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Resolving the origin of hydrogen-line emission in YSOs with near-infrared interferometry

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Abstract. The origin of the Brγ-line emission in Herbig Ae/Be stars is still an open question and might be related e.g., to a disc wind or the stellar magnetosphere. The study of the continuum and Brγ-emitting region of Herbig Ae/Be stars with high-spectral and high-spatial resolution gives great insights into the sub-au scale hydrogen gas distribution.
We observed the Herbig Be star MWC 120 with the VLTI/AMBER instrument in different spectral channels across the Brγ line with a spectral resolution of $R \sim 1500$. Using radiative transfer modeling we found a radius of the line emitting region of ~0.4 au that is only two times smaller than the K-band continuum region. This is consistent with a disc wind scenario rather than an origin of magnetospheric emission.
We present near-infrared AMBER (R~12000) observations of the Herbig B[e] star MWC297 in the Brγ-line. We found that the near-infrared continuum emission is ~3.6 times more compact than the expected dust-sublimation radius, possibly indicating the presence of highly refractory dust grains or optically thick gas emission in the inner disk. Our velocity-resolved channel maps marking the first time that kinematic effects in the sub-AU inner regions of a protoplanetary disk could be directly imaged.

Keywords. stars: individual (MWC 120, MWC 297); pre–main-sequence; stars: imaging; stars: winds, outflows; accretion, accretion disks; radiative transfer; techniques: high angular resolution; techniques: interferometric; circumstellar matter; stars: emission-line, Be

1. High-angular resolution observations of Herbig Ae/Be stars

Jets and outflows play a fundamental role in star formation and the physics of the accretion-ejection process. While the hot circumstellar dust (T~1500 K) can be studied in the near-infrared continuum, gas and its kinematics can be studied in lines, in particular, the Brγ line (λ=2.1661μm).

Comparison of the visibilities, differential and closure phases in the continuum and the line emission region of Herbig Ae/Be star MWC 120 (Fig. 1, top left) with geometric and radiative transfer disc wind models (Fig. 1, top left, channel maps) reveal that the Brγ emission arises from a 2 times more compact region (0.15 au) than the K-band continuum (0.35 au), consistent with emission dominantly emerging from an extended disk wind. A comparison with other Herbig Ae/Be star shows that for stars of late spectral type (A1–B9), the derived inner radii of the disc-wind base can be approximately described by the corresponding Alfvén radii for each target (Fig. 1, top right; Kreplin *et al.* 2018).

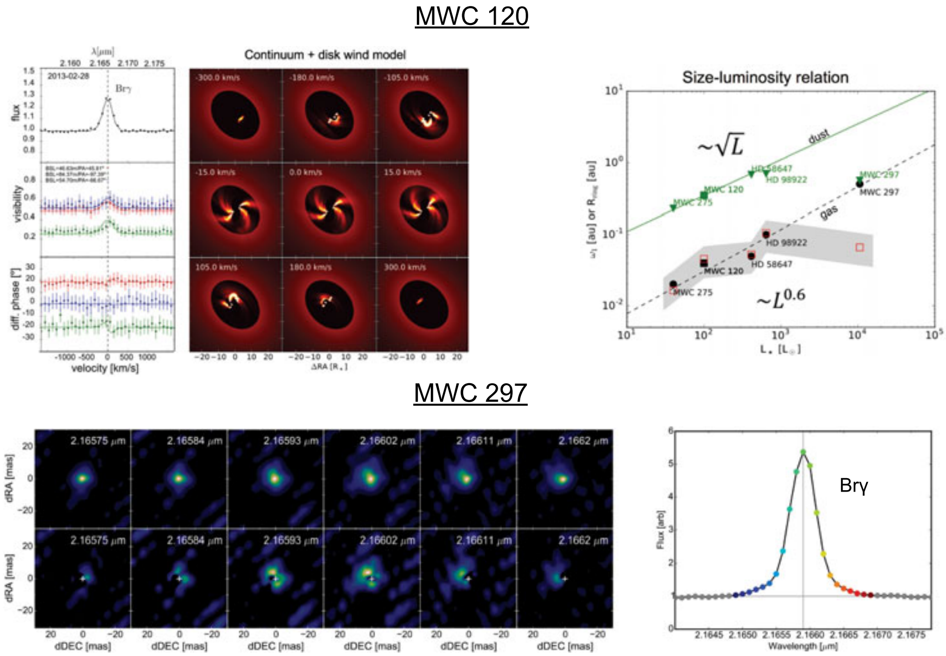

Figure 1. Top: Comparison of the MWC 120 measurements (data points) with the best-fitting disc-wind model (from top to bottom: spectrum, visibilities, differential phases). Right: Size-luminosity relation of a Herbig Ae/Be target sample showing the continuum dust emission size (green) and the inner disk wind radii (black). The inner disk wind base radius (black squares) might be proportional to the Alfvén radius (red squares) for late-spectral type stars (A1-B9). **Bottom:** First velocity-resolved reconstructed images (left) across the Brγ line (right) for a young star (MWC 297) at infrared wavelengths (IRBis algorithm; Hofmann *et al.* 2014). Top panels: continuum+line emission; Bottom panels: line emission only (i.e. continuum subtracted)

High spectral resolution VLTI/AMBER observations (R=12000) of the Herbig Be star MWC 297 show a very compact K-band continuum region ($\sim$0.8 au) compared to the expected dust sublimation radius of $\sim$3 au. The modelled Brγ emitting region is $\sim$2.3 times larger than the continuum region. We applied a disk-wind model and were able to fit the Brγ-line profile (Fig. 1, bottom right), as well as the high-resolution spectro-interferometry and spectro-astrometry data (see Hone *et al.* 2017). Our model-independent channel maps have an angular resolution of 2 mas and represent the first velocity-resolved image obtained for a young star in the infrared (Fig. 1, bottom left).

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