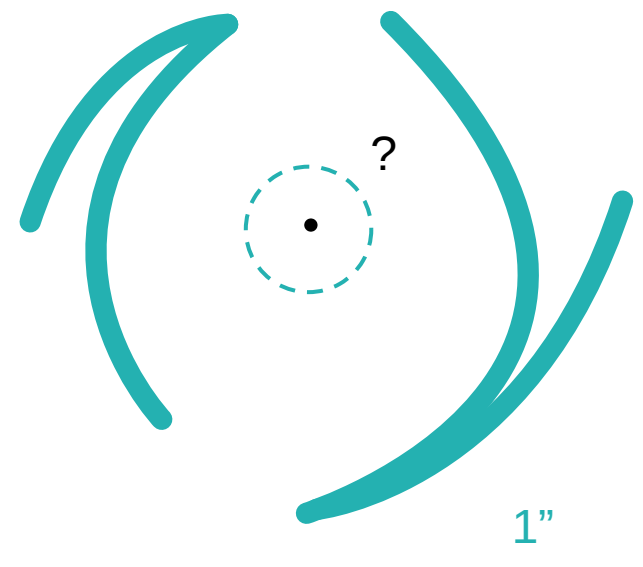


## INTRODUCTION

HD 142527 (F6III, H AeBe) is a well-studied stellar system with a transitional disk configuration, a large dust cavity, spiral structures, and an accreting low-mass companion. However, the system's inner regions are poorly understood, particularly regarding their influence on disk morphology and planet formation.

- Distance:  $159 \pm 0.8$  pc
- Age:  $5.0 \pm 1.5$  Myr
- Mass:  $2.0 \pm 0.3 M_{\odot}$



We conducted a multi-wavelength analysis from VIS to NIR of high-contrast imaging data obtained with the VLT/SPHERE instruments using the PACO (Flasseur et al. 2018, 2020) and REXPACO (Flasseur et al. 2021, 2024) algorithms, dedicated respectively to the detection of point-like sources and to the reconstruction of circumstellar disks with high reliability, while exploiting both angular and spectral variations.

## OBSERVATIONS

• Observations in 2016 and 2025 using the high-contrast imager and spectrograph VLT/SPHERE (Beuzit et al. 2019) at the Paranal Observatory. Data are from the three instruments: Integral Field Spectrograph (IFS; Claudi et al. 2008), the InfraRed Dual Imaging Spectrograph (IRDIS; Dohlen et al. 2008) and the Zurich IMaging POLarimeter (ZIMPOL; Schmid et al. 2018).

• All the data are non-coronagraphic and were taken in pupil-stabilized mode to make use of the angular combined with spectral differential imaging technique (ASDI; Racine et al. 1999; Marois et al. 2006).

• Operating bands: YJH (950 to 1650 nm), K1–K2 ( $\lambda_c = 2110$  nm and 2251 nm, respectively), continuum H $\alpha$  (CntHa;  $\lambda_c = 644.9$  nm) and line H $\alpha$ , either broad- (B\_Ha;  $\lambda_c = 656.6$  nm) or narrow- (N\_Ha;  $\lambda_c = 656.53$  nm) band.

Table: Summary of observations.

UT Date	Instr.	Filters	DIT $\times$ NDIT $\times$ N <sub>exp</sub>	Field rot. (°)	Seeing (")
2016-03-26	IFS	YJH/ND1	4.0 $\times$ 56 $\times$ 16	65.24	0.69
	IRDIS	K1–K2/ND1	0.84 $\times$ 88 $\times$ 32	64.86	0.69
2016-03-30	ZIMPOL	CntHa/N_Ha	30 $\times$ 10 $\times$ 7	48.66	0.28
	ZIMPOL	CntHa/B_Ha	30 $\times$ 10 $\times$ 7	47.80	0.29
2016-06-13	IFS	YJH/ND1	4.0 $\times$ 60 $\times$ 16	64.77	0.77
	IRDIS	K1–K2/ND1	0.84 $\times$ 49 $\times$ 64	66.03	0.84
2025-04-27	ZIMPOL	CntHa/N_Ha	30 $\times$ 15 $\times$ 7	64.11	0.27
	ZIMPOL	CntHa/B_Ha	30 $\times$ 15 $\times$ 7	66.35	0.28
2025-05-09	IFS	YJH/ND1	4.0 $\times$ 61 $\times$ 16	65.73	0.38
	IRDIS	K1–K2/ND1	0.84 $\times$ 50 $\times$ 64	67.28	0.33

## CONCLUSIONS

• HD 142527 represents an interesting planetary system, in which the inner region can provide a theoretical framework for studying planet formation processes.

