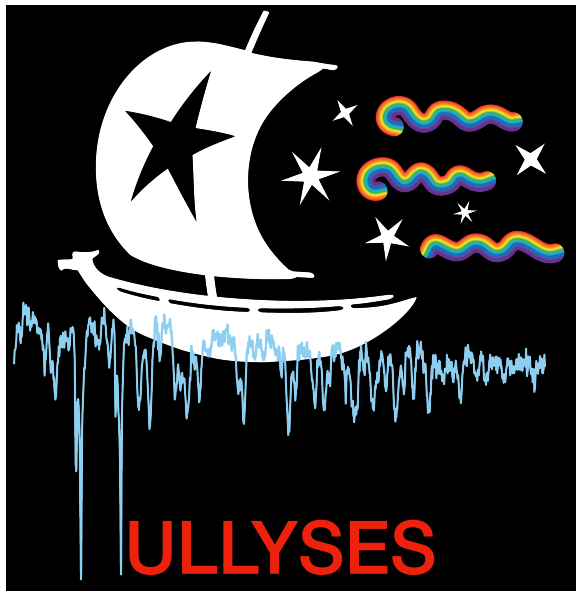
Result and impact

XX Cha –like variability is rare and not big enough to explain observed spread!





A world-wide collaboration



Hubble UV Legacy Library of Young Stars as Essential Standards

500 orbits of HST COS/STIS for low-mass stars (Director's Discretionary program)
PI Roman-Duval

ODYSSEUS

Outflows and Disks around Young Stars: Synergies for the Exploration of Ullyses Spectra

- ~90 astronomers worldwide
- **using the ULLYSES data** to study accretion, outflows, and inner disk composition
- **coordinating complementary data collection** efforts.
- **Lead:** G. Herczeg (KIAA Beijing), C. Espaillat (Boston University)

PENELLOPE

Large international team acquiring complementary data with a **~250h Large Program** at the ESO Very Large Telescope (VLT).

