

TOI-179

Silvano Desidera
INAF-Osservatorio Astronomico di Padova

The planet candidate

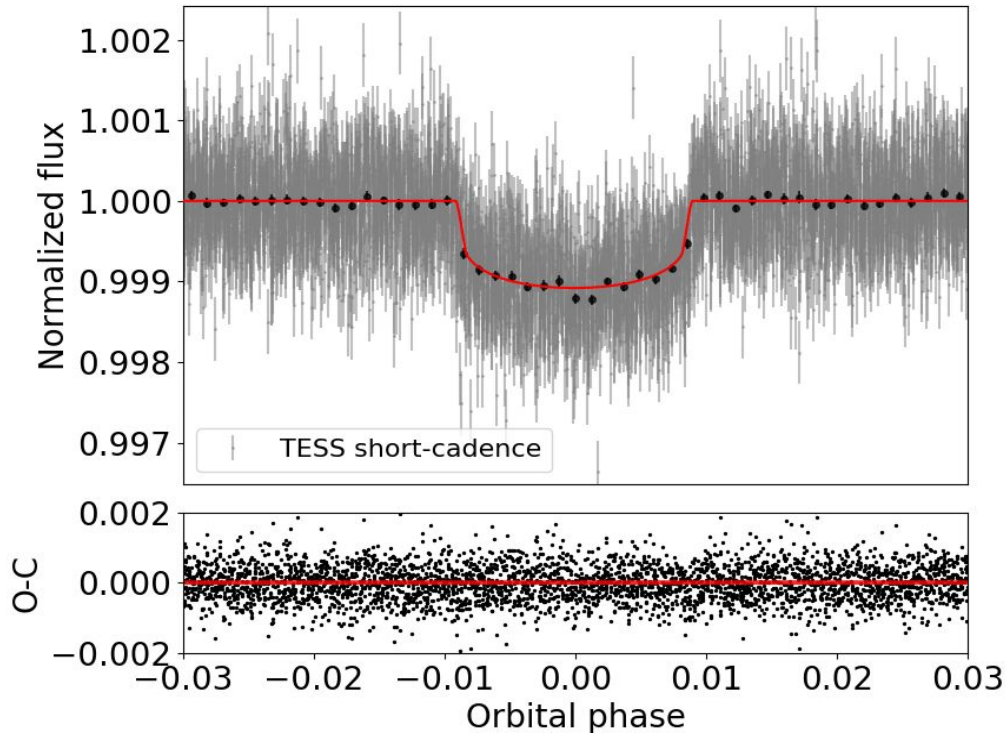
Period 4.137d

Radius 2.62 R_E

Single-planet (no additional transiting candidates)

