

High-Resolution Spectroscopic Survey of a Large Population of Herbig Ae/Be Stars with HARPS/GIANO

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ABSTRACT

We present a spectroscopic survey of 25 Herbig Ae/Be (HAeBe) stars with HARPS-N and GIANO, installed at the Telescopio Nazionale Galileo. Covering a range from 387 to 691 nm at R=115,000 (HARPS-N) and from 967 to 2368 nm at R=50,000 (GIANO), this survey provides simultaneous unprecedented resolution and spectral coverage for >10% of all known HAeBes.

In this poster, we present our results on the star HD 141569.

HD 141569

It is an A0, 2 solar mass star. It is the only known pre-main sequence and youngest star hosting a hybrid disk, in the transition from a proto-planetary to a debris disk (GRAVITY et al. 2021, DiFolco et al. 2020). The star shows prominent double peaked emission in [O I] and H lines throughout the spectrum hinting at a Keplerian origin of the emission. Using the inclination of the star's inner disk of 54° (Lazareff et al. 2017), the corresponding orbital radius can be calculated.

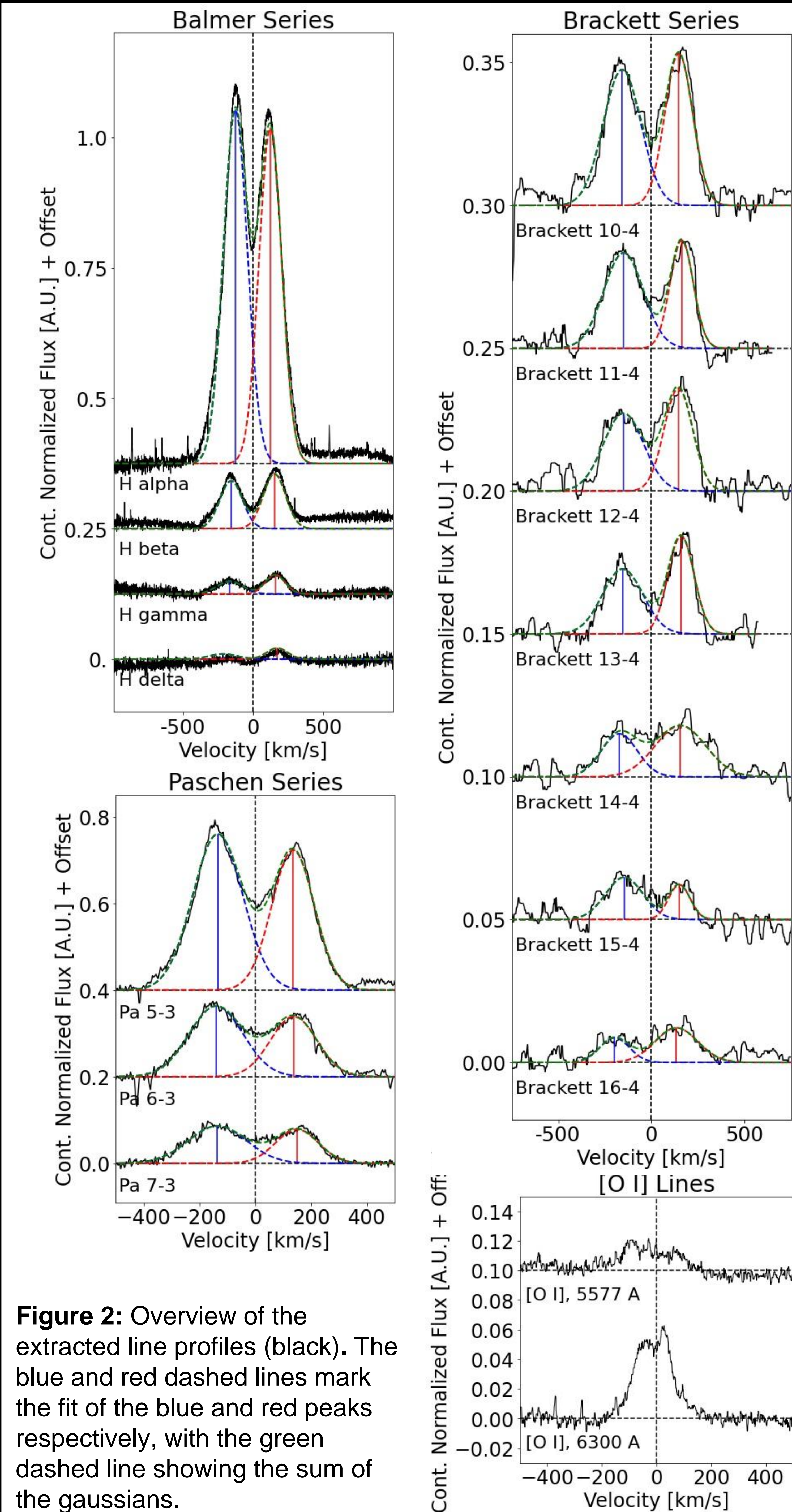


Figure 2: Overview of the extracted line profiles (black). The blue and red dashed lines mark the fit of the blue and red peaks respectively, with the green dashed line showing the sum of the Gaussians.