• The CC to HD 142527 at  $\sim 0.09''$  was detected in two epochs of NIR observations with IRDIS/IFS in 2016. Its red spectrum suggests it may be embedded in the disk material, contributing to the dynamical shaping of the inner disk.

• The accreting spiral suggests hot gas flows inward to the inner disk around the star. It could explain the mass transfer mechanism of the system and complements the observations of cold gas in the literature. With hints of co-rotation with B, it provides a direct connection between companion dynamics and disk morphology.

• Future observations are indispensable to confirm the CC's nature, clarify the accretion processes and the role of the companion(s) in the system's dynamics and structure.

## IMAGE RECONSTRUCTION

• **A candidate companion (CC):** Apart from the known companion HD 142527 B, there is an additional red point-like feature across all the NIR images. If the CC is indeed a companion, it is likely embedded in opaque dust, making it challenging to detect at visible wavelengths. Nevertheless, with given information, it cannot be ruled out that it could be a disk clump.

• **An H $\alpha$  spiral:** Line H $\alpha$  images shows a spiral-like extended feature that appears to evolve with time, both in morphology and in intensity.

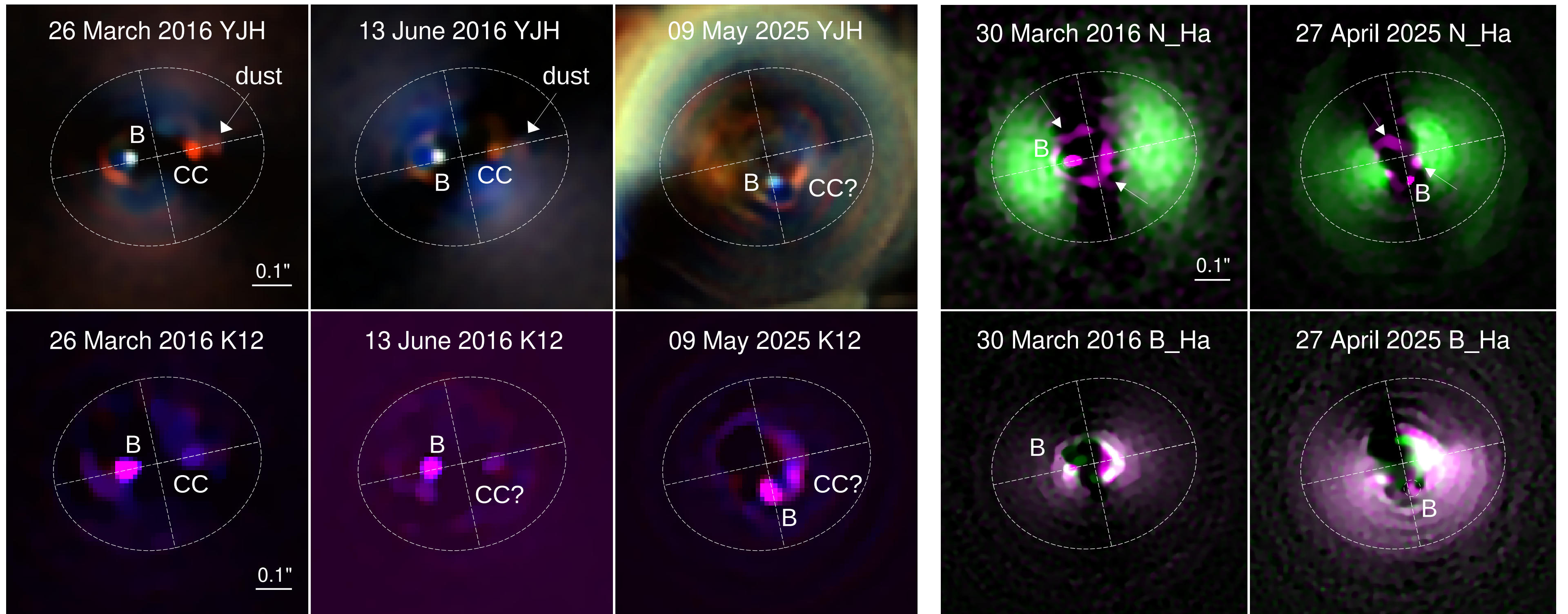


Figure 1: Deconvolved reconstructed images using IFS, IRDIS (left) and using ZIMPOL (right). Intensity scales of images are only comparable across different epochs of the same observing filters.