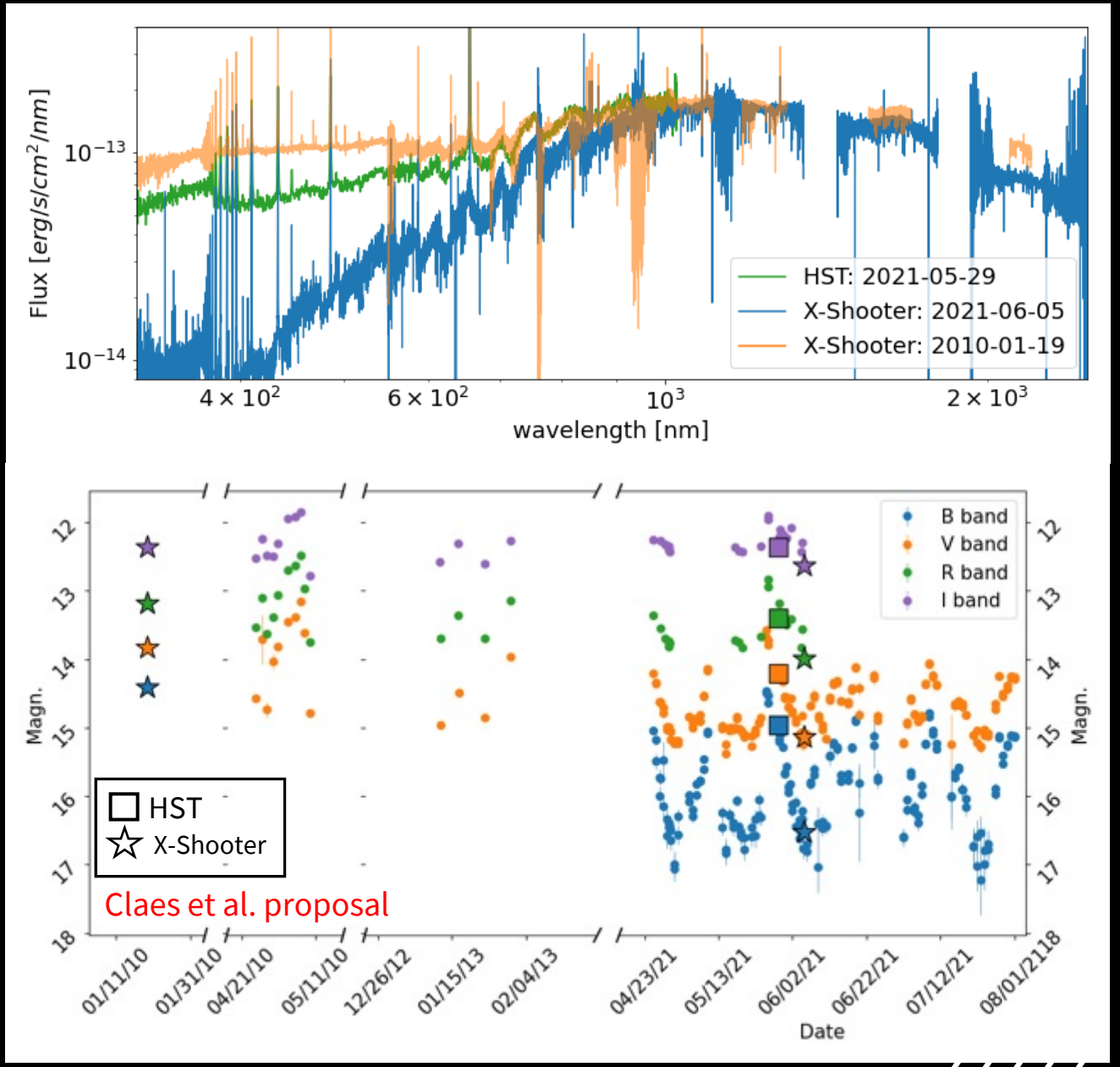
PI: C.F. Manara (ESO)
Data public

Several other teams are collecting **photometry**, **high-resolution spectra** and more. Observations are coordinated with **TESS**.

HST data

- HST spectrum suggests a short timescale of ~week. In line with magnethospheric accretion variability

- Follow-up observations can provide clarity about the mechanism driving this variability



Take home messages

Feel free to reach out:
rclaes@eso.org

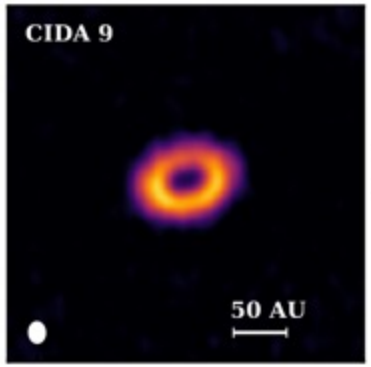
- An understanding of the accretion properties of disks provides a neccecary constraint on their evolution
- Variability is unlikely to explain the observed spread in $\dot{M}_{\rm acc}$, although some extreme variables such as XX Cha are present and need to be explained
- A thourough analysis of flux calibrated broad wavelength range spectra is needed to understand the accretion properties of young stars

Letter on XX Cha
(Claes et al. 2022)
Published on A&A:

Future work

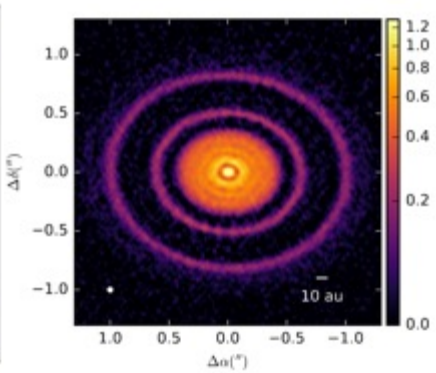
- The tool used to derive mass accretion rates from a UV excess needs to be made more straightforward
- Impact of disk structures on mass accretion rate

