# Stellar characterization of planet hosts

**Silvano Desidera**
INAF-Osservatorio Astronomico di Padova

M. Baratella, D. Bossini, R. Claudi, V. D'Orazi, L. Girardi, V. Granata,
R. Gratton, L. Malavolta, D. Nardiello, S. Ortolani, G. Piotto,
E. Rigliaco, A. Ruggieri, L. Spina, V. Squicciarini

# Motivations

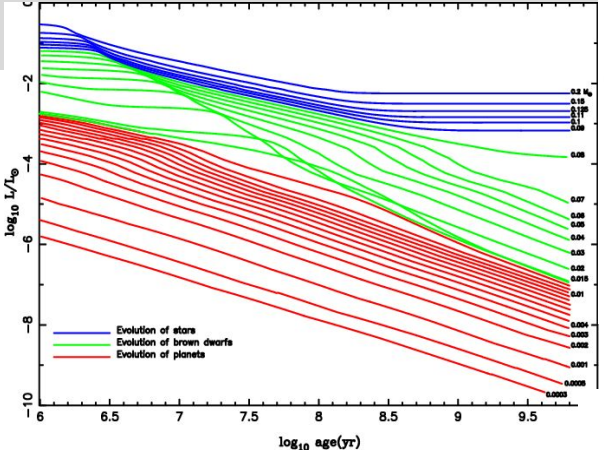
**Strong link between the planetary systems and their host stars**

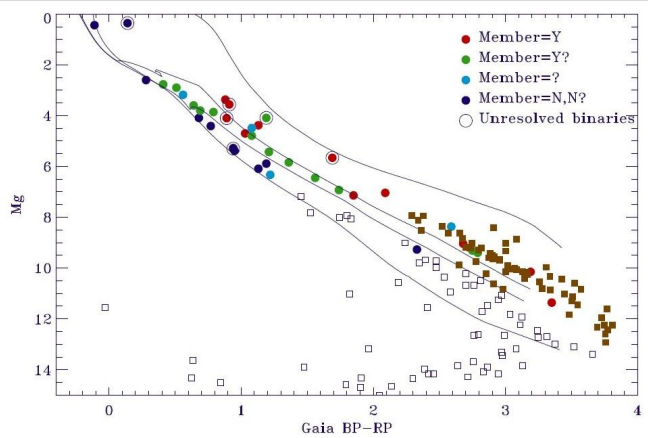
- Planet properties depend on adopted stellar properties (mass, radius, age)
- Dependence of planet frequency and properties on stellar mass and metallicity
- Link with planet structure and atmospheric composition
- Role of dynamical environment (binaries, clusters): disk truncation; dynamical perturbations
- Star-planet interactions (tidal effects; atmosphere evaporation)
- The challenge of magnetic activity for planet detectability (especially with RV)

**Traditional expertise on stellar science at OAPD** (specific background by several of us)

# Direct imaging & age

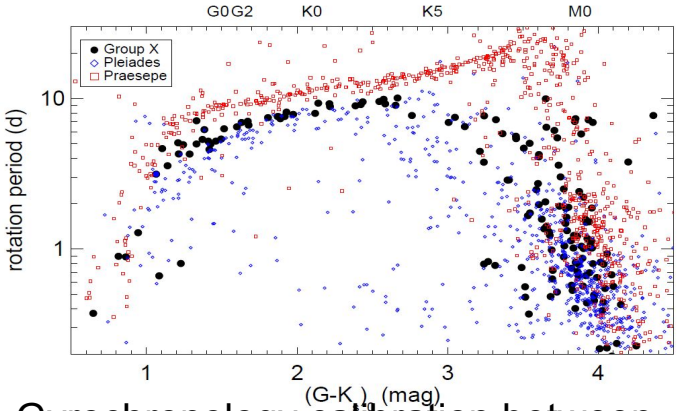
**Searching for self-luminous planets. Inferred planet masses or detection limits depend strongly on the adopted stellar age**




