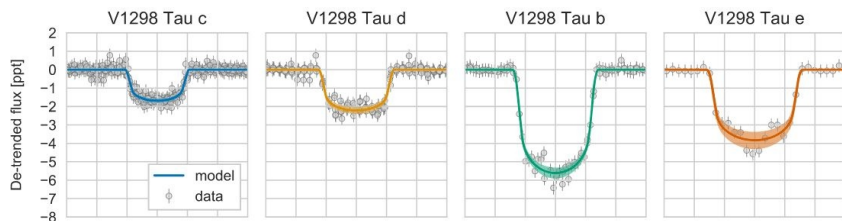
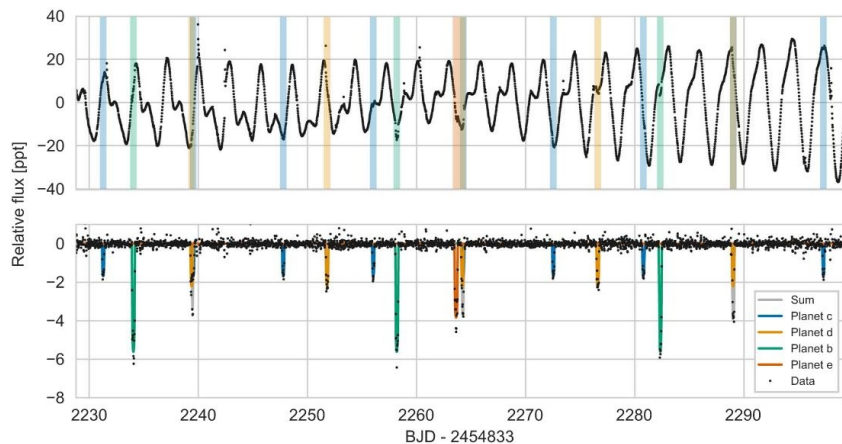


**An updated view on the infant
multi-planetary system V1298 Tau:
RVs, photometry, and radio follow-up**

**Mario Damasso
(INAF - Astrophysical Observatory of Torino)
[+ the GAPS team and several other collaborators]**

System detected with the photometric transit method

K2 data (David et al. 2019)



age: 20 ± 10 Myr

confirmed planets:

