Image synthesis of HD100546 using SAM data at NACO/VLT

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Introduction

HD100546 is a system of a Herbig Ae/Be star surrounded by a circumstellar disk. From the spectral energy distribution (SED) and line profiles observations and modeling, is expected that the disk has a zone with a decrement of the gas and dust density, what is called **gap**. The existence of this gap is probably due to **planet formation** and it has not been observed in optical images yet.
We report on observations at 3.81 μm of HD100546, obtained with NACO/VLT Sparse Aperture Masking. The data was reduced by Sylvestre Lacour. We performed different image synthesis methods detecting apparently the gap in the disk.

About HD100546

- The star
  - Young star (5-10 Myr).
  - 2.4 $\mathrm{M}_{\odot}$.
  - Herbig Ae/Be star.
  - 97 pc from the Sun.
- The disk
  - Inclination of $\sim$51°.
  - Inner disk: $\sim$0.2-0.7 AU.
  - Gap: $\sim$0.7-13 AU.
  - Outer disk: 13-$\sim$380 AU.

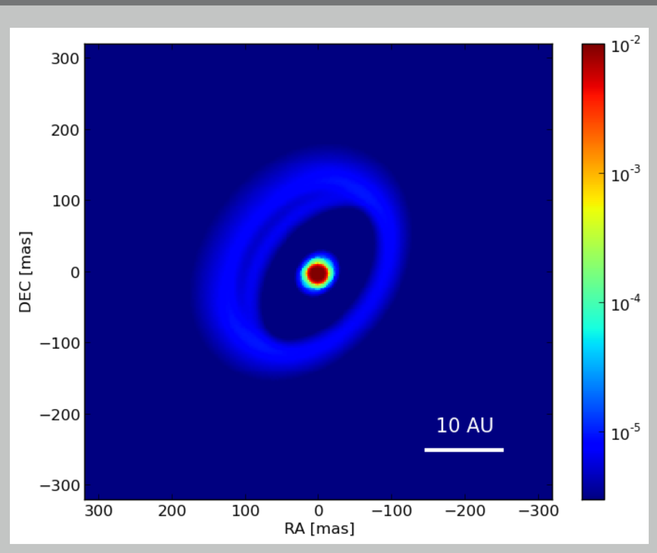

Figure 1: Model image.

Dynamical evidence of a massive planet based on asymmetries in lines profile, also supported by spiral arms seen on images. In figure 1 it is presented a model image made by Christophe Pinte using MCFOST based on SED observations.

Optical Interferometry

Two main issues appear when trying to reconstruct an image:

- Sparseness of the **u** — **v** coverage: non unique solution (image).
- Atmospheric turbulence contamination of the complex gain: Phase calibration becomes an impossible task.

To avoid this problem, we used the *powerspectrum* (eq. 2) to recover information of the modulus of the visibilities and *closure phases* (eq.3) to recover information about the phases. Both quantities remove the atmospheric effects on the data.

$$\mathbf{V}_{j_1j_2} = |\mathbf{V}_{j_1j_2}|\mathbf{e}^{i\varphi_{j_1j_2}} \quad (1)$$

$$\mathbf{S}_{j_1j_2} = |\mathbf{V}_{j_1j_2}|^2 \quad (2)$$

$$\beta_{j_2j_3} = \mathbf{arc}(\varphi_{j_1j_2} + \varphi_{j_2j_3} + \varphi_{j_3j_1}) \quad (3)$$

Sparse Aperture Masking data

- NACO/VLT
- 3.81 μm
- Max baseline: 6.4 m
- Min baseline: 1.8 m
- 126 Baselines
- 126 *Powerspectrum* measurements
- 210 *Closure phases* measurements

Methods

- We fitted a basis of the Zernike polynomials in the **u** — **v** plane to the *powerspectrum* and the phases to reconstruct the visibilities and then create a image.
- We used a software for image reconstruction for optical interferometric data named **MIRA** written by Éric Thiébaut.