A new 10 Myr old MG in Cepheus

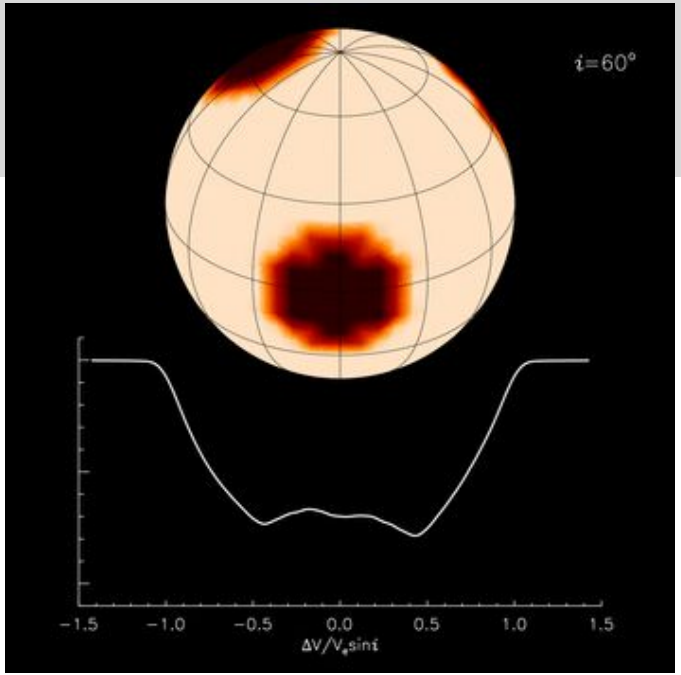
- Specific expertise for the characterization of young stars (SPHERE resp.)
- Approach: considering variety of indicators membership to groups/clusters/associations; lithium; rotation (gyrochronology); chromospheric and coronal activity; isochrone fitting

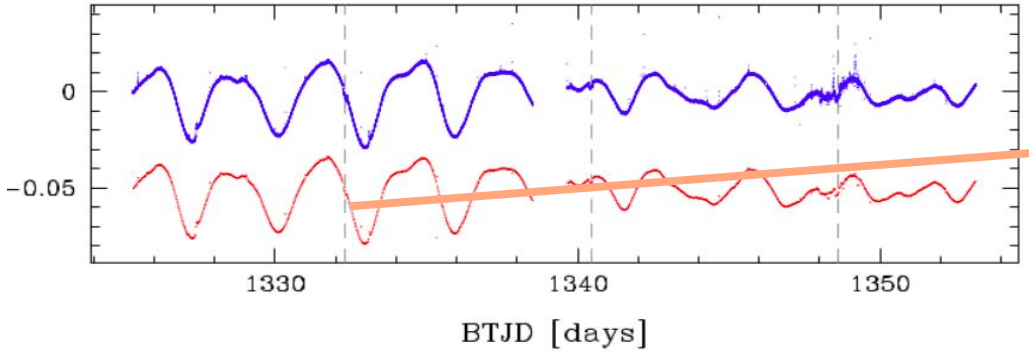


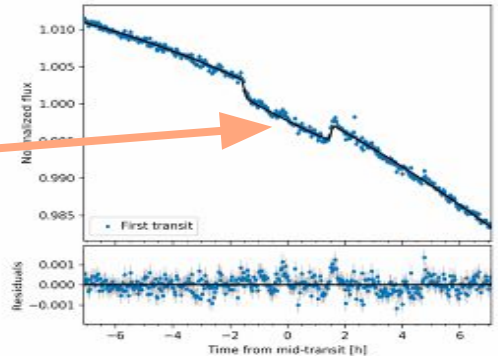

Gyrochronology calibration between Hyades and Pleiades: Group X (300 yr) from the analysis of TESS data

# Magnetic activity

- Active regions alter the profile of the spectral lines, seen as spurious RV variations
- Photometric variability also affects the transit techniques
- Specific expertise in the modeling of stellar activity (rotational modulations, activity cycles) and lots of high-quality data in the framework of the GAPS collaboration (Claudi+; Nardiello+; Ruggieri+)