Sectors: 2,3,29,30

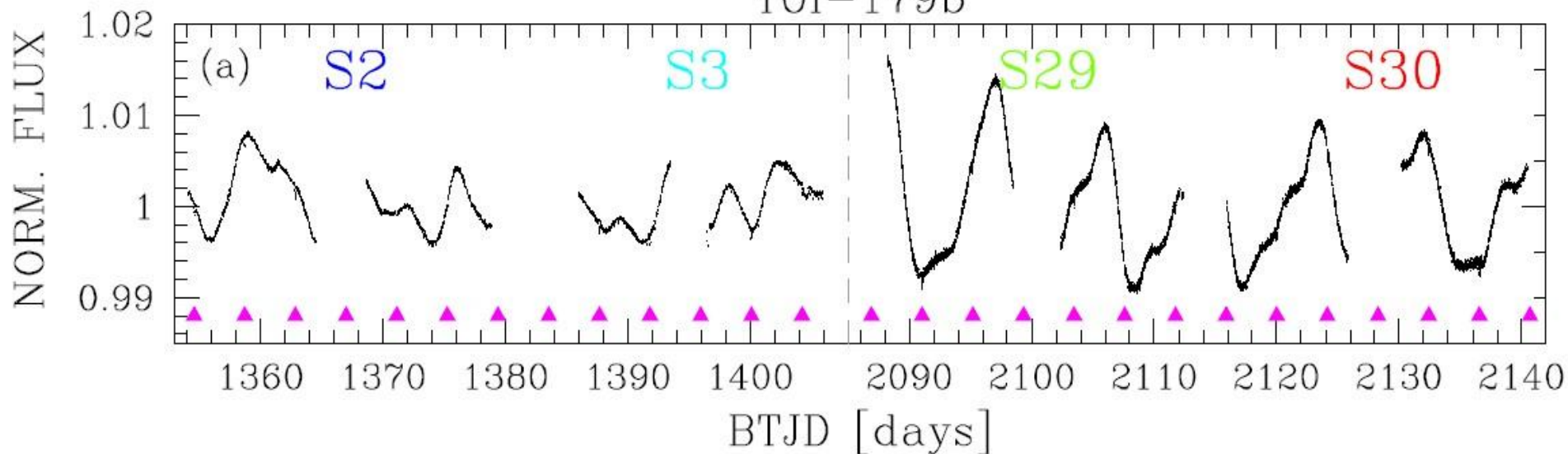
On a bright star: $V=8.99$



The star

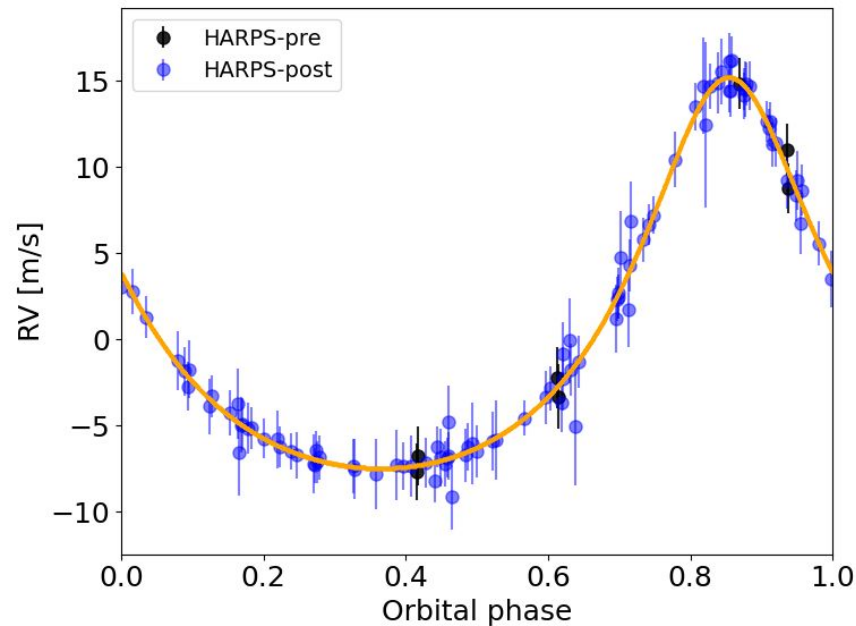
- Light curve dominated by rotational modulations: $P_{\text{rot}}=8.73$ days
- Age 400 ± 100 Myr, not member of groups/associations
- ST K2V, solar chemical composition
- Triple system (+ new): close pair of K dwarfs at 3400 au

TOI-179b



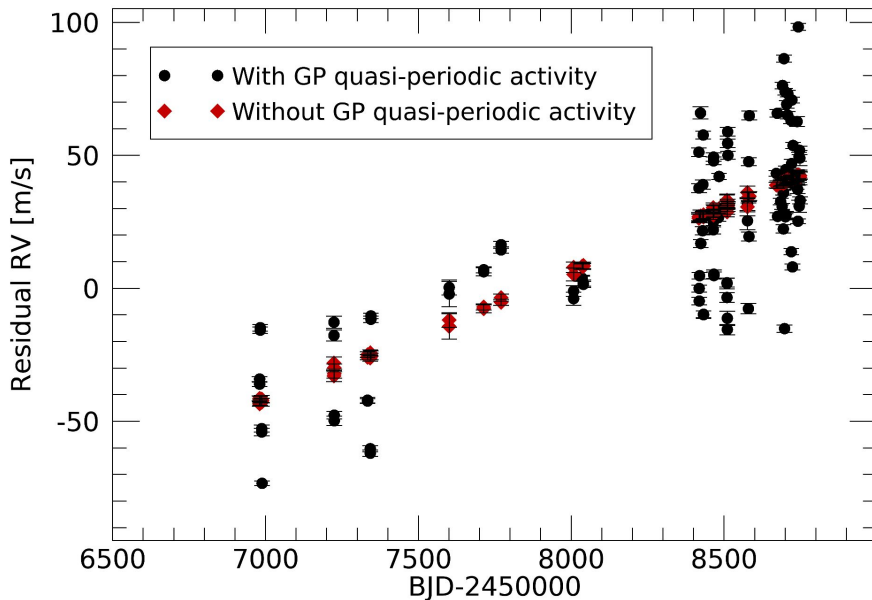
HARPS RV observations

- Dedicated observations after TOI release + previous observations for RV planet search around young stars (Grandjean+2020)
- 103 HARPS RVs overall, 5 yr baseline
- Planet confirmation (fit with GP to model stellar activity)
- Mass 24 ± 7 Me
- High density 7.5 g/cm^3
- Planet eccentricity 0.34 ± 0.08