## IS CC A POINT SOURCE?

• **Photometry:** CC shows average contrast of  $\sim 1 \times 10^{-4}$  in YJH and  $\sim 5 \times 10^{-4}$  in K1–K2 bands. Even with extinction and reddening taken into account, the red color of CC remains excessive compared to known companions and evolutionary models.

• **Astrometry:** The few data points hinders a conclusive common proper motion confirmation. Only if the 2025 red signal was CC, its gravitational link to the central star could be proved.

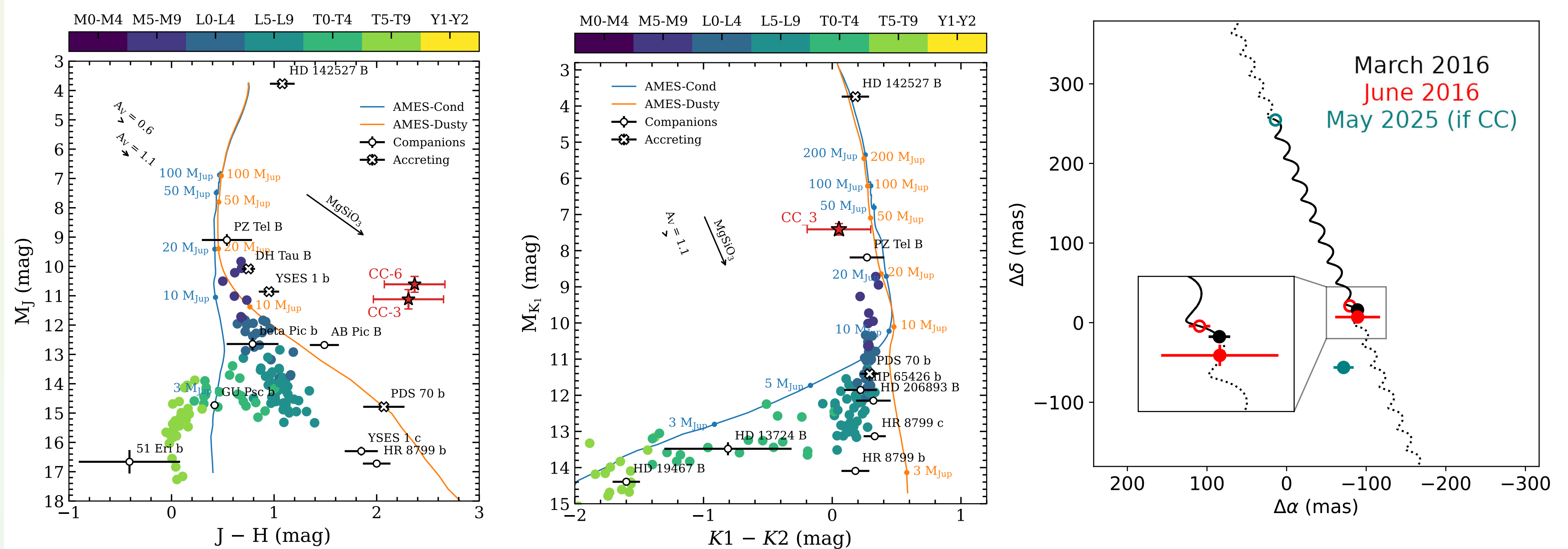


Figure 2: Left and middle: Color-magnitude diagrams of CC. "CC\_3" and "CC\_6" mark the position of CC within  $3\sigma$  errors in March and June 2016. Right: Astrometry displacements of CC relative to the star.