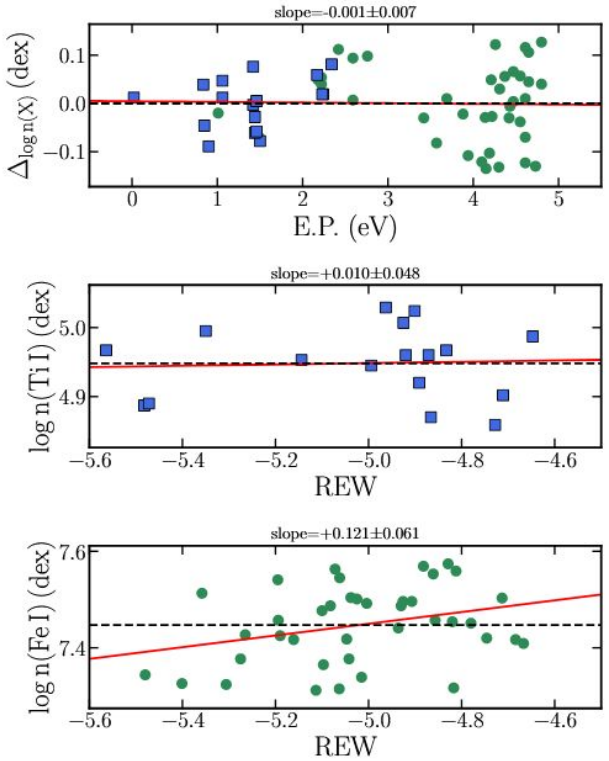


# Chemical abundance of young active stars

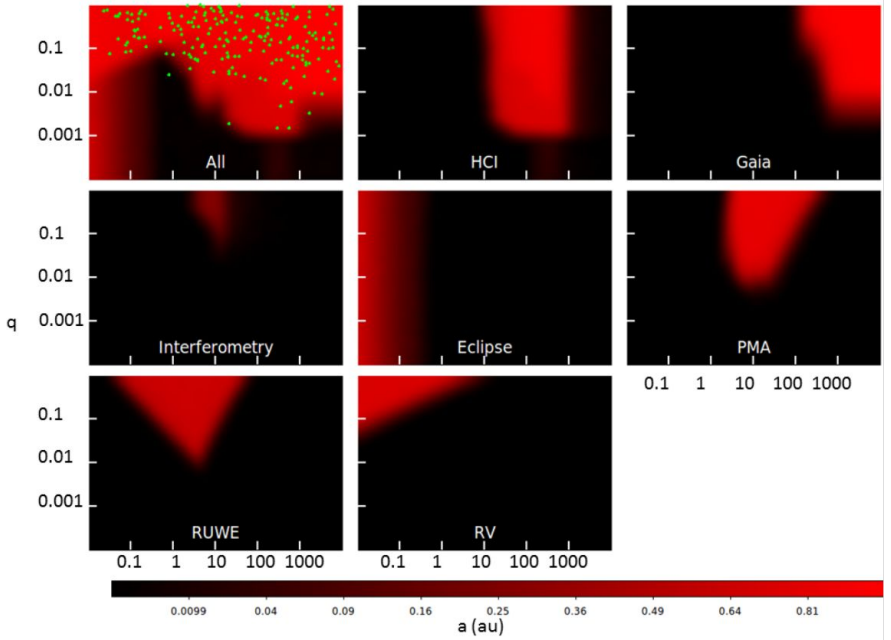
- Alterations of temperature profile in the stellar atmosphere of active stars
- Standard analysis produces unreliable results. Spurious effects of microturbulence; large enhancement of abundance of some elements (e.g. Ba) in young stars.
- Optimized technique considering Fe and Ti lines mitigates  the issue




Baratella+2020

# The impact of stellar multiplicity

- Dynamical impact of stellar companions on the presence and characteristics of planets
  - disk truncation at formation stage
  - dynamical interactions at any epoch (e.g. eccentricity enhancement)
- First OAPD exoplanet project was on planets in binaries (SARG at TNG; 2000-2012)
- **Unified view of companions over full mass ratio and separation range** (especially relevant for brown dwarfs)

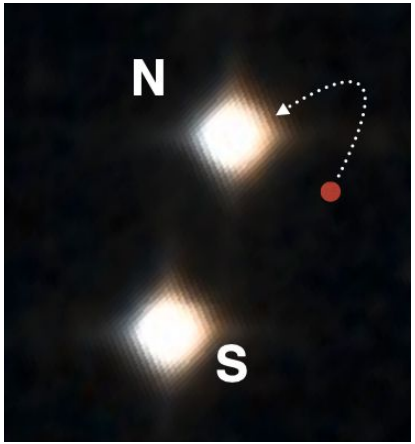


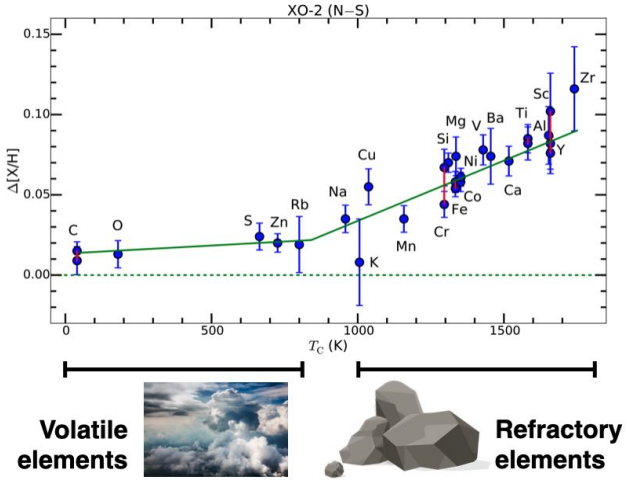

Multiplicity of B stars in the Sco-Cen association (Gratton+2023)

