# Searching for accreting protoplanets in transitional disks:
## SPHERE/ZIMPOL observations

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**The project:** When planets formed, they are surrounded by circumplanetary disks (CPDs). Different theories predict that magnetospheric accretion can occur from the CPD onto the planet. **We aim at detecting accreting protoplanets within the gaps of transitional disks, using the $H_\alpha$ emission line as an accretion tracer**. To achieve our goals, we have performed spectral angular differential imaging (ASDI) observations with SPHERE/ZIMPOL at the VLT. In this poster, we show our results for two transitional objects: the Herbig Ae star **MWC758**, and the T Tauri star **RXJ1615.3-3255**.

## MWC758

(Huélamo et al. 2018)

L'-band | SPHERE/ZIMPOL optical images

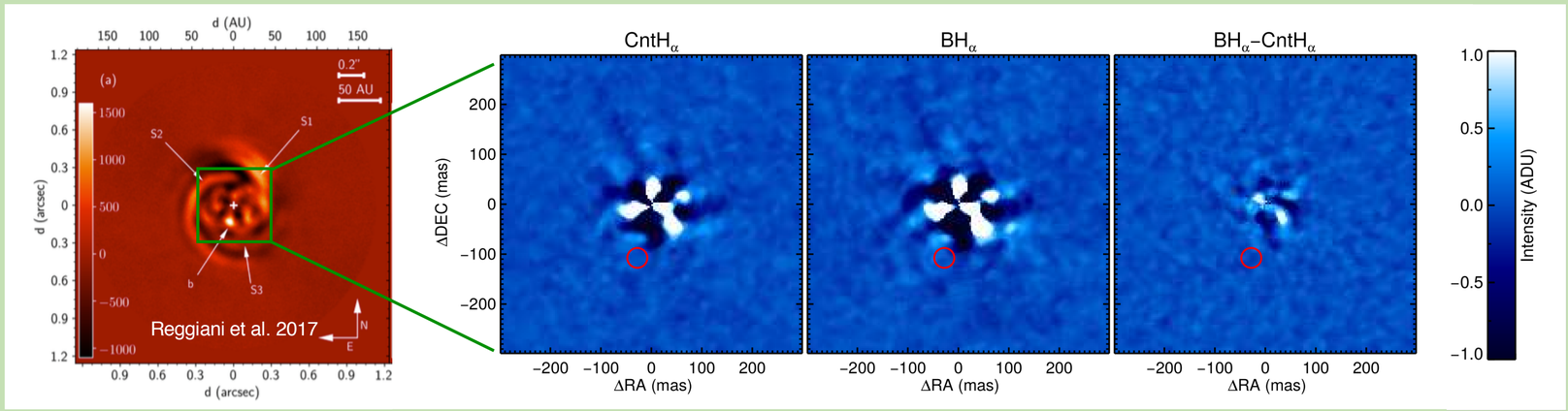


**Figure 1 – Left:** L'-band image of MWC758 from Reggiani et al. 2017. The spiral arms in the disk (S1, S2 and S3), together with the protoplanet candidate (b), are marked. **Right:** SPHERE/ZIMPOL images of MWC758 in two individual filters centered in the $H_\alpha$ line (BHa) and the adjacent continuum (ContHa), and the differential image (BHa-ContHa). The red circle shows the position of the L' source detected by Reggiani et al. 2017.

Contrast curves

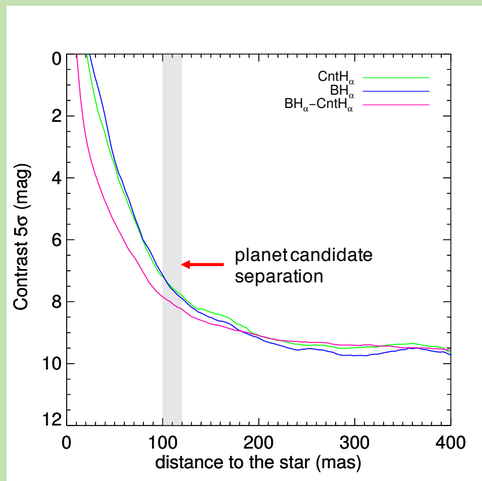


**Figure 2:** SPHERE/ZIMPOL 5σ contrast curves obtained in CntHa, BHa in ADI, and in BHa-CntHa in ASDI. The grey area shows the separation of the companion candidate detected in L'.

**MWC758:** This Herbig Ae star is surrounded by a disk with several spiral arms. Reggiani et al. (2017) reported the detection in the L'-band of a planet companion candidate at 111 mas (see Fig. 1, left). We do not detect it in the SPHERE/ZIMPOL images. Note that we reach a contrast of ~8 mag at 111 mas (see Fig. 2) in the ASDI image.

Considering the $H_\alpha$ flux of the primary, and the BHa contrast curve, we can estimate the line luminosity ($L_{H\alpha}$) and the accretion luminosity ($L_{acc}$) at 111 mas (see Table 1). For the predicted mass range of the planet candidate, 0.5-5$M_{Jup}$, we have also derived the accretion rates for an average radius of 1.1 $R_{jup}$ (Table 1).