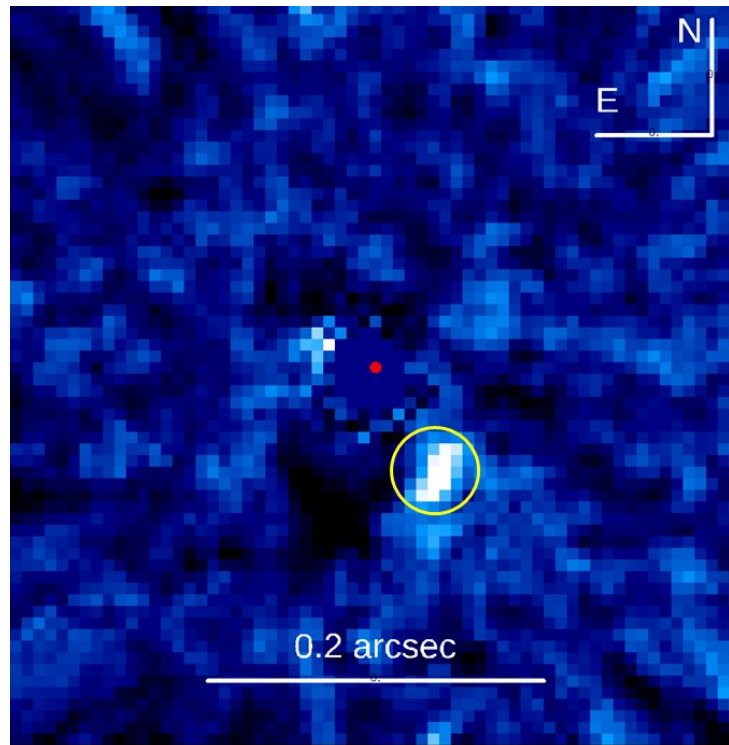
RV long-term trend

- Long-term RV trend (5 yr baseline)
- Not due to activity cycle
- Amplitude (smaller than typical cycles)
- No trend for line profile indicators
- Dedicated modeling with/without activity indicators
- Also Gaia-Hipparcos proper motion anomaly (SNR 11)



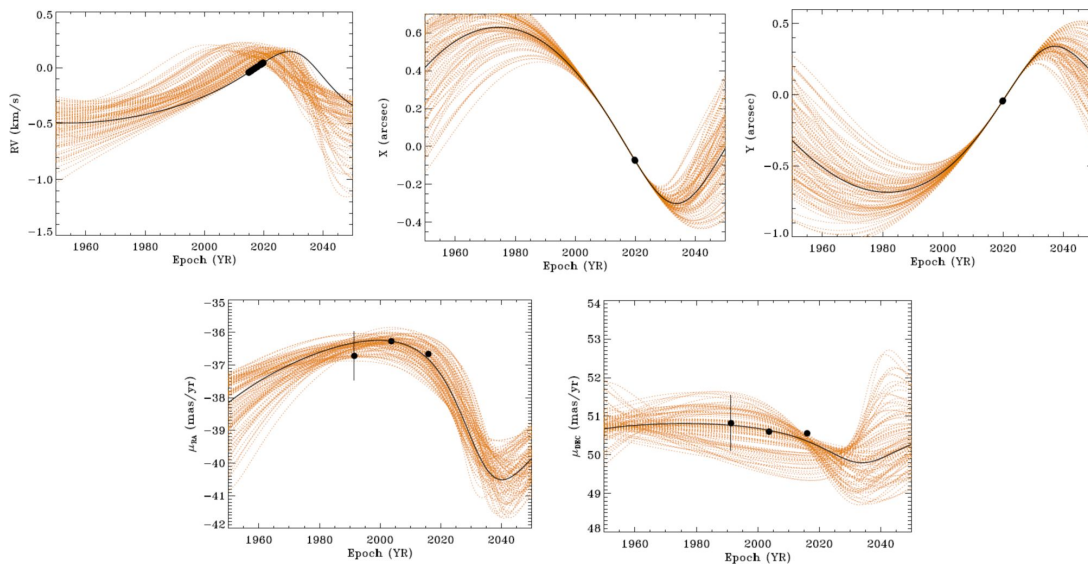
SPHERE data (2 epochs close in time with different set-ups)