# Abundance differences between binary components

- How rare are stable planetary systems around Sun-like stars?
- Planet engulfment events can leave a mark on the chemical pattern of stars. Stellar atmospheres are enriched of rocky-forming elements, while volatile elements remain unadulterated.
- It is by studying the frequency of chemically dissimilar stars in binary systems that we can get insights on the nature of these events (e.g., Spina 2024).

XO-2 binary system

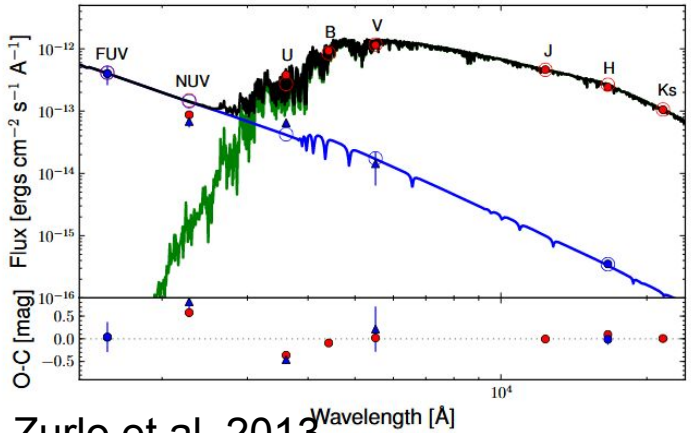


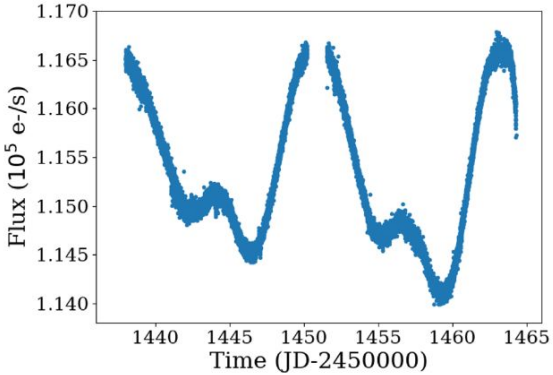

Abundances from Ramirez+14

# Rejuvenated objects

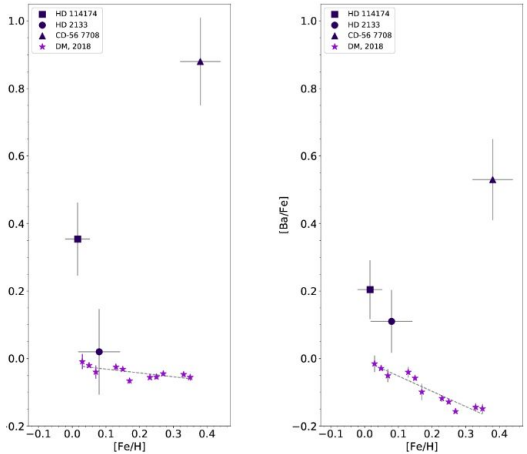
- We met few times stars with WD companions at few tens of au
- Misclassified as young because of accretion of angular momentum through stellar wind
- Also peculiar abundance pattern linked to the accreted material from WD progenitor while on AGB