Cavities



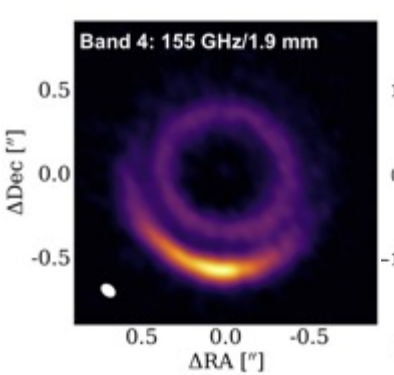
Long et al. 2018

Rings: AS 209



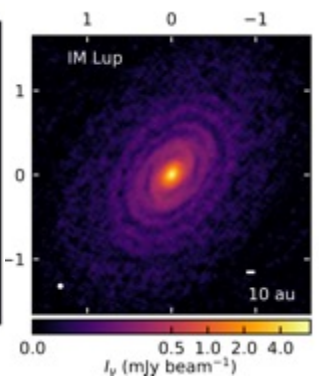
Huang et al. 2018c

Arcs: HD 135344B

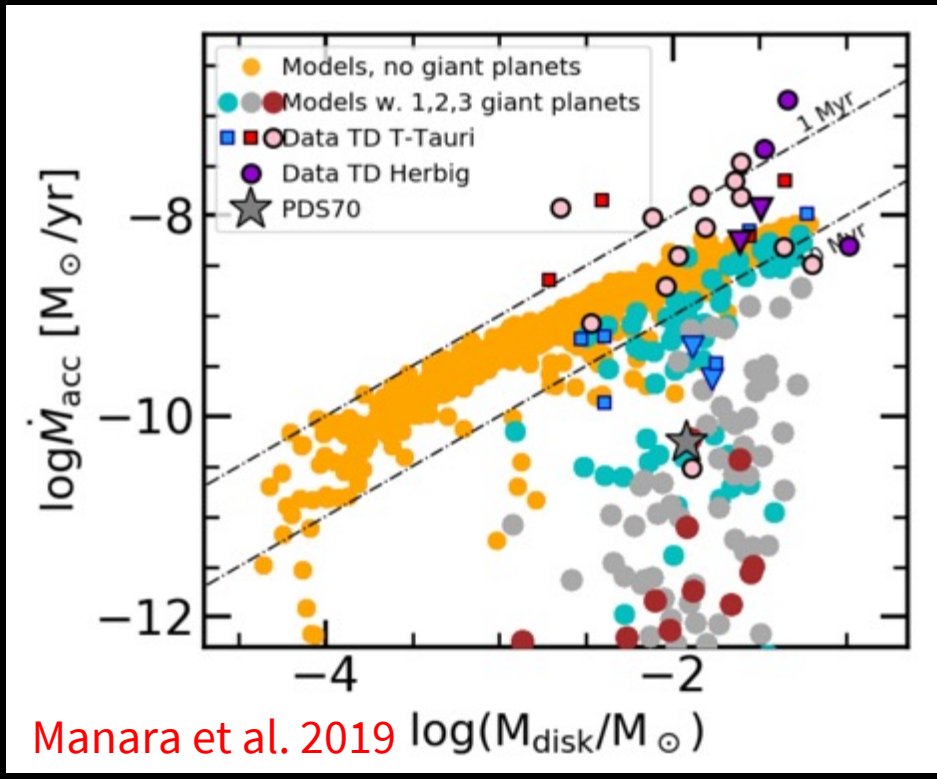


Cazzoletti et al.2018

Spirals: IM lup



Huang et al. 2018b



Manara et al. 2019

Interested in being an ESO student?

Come and have a chat!!!

More information in later talk by Henri Boffin

Also here: Adrien Houge
Ms: ULiège
Currently: Exeter + ESO Studentship

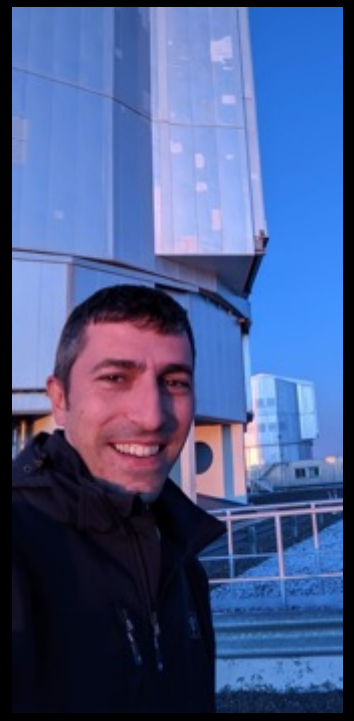
RIK CLAES

WANDA @ ESO

ERC grant of Carlo Manara

Aims to study structures in protoplanetary disks and answer:

- How the presence of planets affects accretion properties
- If large cavities and ring are related to strong MHD winds
- How external photoevaporation affects disk properties
- How planet formation differs across star forming regions



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Shameless advertisement: Open fully funded PhD position!!