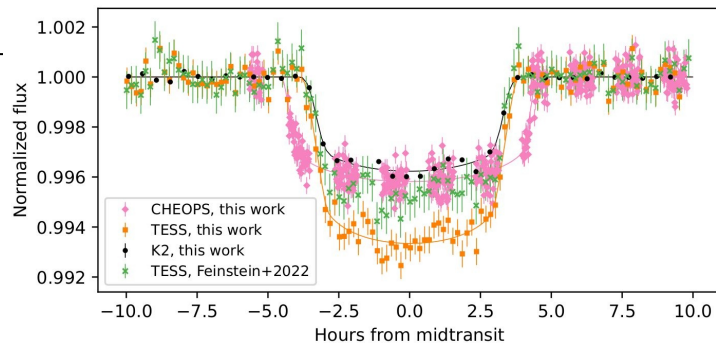
-c: $P = 8.2$ d, $R \sim 5 R_{\oplus}$

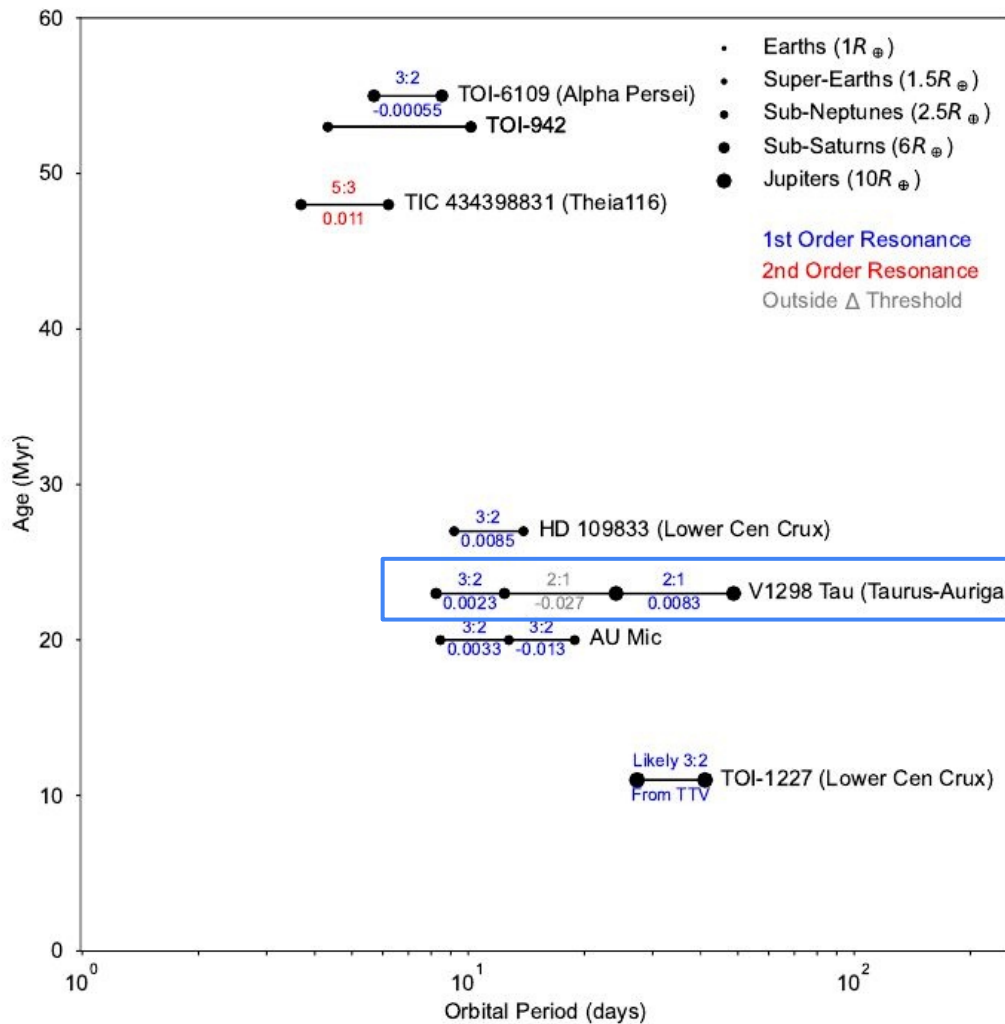
-d: $P = 12.4$ d, $R \sim 6 R_{\oplus}$

-b: $P = 24.1$ d, $R \sim 9.5 R_{\oplus}$

-e: $P = 48.7$ d, $R \sim 10 R_{\oplus}$

A transit-like signal (of a fifth planet?) detected by CHEOPS (Damasso et al. 2023).





Prevalence of Resonance Among Young, Close-in Planets (Dai et al. 2024)

(also Livingston et al. subm.)

Multi-faceted interest around V1298 Tau

A few examples from the literature:

see a poster by
Sérgio Gomes

Photometric and RV follow-up

(e.g. Feinstein et al. 2021; Suarez Mascareño et al. 2021; Damasso et al. 2023; Finocietty et al. 2023; Sikora et al. 2023)

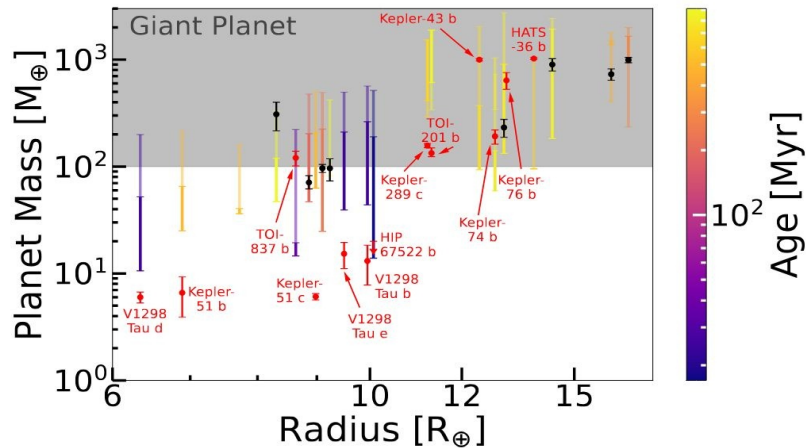
- characterising the planetary orbits
- RVs and TTVs analysis for mass measurements (in the range 3-21 M_{\oplus} according to Livingston et al., ESSV 2024)
- detection of additional companions

Atmospheric characterisation

- V1298 Tau b as a sub-Neptune progenitor ($M < 20 M_{\oplus}$ for b; $17+13 -6 M_{\oplus}$ for c; Barat et al. 2024)