If the L' detection is indeed related to a planet, our non-detection is consistent either with a planet that accretes at a lower rate than our ZIMPOL limits, or with a planet displaying episodic (variable) accretion.

**Table 1:** SPHERE/ZIMPOL BHa contrast, and upper limits to the Hα line luminosity and accretion luminosity ($L_{acc}$), at a separation of 111 mas. We also show the estimated accretion rates ($M_{acc}$) for a 0.5-5 $M_{Jup}$ planet with 1.1 $R_{Jup}$ radius.

| Separation (mas/au*) | Contrast BHa (mag) | log $L_{H\alpha}$ ($L_\odot$) | log $L_{acc}$ ($L_\odot$) | log $M_{acc}$ ($M_\odot$) |
|---|---|---|---|---|
| 111 / 17 | 7.6 | < -4.3 | < -3.4 | < -7.5 (0.5 $M_{Jup}$)<br>< -8.5 (1 $M_{Jup}$) |

* distance ~ 151 pc (GAIA DR2)

## RXJ1615.3-3255

(Huélamo et al., in prep.)

H-band | SPHERE/ZIMPOL optical images | Contrast curves

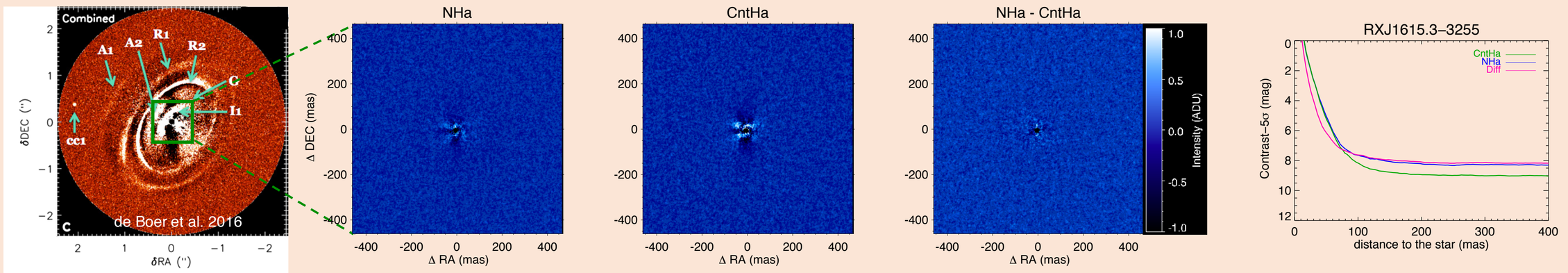


**Figure 3 – Left:** SPHERE/IRDIS H-band image of RXJ1615 from de Boer et al. 2016, where several rings (R) and arcs (A), a gap (G), and an internal disk (I1) are detected. **Right:** SPHERE/ZIMPOL images of RXJ1615 in two individual filters (NHa & CntHa) and the difference image (NHa-CntHa).

**Figure 4:** SPHERE/ZIMPOL 5σ contrast curves obtained in the two individual filters NHa and CntHa in ADI, and in the NHa-CntHa difference in ASDI. Preliminary curves obtained using Classical ADI.

**RXJ1615.3-3255:** This T Tauri star (TTS) has been imaged by SPHERE/IRDIS in the near-IR (de Boer et al. 2016, Figure 3, left), and shows a disk with several structures: arcs, rings and a clear gap at 0.5 arcsec (79 au@158 pc). Our ZIMPOL ASDI dataset does not show any source within a 1" radius from the central star. Note that our preliminary analysis shows a contrast of 6 mag at 50 mas (8 au) in the ASDI image, and 8 mag at 200 mas (32 au) using classical ADI (cADI).

Taking into account the $H_\alpha$ line flux of the primary (measured in a spectrum) and the 5-σ contrast curve in the NHa filter, we can estimate the expected $H_\alpha$ line luminosity at different separations from the star (log $L_{H\alpha}$, see Table 2). If we assume that $L_{Ha}$ scales with the accretion luminosity as in Classical TTSs, we can also derive $L_{acc}$. For a 1 $M_{Jup}$ giant planet with 1 $R_{Jup}$ radius, we provide the upper limits to the accretion rates (log $M_{acc}$, Table 2).

**Table 2:** SPHERE/ZIMPOL $H_\alpha$ contrast, line and accretion luminosity at different separations from the star. We have also estimated the accretion rates ($M_{acc}$) for a 1 $M_{Jup}$ planet with 1 $R_{Jup}$ radius.

| Separation (mas/au*) | Contrast NHa (mag) | log $L_{H\alpha}$ ($L_\odot$) | log $L_{acc}$ ($L_\odot$) | log $M_{acc}$ ($M_\odot$) |
|---|---|---|---|---|
| 50 / 8 | 5.0 | -5.0 | -4.0 | -8.4 |
| 100 / 16 | 7.6 | -6.1 | -5.3 | -9.7 |
| 200 / 32 | 8.2 | -6.3 | -5.6 | -10.0 |

* distance ~ 158 pc (GAIA DR2)

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