The ESO Garching experience

Take home messages

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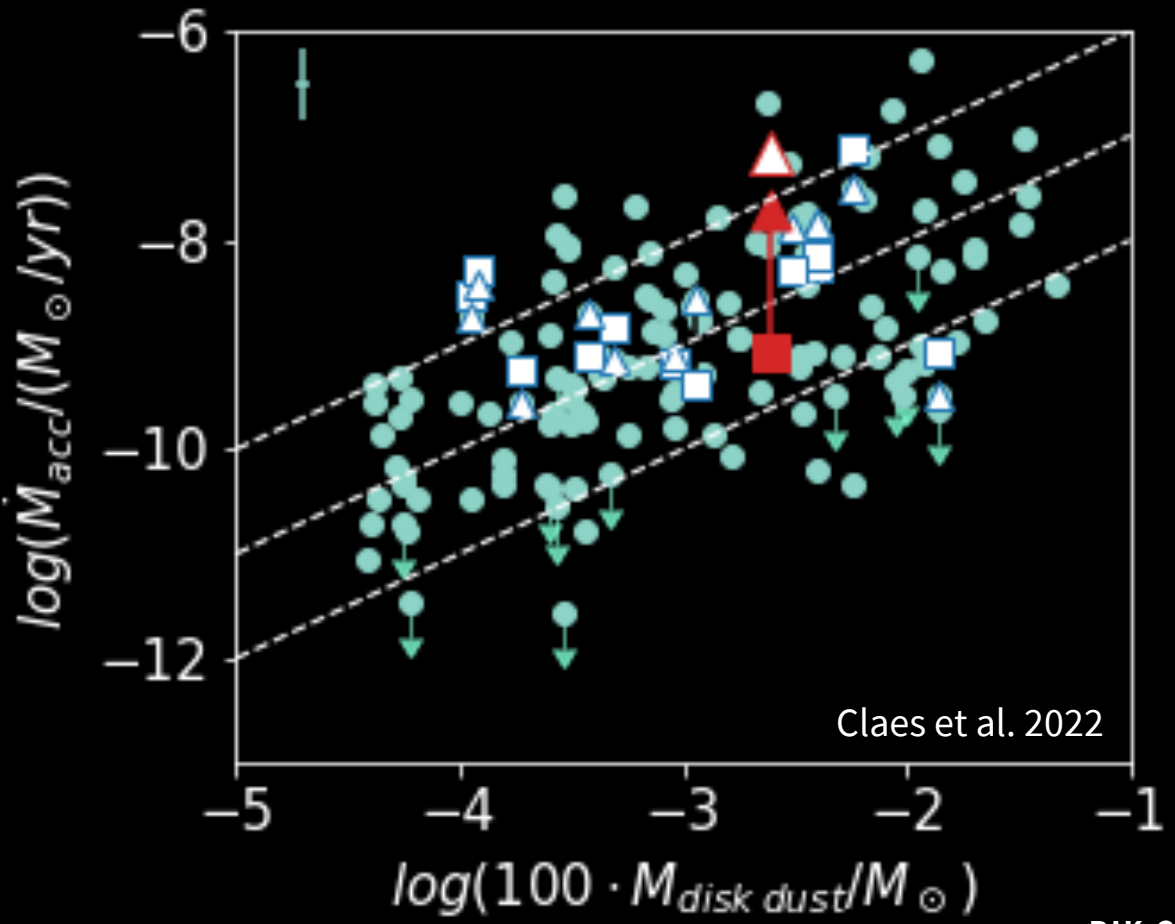
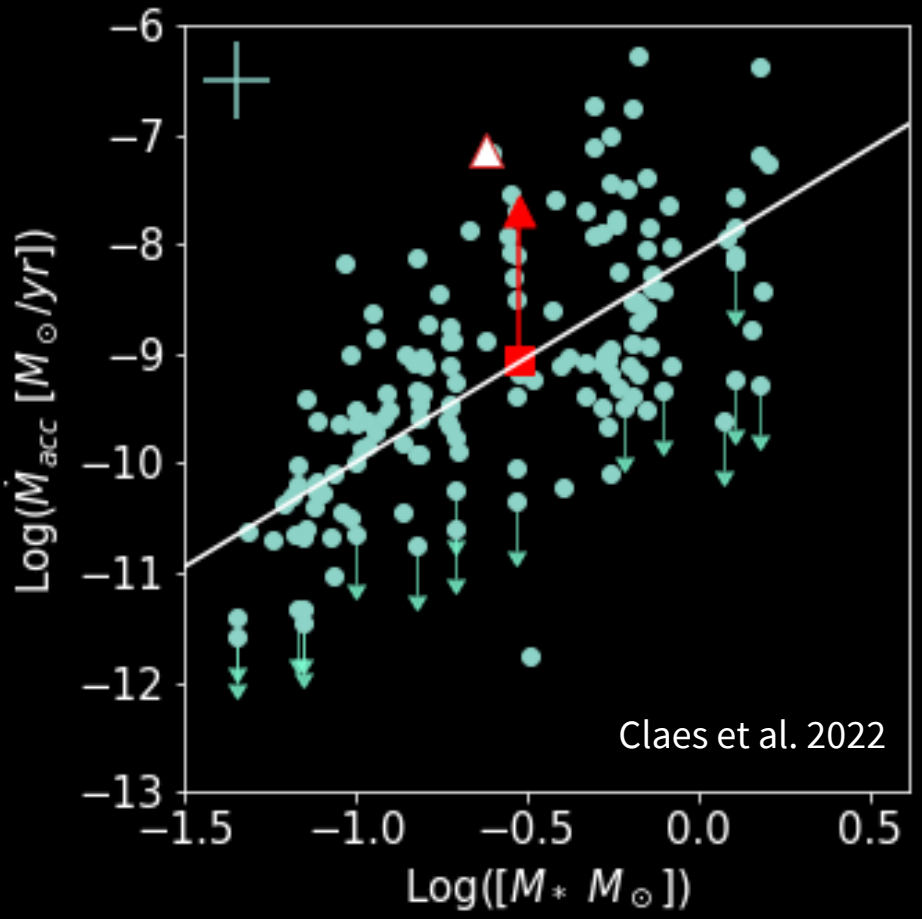
XX Cha: Implications