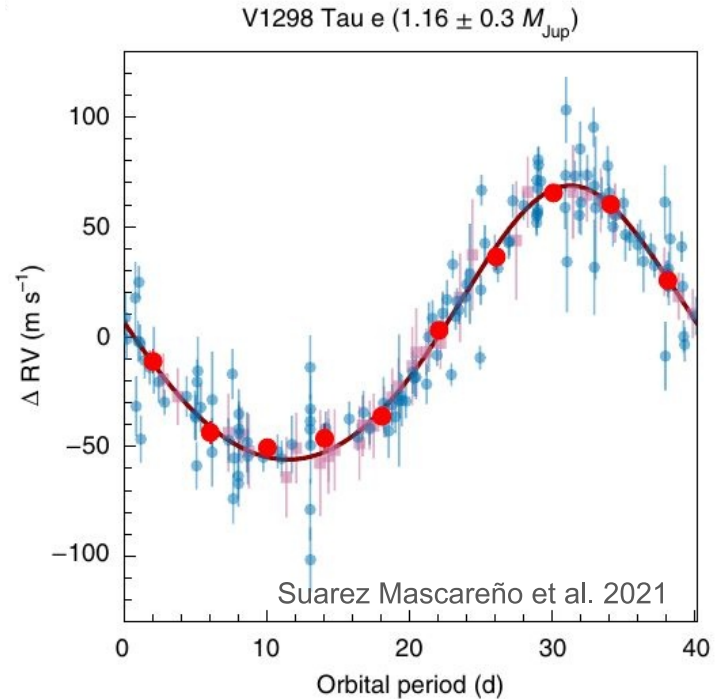
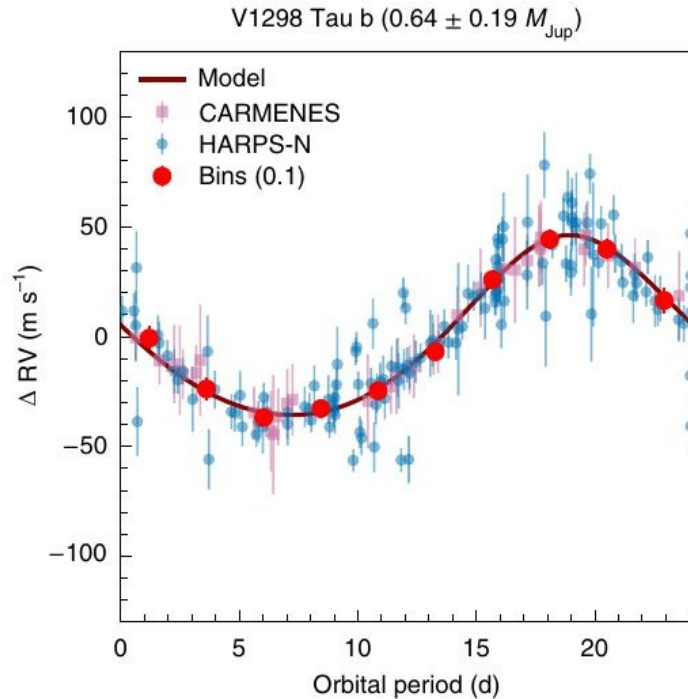
Architectures, evolution/migration, population studies

- Dai et al., 2024; RML of V1298 Tau b (Johnson et al. 2022)
- super-puffy planets vs. Hot-Jupiters (Karalis, Lee, & Thorgren 2025)

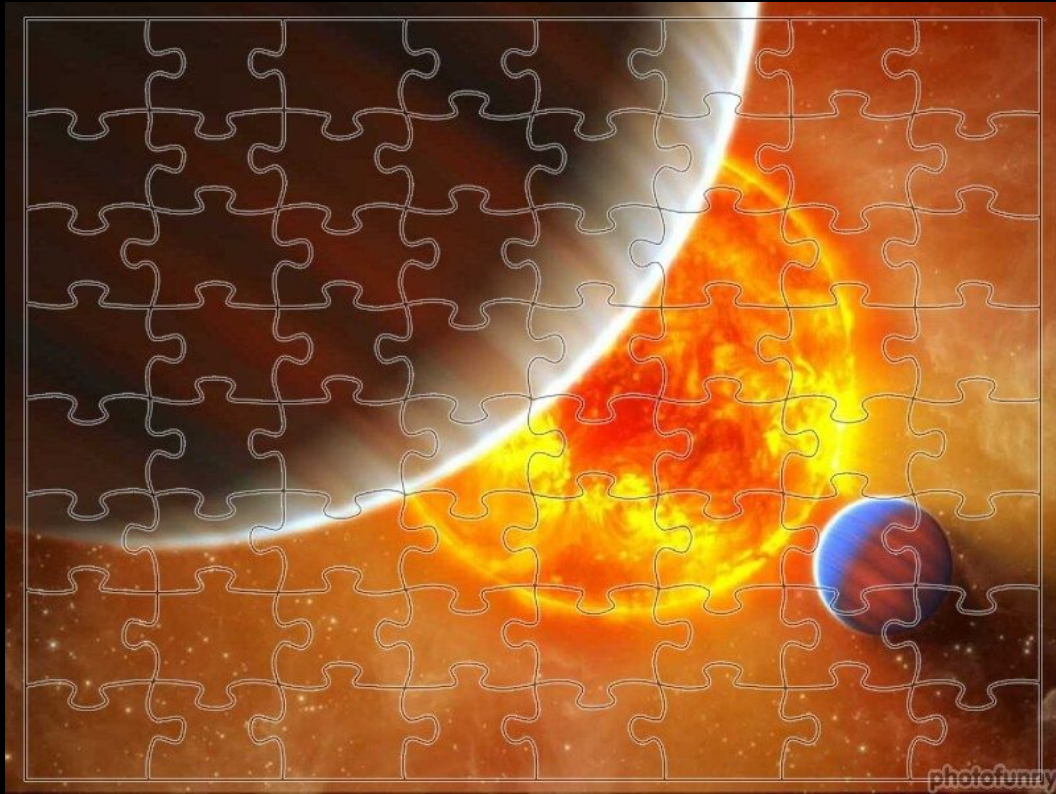


(Karalis, Lee & Thorgren 2025)

Are planets -b and -e giant and massive?