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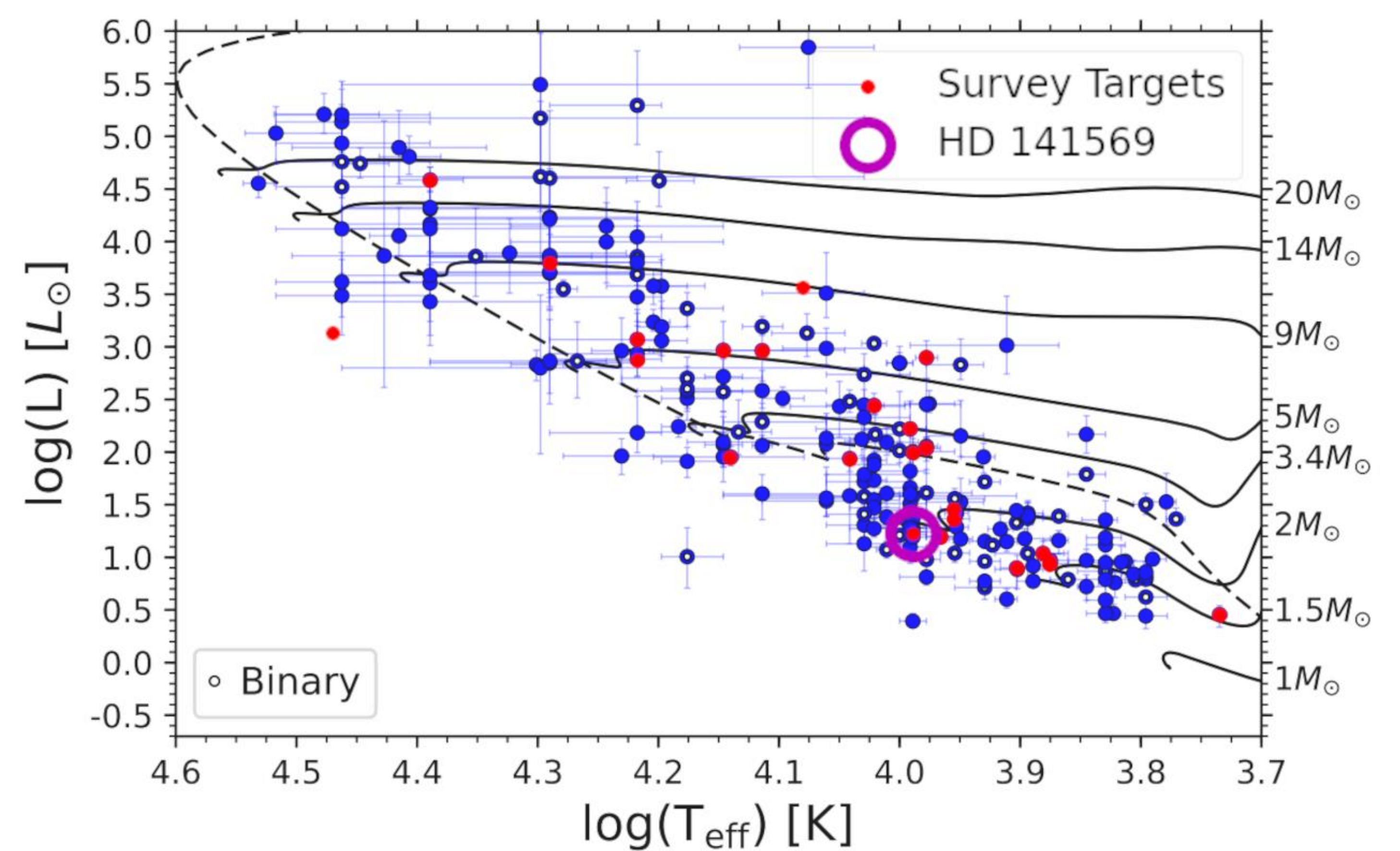


Figure 1: HR-diagram of known HAeBes, with the members of the survey marked in red. Modified after Vioque et al. 2018, fig.1

METHODS

We performed the telluric correction using telluric standard stars, and removed the photospheric absorption of the standard and HD 141569 using synthetic spectra generated with PySME (Wehrhahn 2021). The error in the wavelength calibration was ~1 km/s and much smaller than the error of the radial velocity (of 7 km/s). All lines reported here are given in the stellar restframe. The emission line profiles were fitted with the sum of two Gaussians using LMfit.

RESULTS

The distribution of the peak velocities of the H lines suggests as the origin a compact region between radii of 0.026 au (=3.8 R*) and 0.069 au (=9.89 R*), ergo in the dust-free inner disk. Given the weak magnetic field of the star (Alejian et al. 2013), it is unlikely that magnetospheric accretion is taking place. The [O I] lines suggest an origin at a distance of about 1 au from the star. These two positions are consistent with the constraint on the Br gamma emission region from GRAVITY, and the location of the VLTI K-band dust continuum at ~1 au.