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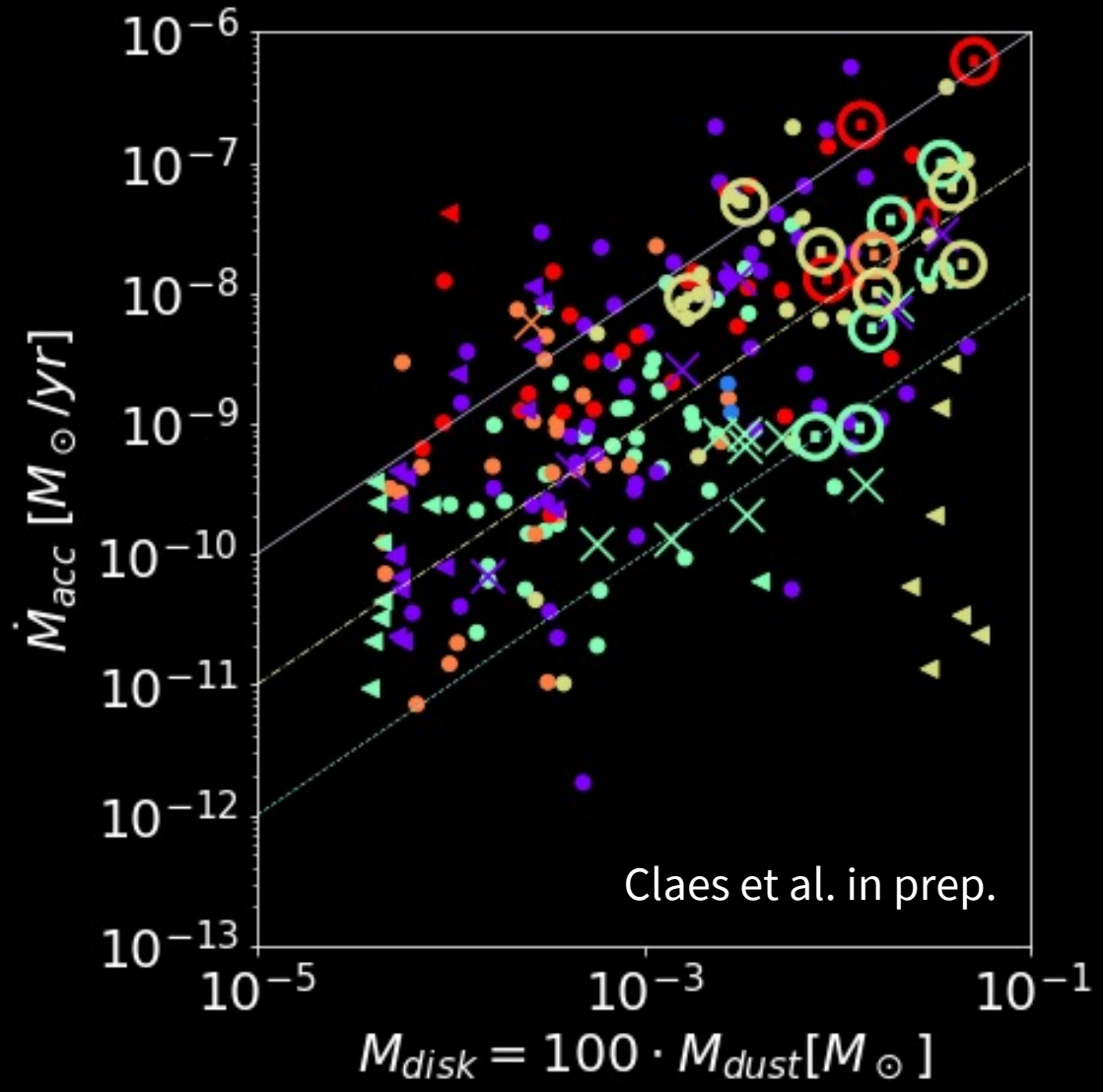
Other future work