Zurlo et al. 2013



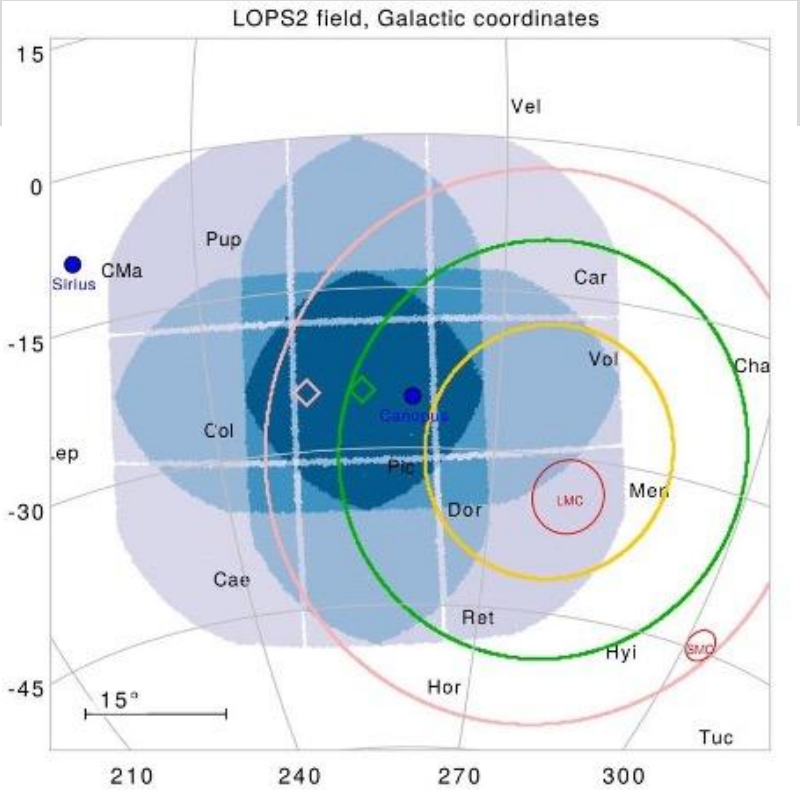

Bonavita et al. 2020




Gratton et al. 2021

# The PLATO Input Catalog

- Responsible for selection of PLATO field and of (pre-selected for on-board processing) targets
- Long-lasting efforts merging expertise in stellar properties, Galactic structure, and exoplanet science
- First PLATO field now released

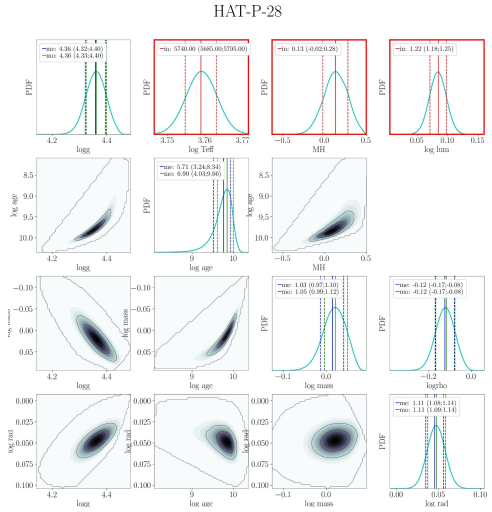



More on PLATO in Nascimbeni talk

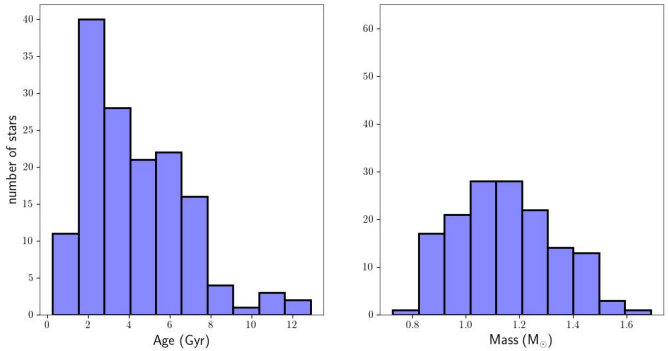
Montalto+2021; Nascimbeni+2022, Nascimbeni+ in prep.

# Participation to the Ariel consortium

- Participation to the Ariel stellar characterization Working Group (lead by C. Danielski, INAF-OAA)
- We use our Bayesian tool PARAM 1.5+ (http://stev.oapd.inaf.it/param) to estimate stellar properties (ages, masses and radii) of the *Ariel Candidate Sample*, by comparing observational data with a grid of stellar models.




(*left*) Example of PARAM output using as input Teff, [M/H] and luminosity (by SED+Gaia parallax) (*right*) Results on Magrini+22 Ariel sub-sample.




Bossini et al. (in prep)

# Conclusion

- **Relevant activities focused on stellar science within the exoplanet groups and projects**
- **Coordination roles on target selection and target properties (PLATO, SPHERE, etc.)**
- **Further synergies within our institutes beyond the current teams possible**