- Null detection from coronagraphic images
- Faint candidate from non-coronagraphic images at $85 \text{ mas} = 3.3 \text{ au}$ projected sep.
 - Not detected in NaCo archive images
 - Not detected in SOAR speckle data (Ziegler+2020)
- Physical companion
 - Presence of dynamical signatures
 - Red color consistent with luminosity if bound
 - Would have been detected in NaCo images if a stationary background object
- Mass from luminosity $83 \text{ M}_{\text{jup}}$ (VLM/BD boundary)



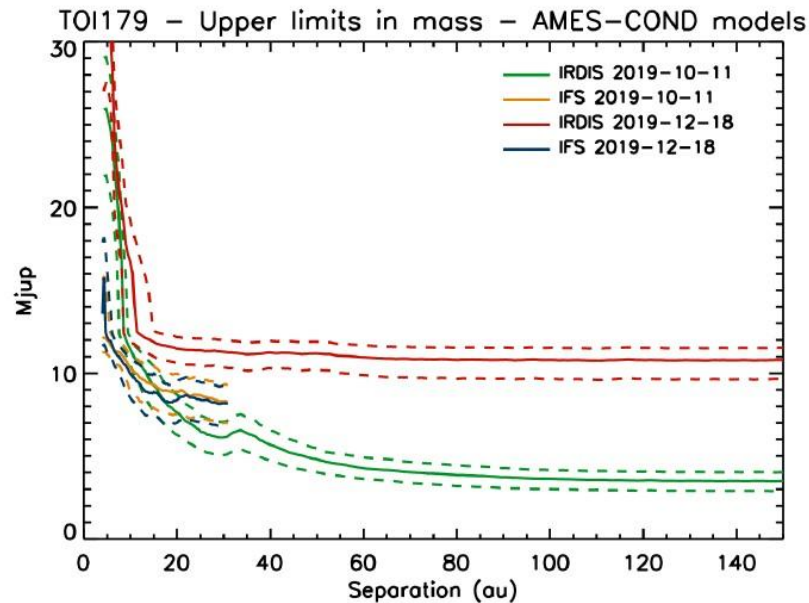
Preliminary orbital fitting

- Caught at a projected separation smaller than semimajor axis
- Orbit not well determined
- Dynamical effects on the transiting planet? (eccentricity pumping)



Limits for additional companions

- Well into planetary regime from direct imaging thanks to the young age and close distance

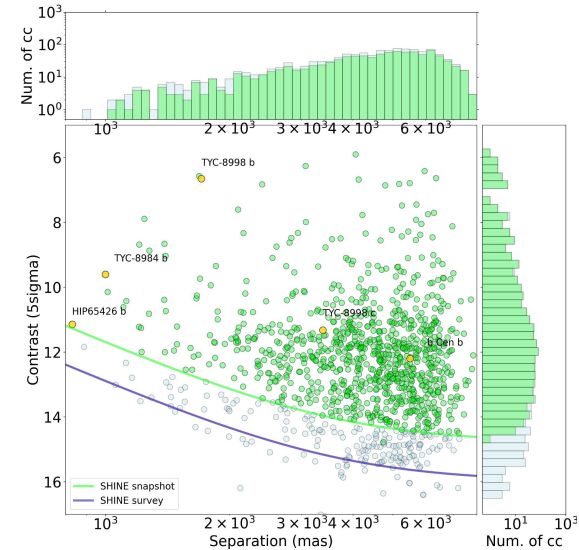


Lessons

- Companion at VLM/BD boundary discovered with SPHERE
- Escaped previous observations (SOAR, NaCo)
 - High contrast: Delta J 6.42 mag, Delta H 6.05 mag
 - Very small projected separation: 85 mas (3.3 au)
- High scientific interest
 - System architecture, dynamical interactions with the transiting planet
- Remind that imaging achieve detection limits in planetary regime for young stars. Further improvements with E-ELT (smaller/closer planets and/or also around older stars)
- Systematic high-contrast imaging (AO@>8m telescopes) needed?

Systematic high-contrast imaging with >8m telescopes?

- Large amounts of time at large telescopes
- Not at the beginning of the follow-up
- Only High-priority (candidates from P1 sample) targets ?
- Only when indications of long period companions (astrometry, RV trends)?
- Optimized observing strategy to save time and to have less constraints on obs ?
- e.g. technique based on PSF reference exploiting a large sample (see YSES survey, Bohn et al.) with respect to standard angular differential imaging



Courtesy SHINE team