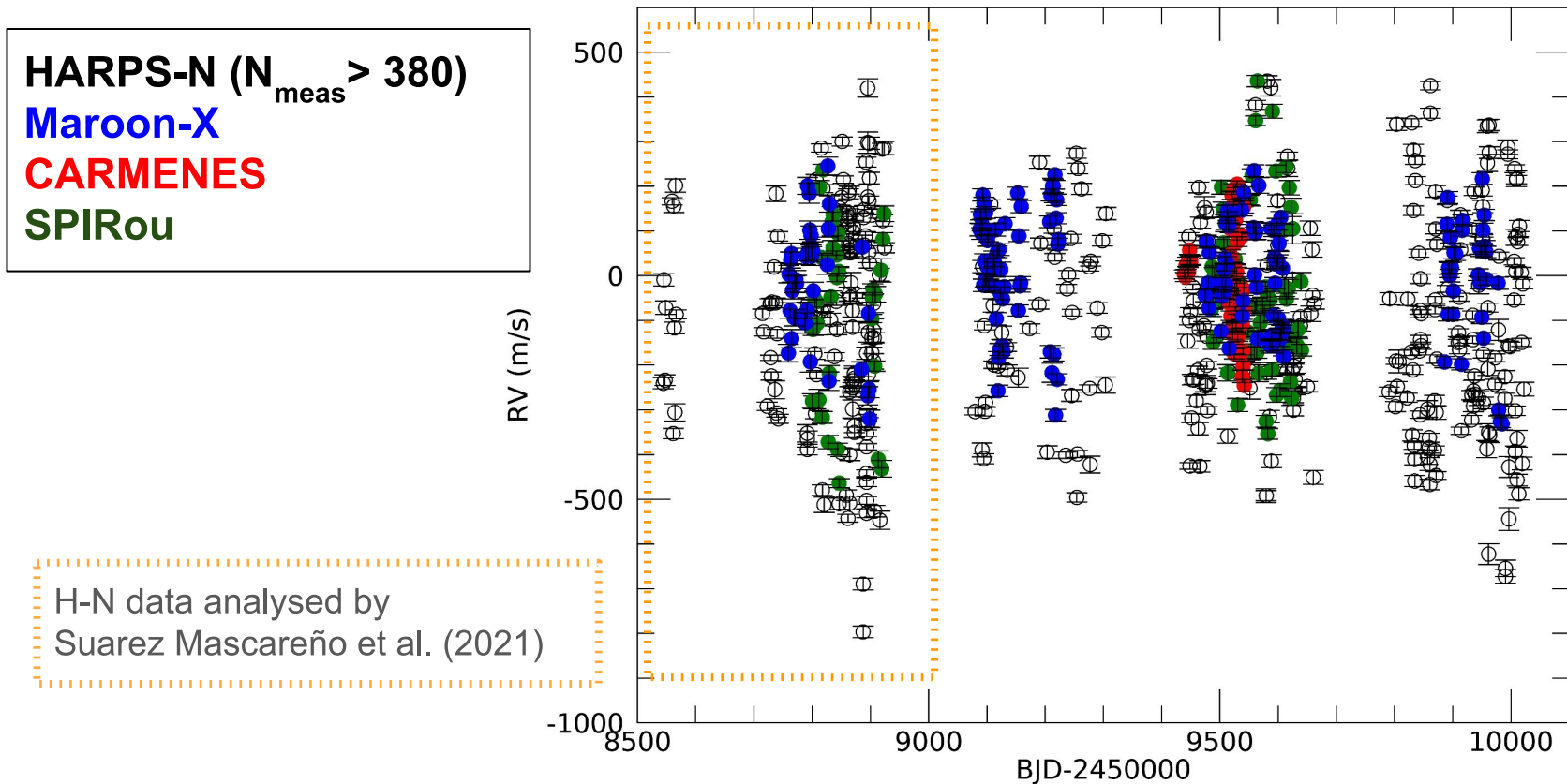


- Non interacting planets were assumed (P_e was unknown)
- Results are probably affected by overfitting [Blunt et al. 2024]