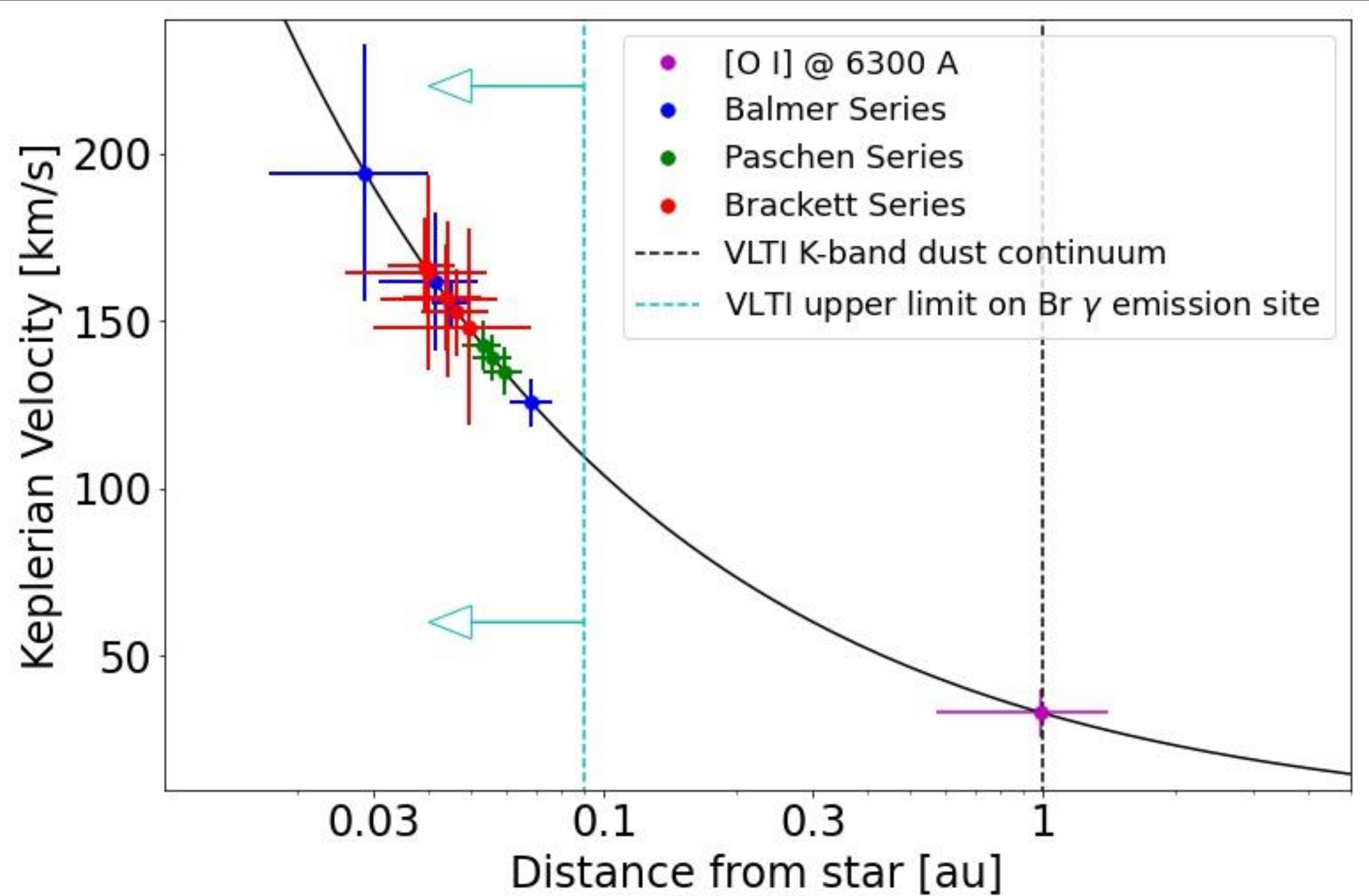


Figure 3: Keplerian velocity (equal to the mean peak velocity) for our measured emission lines in HD 141569 versus the resulting orbital radius. Cyan vertical line: Upper limit on extent of VLTI Br gamma emission. Black vertical line: Position of VLTI K-band continuum at ~1 au.

CONCLUSIONS

- We present a spectroscopic survey of 25 HAeBes with unprecedented spectral resolution and coverage in the optical and Near-Infrared,
- We present preliminary results on HD 141569, the youngest host of a hybrid disk
- Spectrum of star shows prominent double peaks in [O I], H lines
- [O I] lines emerge at greater distance from star at around 1 au radius
- H lines suggest origin at distances between 0.026 and 0.069 au within dust-free disk, ruling out magnetospheric accretion because of the star's weak magnetic field.
- This study provides new insight into kinematics of the not well understood inner disk of this transitional disk, and potentially Herbig Ae/Be stars in general

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