- Accretion rate in structured sources

- An improved publicaly available tool for fitting the UV excess in Class II YSO



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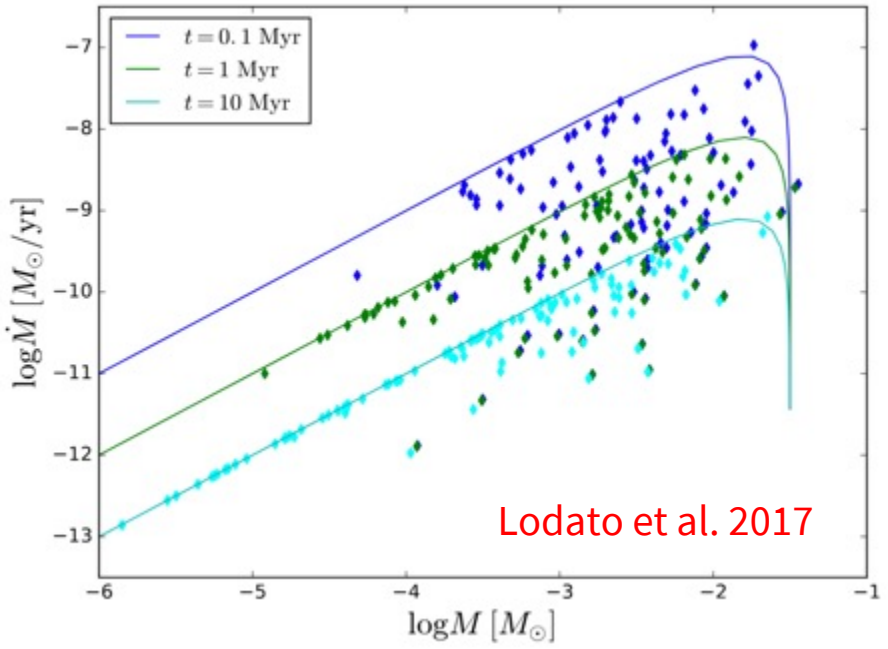