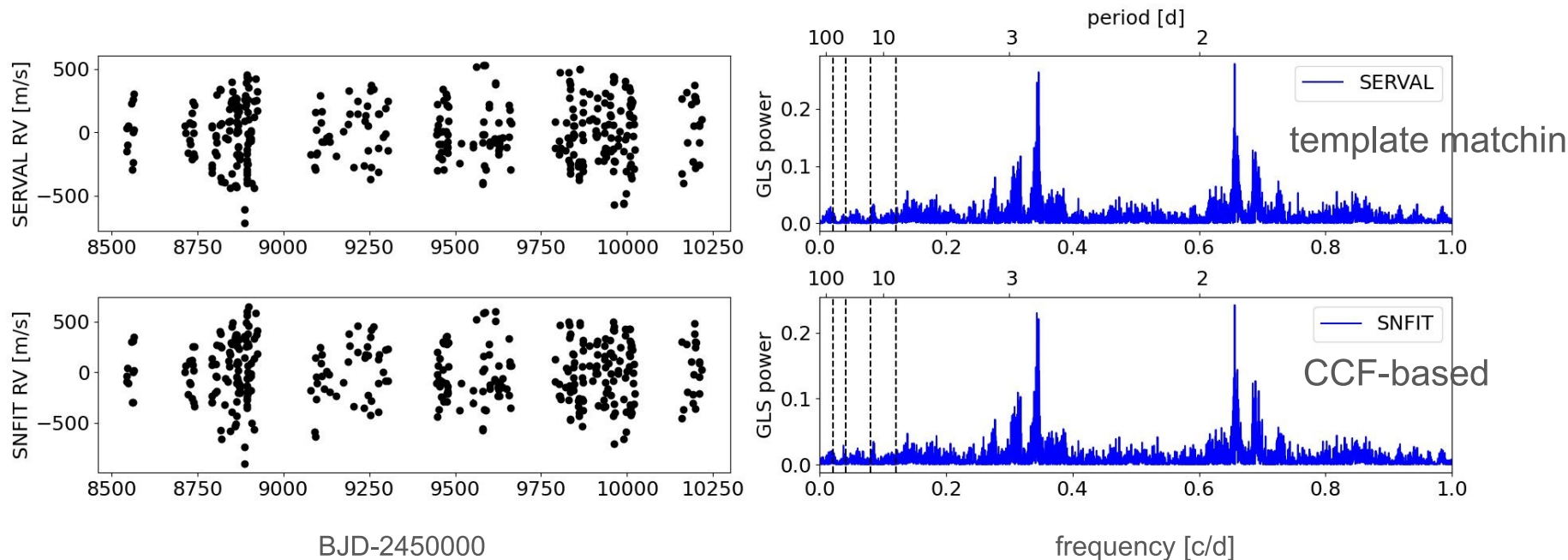


**New pieces of the puzzle are now in place, but...
...no consensus yet around the measurement of the planetary masses**

A larger RV time series from HARPS-N (GAPS programme)



HARPS-N RV time series and periodograms



stellar activity is a major issue ($\Delta RV > 200$ m/s)

Dynamical mass determination

So far, we took care of some levels of complexity, with some innovations:

RV analysis

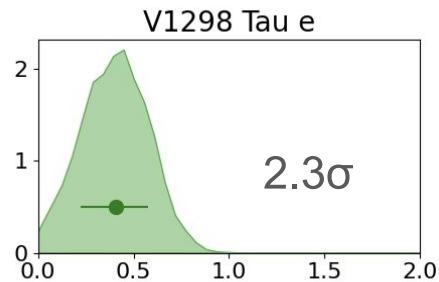
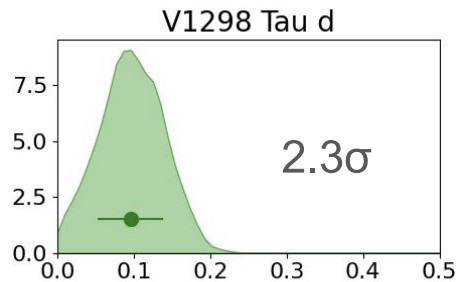
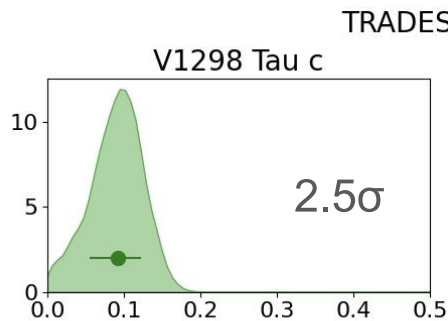
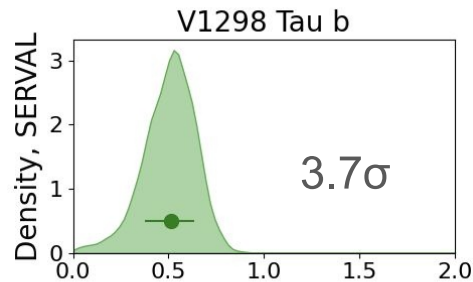
- a) **RV extraction techniques** (HARPS-N spectra) → SERVAL (Zechmeister et al. 2018)
SNFit (Simola et al. 2019)
- b) **Activity modelling** → 1-d or multi-dimensional GP regression (e.g. Rajpaul et al. 2015)
- c) **Planetary signals:** non-interacting Keplerians vs. N-body integrator (TRADES; REBOUND)
- d) **By now, we did not explore in detail the presence of a fifth planet**

TTV analysis

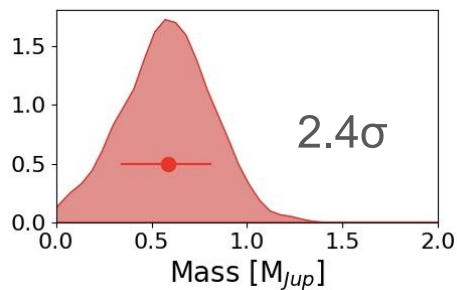
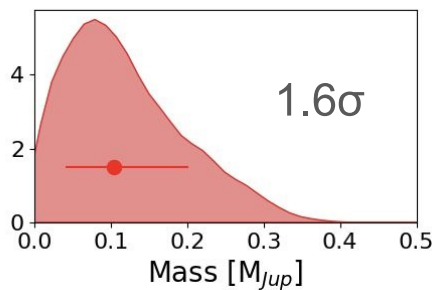
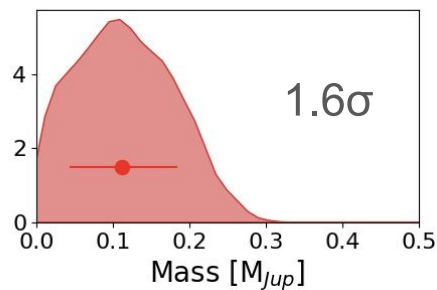
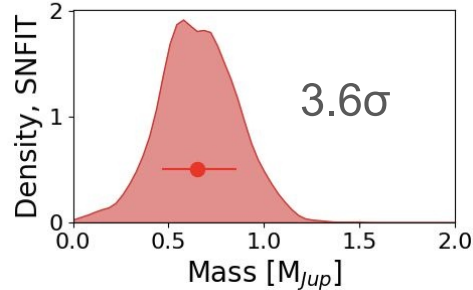
- a) Ongoing intensive follow-up with ground- and space-based facilities