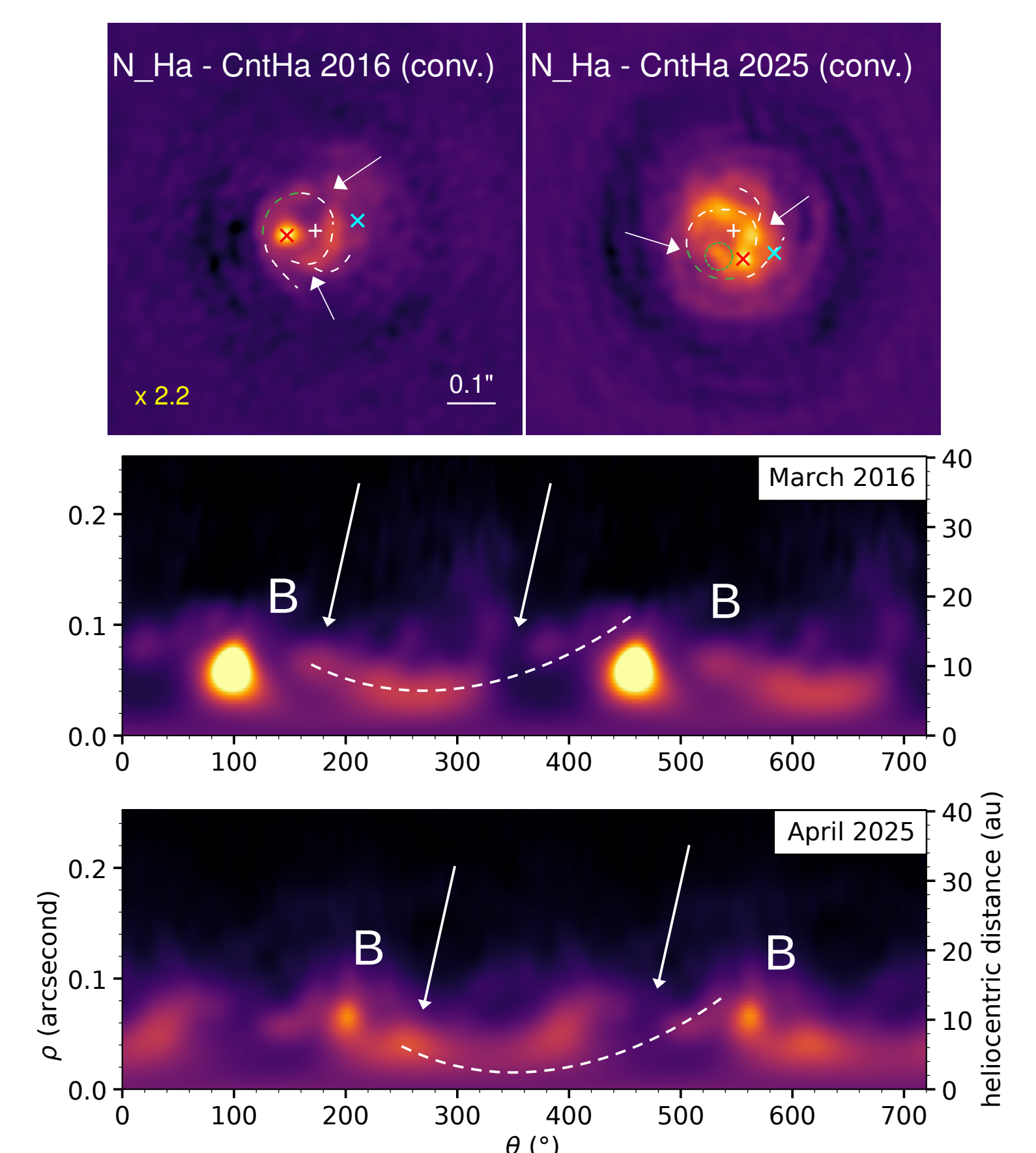
## THE H $\alpha$ ACCRETION FLOWS

• We detect a spiral-like feature in the immediate vicinity of HD 142527 in narrowband H $\alpha$ . As H $\alpha$  traces hot, ionized gas, we interpret this spiral as accretion streams at the shock front. The central star has been observed with high, variable accretion rates (Lopez et al. 2006; Mendigutía et al. 2014).

• The spiral shows hints of co-rotation with B, which has made a motion of  $\sim 260^\circ$  counterclockwise, providing evidence of the spiral being linked to B. However, it is unclear if CC shares a co-rotation with the spiral.

• The B-CC interactions could also link with the non-Keplerian kinematics near the central star observed with ALMA, suggesting either fast radial flows or a warped disk (Perez et al. 2014; Rosenfeld et al. 2014; Casassus et al. 2015; Garg et al. 2021).

Figure 3: Top: ZIMPOL H $\alpha$  line reconstructed distribution of HD 142527 (continuum-subtracted narrowband images), reconvolved with the instrument's PSF. CC and the suspected 2025 signal are marked by cyan  $\times$ . Annotations represents faint features that possibly co-rotate with B (white: found in both epochs; green: found in one epoch only). Middle and bottom: Top panels deprojected to separation/position angle.



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