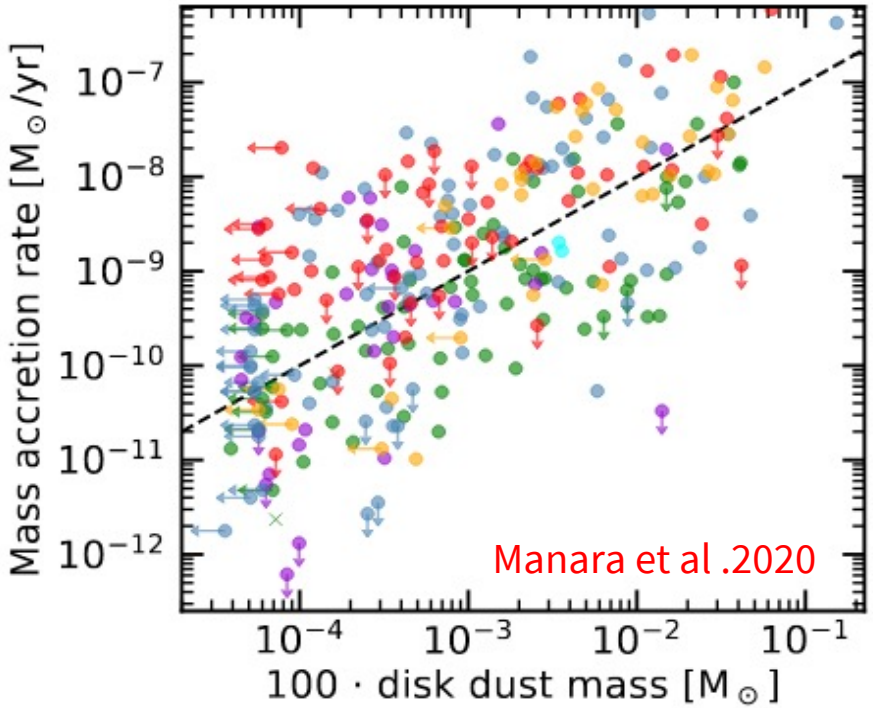

Take home message

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- An understanding of the accretion properties of PPD provides a powerful constraint on their evolution
- Variability Is unlikely to explain the observed spread, Although some extreme variables such as XX Cha are present and need to be explained

Letter on XX Cha (Claes et al. 2022) Published on A&A:

Future work:

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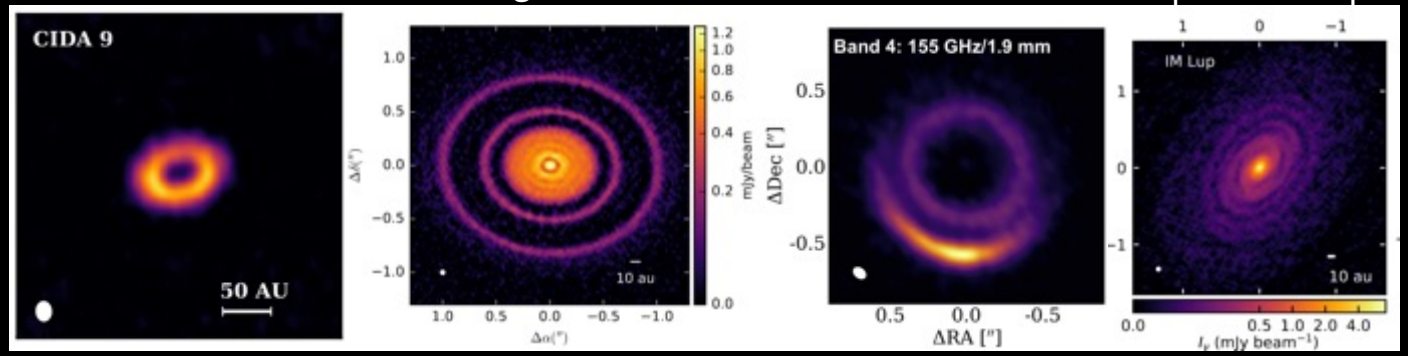
Cavities | Rings: AS 209 | Arcs: HD 135344B | Spirals: IM lup



Long et al. 2018 | Huang et al. 2018c | Cazzoletti et al.2018 | Huanang et al. 2018b