Planetary mass distributions - GP q-per. 1-D

SERVAL



SNfit



0.5-0.65 M_{Jup}

\sim 0.1 M_{Jup}

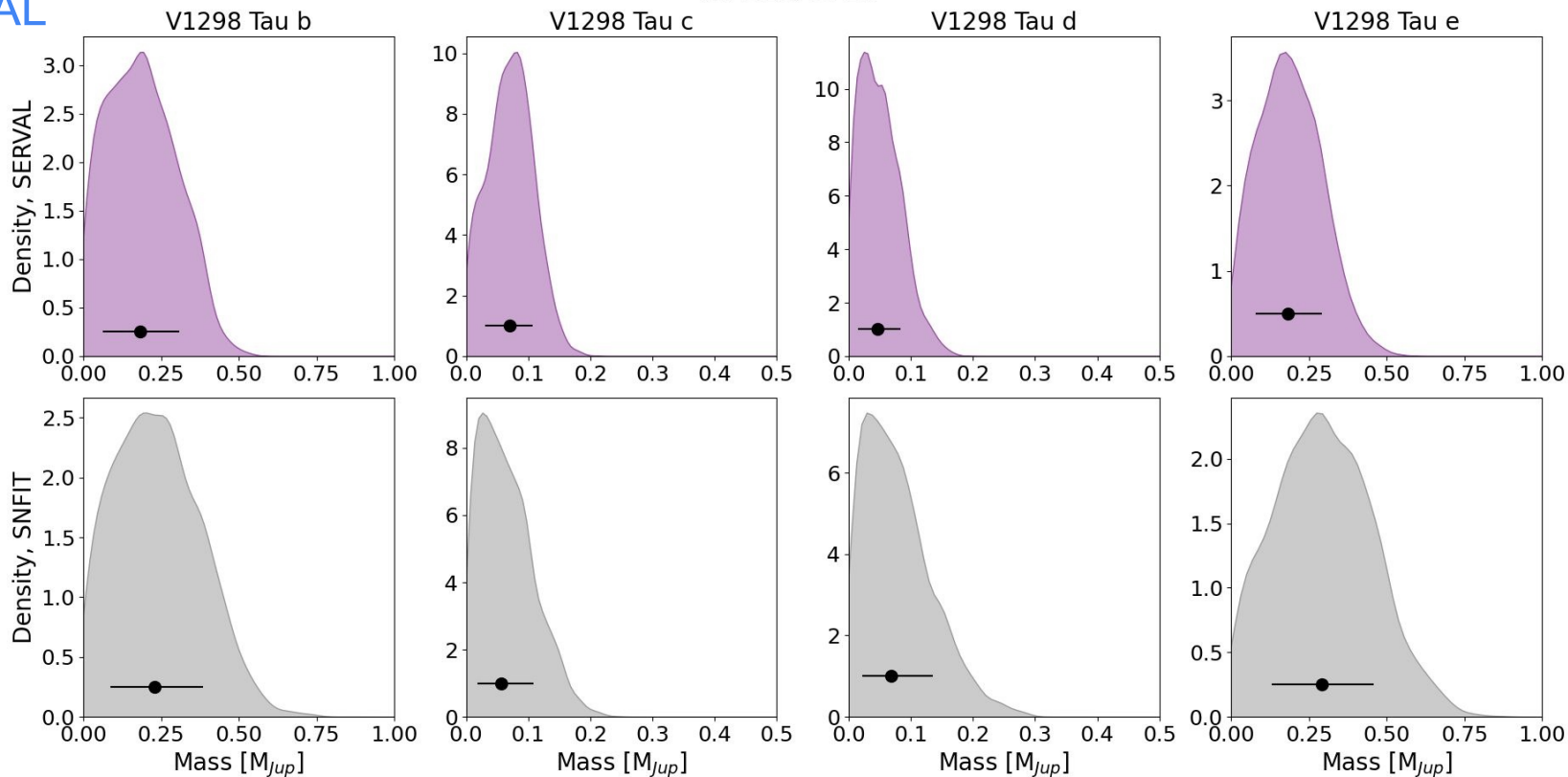
\sim 0.1 M_{Jup}

0.4-0.6 M_{Jup}

Planetary mass distributions - GP q-per. 2-D (using BIS)