Zernike polynomials fit results

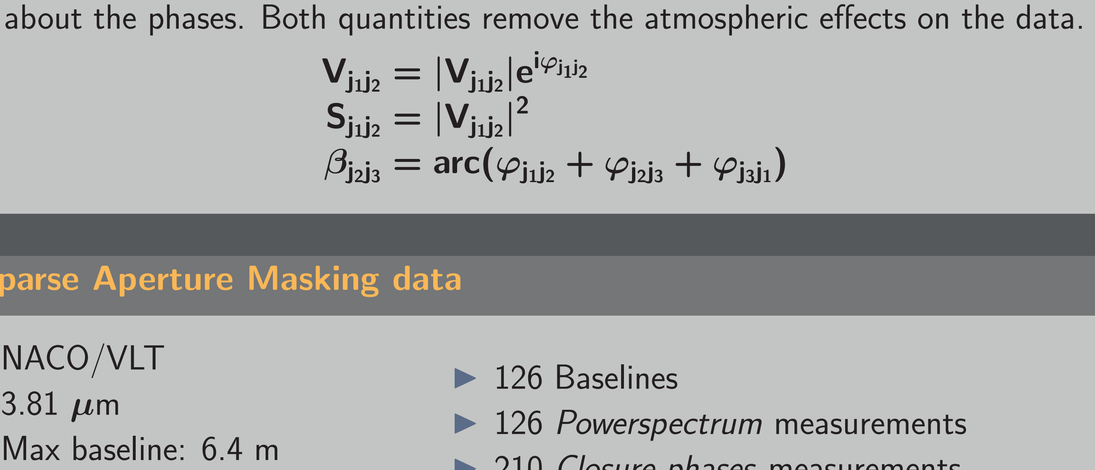

Figure 2: Results of the fit. In the left panel is presented the *powerspectrum* and in the right panel are the phases of the visibilities. The blue dots represent the places in which we have data.