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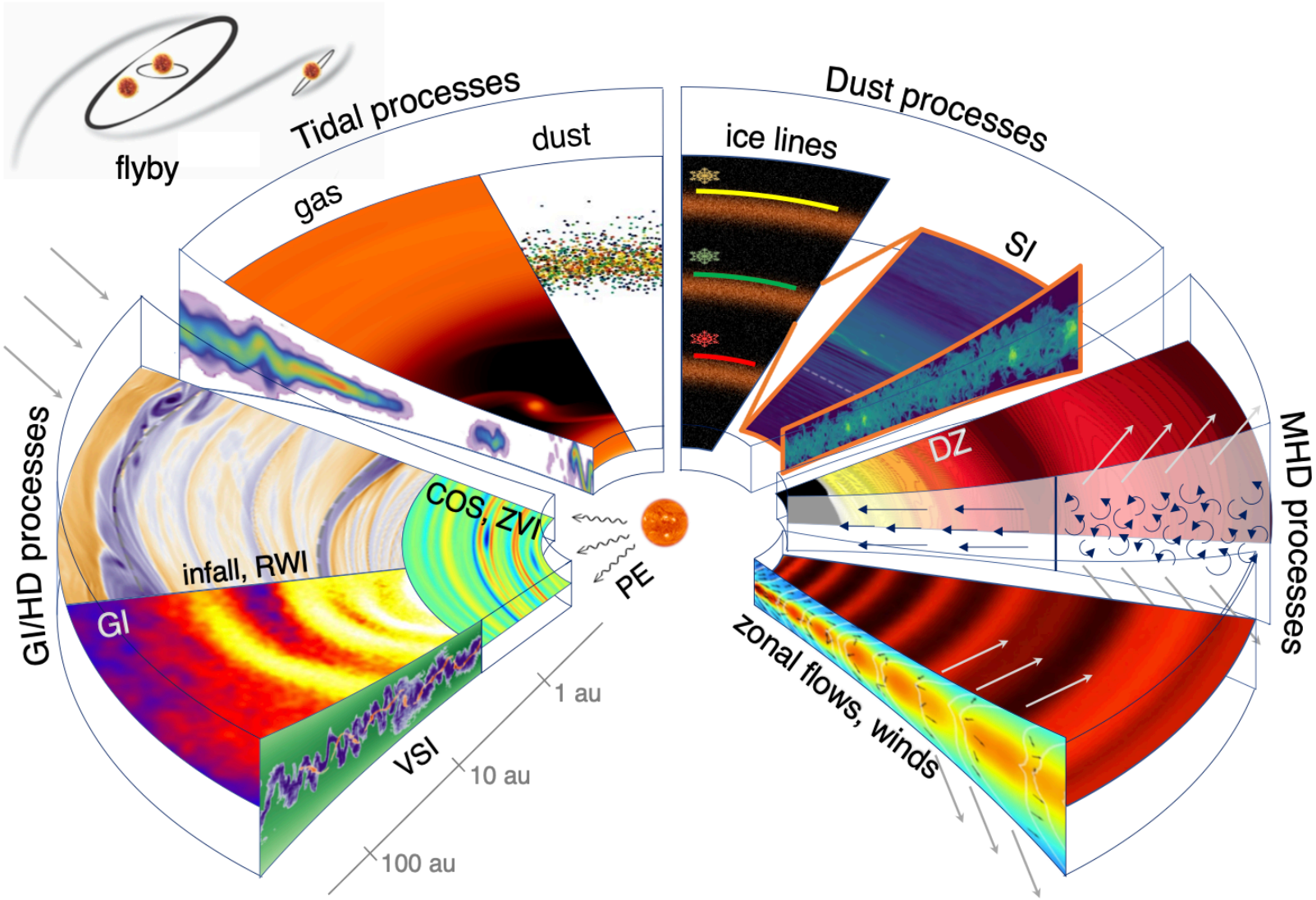
Disk evolution & substructures: key to planet formation?



Bae, Isella, Zhu, Martin, Okuzumi, & Suriano 2022, PPVII chapter

Observing the dynamics (inflow/accretion + outflow/winds) helps us to disentangle the various disk processes