SERVAL

TRADES, GP 2D



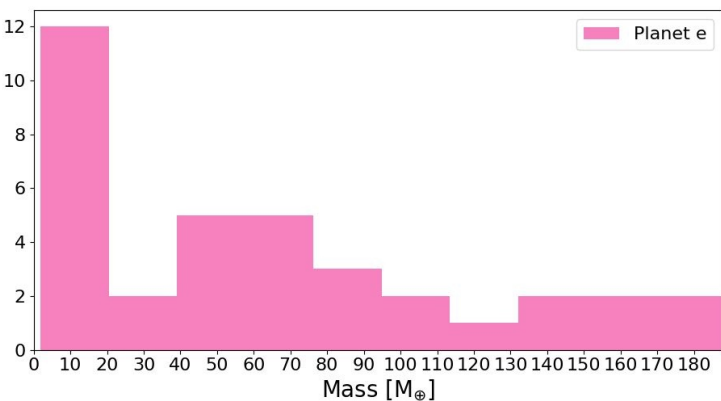
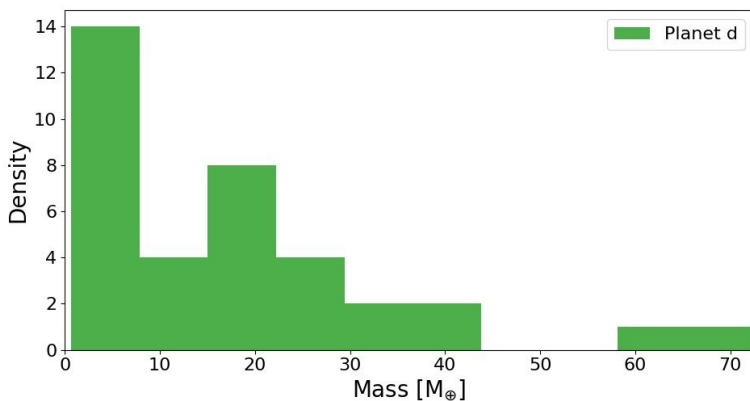
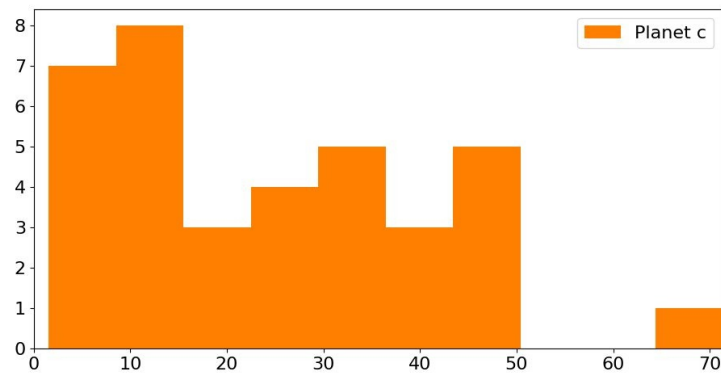
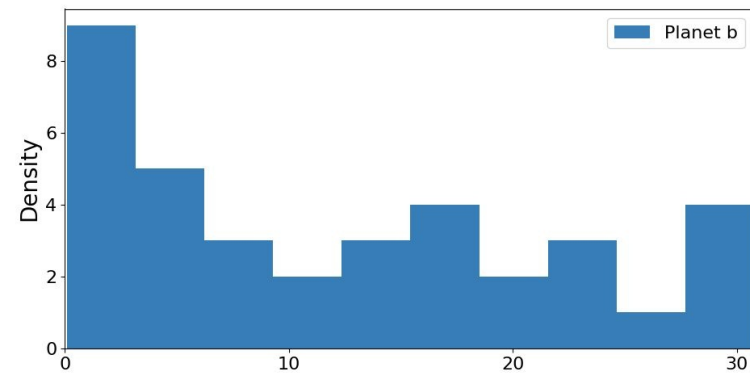
SNfit

Exploring the dynamical stability over 10 Myr

(SERVAL, TRADES, GP 1D)