Zernike final image

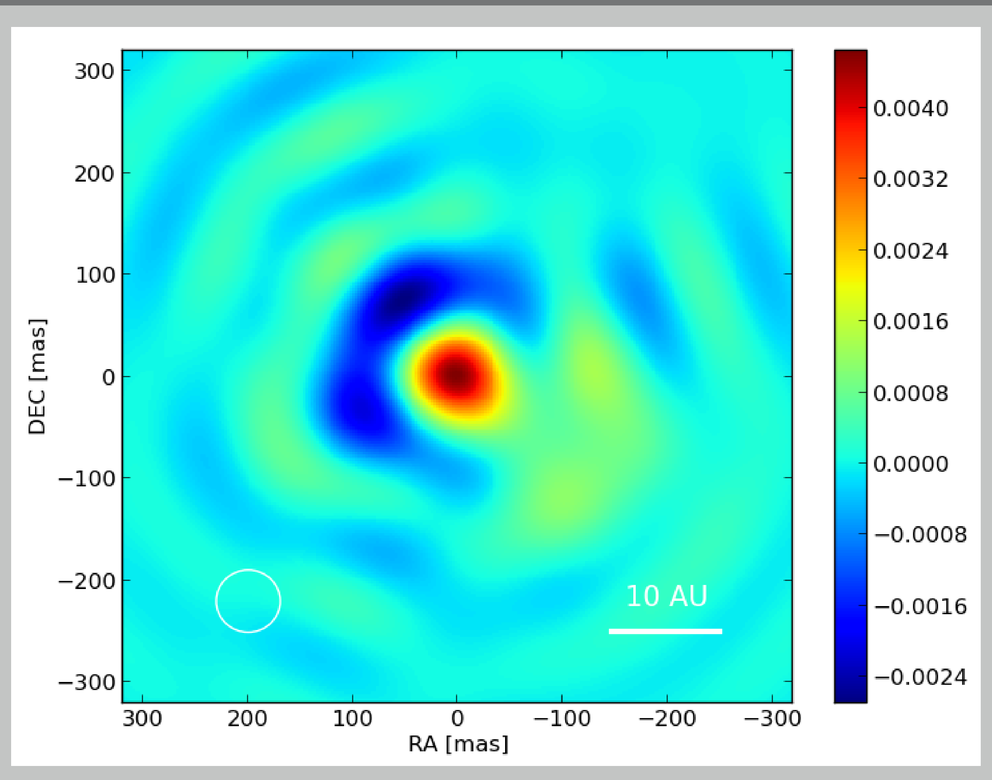

Figure 3: Image reconstructed after fitting the Zernike polynomials.

MIRA results

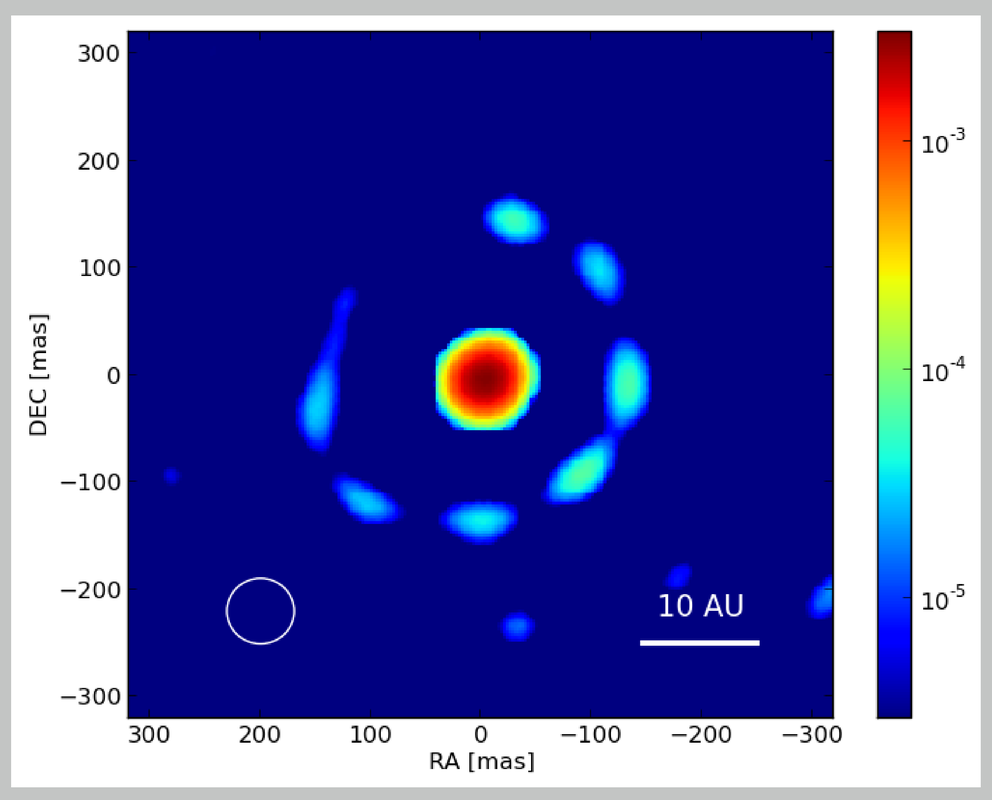

Figure 4: Results using MIRA.

Conclusion

- Using MIRA **apparently we detected the gap** (figure 4). It require more analysis.
- Fitting the Zernike polynomials we obtained a non-axisymmetric image which fits with the expected orientation of the disk (figure 3). We obtained negatives values at a radius $\sim$10 AU. That may be produced by the effect of the gap in the visibilities.
- To improve the Zernike polynomial's method is necessary to impose non negativity, include a regularization term in the fitting process and maybe change the basis.
- Another alternative method to explore is to fit a parametric model of the disk with a gap.

References

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