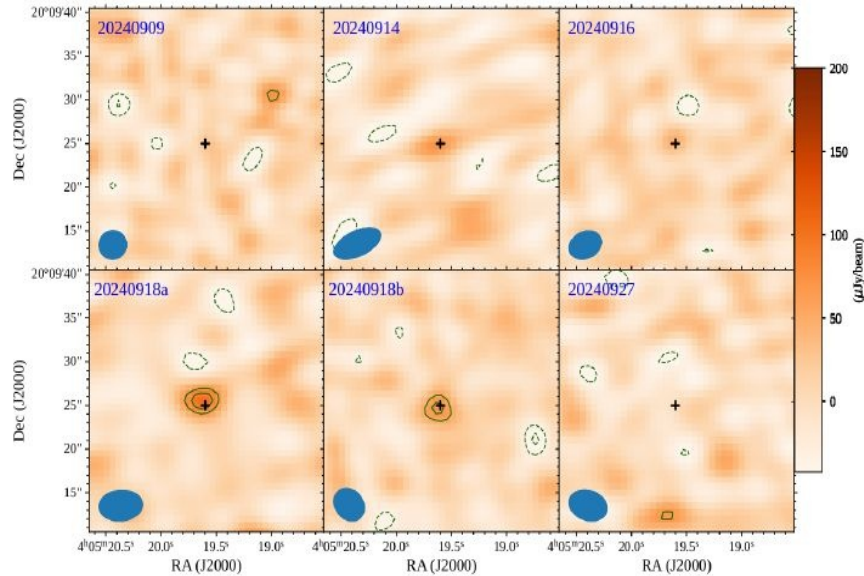
~0.4%
of the system
posteriors

Mass unit: M_{\oplus}

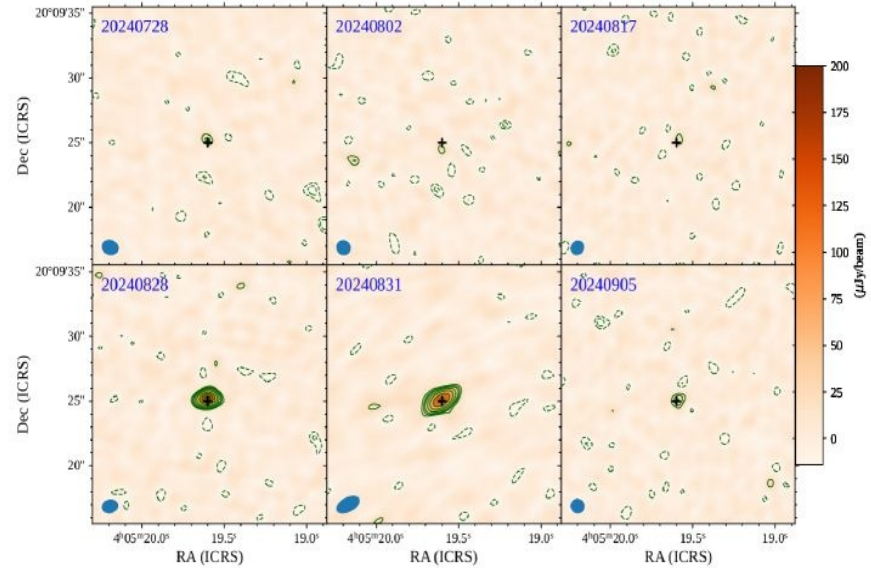


Radio follow-up of V1298 Tau with the JVLA

L-band (1-2 GHz)

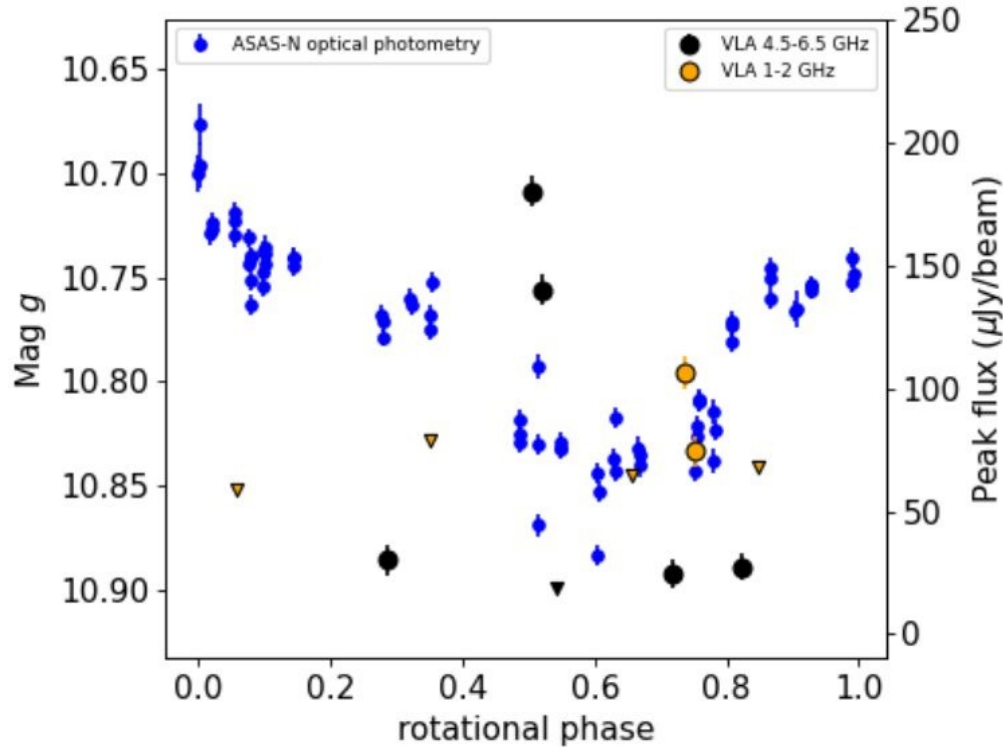


C-band (4.5-6.5 GHz)



(Damasso, Morata et al. 2025)

Radio follow-up of V1298 Tau with the JVLA



Radio and optical (ASAS) light curve phase-folded at the stellar rotation period (2.9 days)

New JVLA observations (20 hrs) scheduled from Sept.

(Damasso, Morata et al. 2025)



THANKS FOR YOUR ATTENTION

We advocate the stellar and exoplanet communities to continue dedicating observing time to the study of this key object from both ground based and space born facilities in the coming years.

(Donati et al. 2025, talking about AU Mic)

