Supergiants and AGB stars at high angular resolution

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RSGs and AGBs

- Red supergiants and asymptotic giant branch stars experience intense mass loss
- Extraction of material from the star, formation of molecules and dust are complex
- High angular resolution techniques now resolve the key spatial scales for nearby stars
- Examples of recent results on Betelgeuse and L2 Pup (+ see other presentations !)
ZIMPOL (0.5-0.7 µm) 2015

ZIMPOL Hα 2015

NACO (1.0-2.2 µm) 2009


ZIMPOL pL NR 2015

Dust shell


VISIR (2011) 8 - 20 µm

Silicates(?)

10 km/s

40 km/s

Dust shell

VISIR (2011) 8 - 20 µm

L2 Puppis

- M5III, SRa (Mira-like) star with $P=141$ d
- Mass: from 0.7 Msun (Lykou et al. 2015) up to 2 Msun (Kervella et al. 2014)
- Suspected binary star from Hipparcos astrometric wobble
- Second nearest AGB star (64 ± 4 pc, $m_V \sim 5$) after R Doradus (~55 pc)
- Long term, slow dimming event ongoing since 15 years (Bedding et al. 2002)
K14 was constructed based on di-observed data and the model is good, given that the model of the RT model of K14. The overall agreement between the phases at the to our observations, we computed the visibilities and closure phases and the observed disk model of K14, we compared the measured interferometric observables—visibilities and closure phases—and the observed quantitatively consistent with the 2-D radiative transfer (RT) model at 2.17 µm. Montarges kindly provided the best-fit model of their paper.

To examine whether our aperture-synthesis image of L4. Discussion

CO bands. Therefore, the analysis of the AMBER data in the CO bands will be presented in a separate, forthcoming paper.

Our AMBER data cover the wavelength region of the CO first overtone bands. However, the speckle data were taken only in the continuum at 2.27 µm, not in the CO bands. This makes the image reconstruction more difficult, if not impossible, in the

antarctic. Our combined aperture-synthesis image is qualitatively consistent with the disk model of K14. They also found out that the disk corresponds to the equatorial dust lane of the disk. At the distance of 64 pc (from the edge-on disk and the half-obscured central star due to the obscuration of the southern half of the central star by the edge-

Pup started a dimming event between our AMBER and NACO observations (December 2011 and March 2012) and the NACO observations of K14 (March 2013). It is possible that the flux contribution of the disk consists of (3 × 10^−6) of the central star, while

Pup reconstructed from the NACO speckle data alone.

AMBER–NACO aperture-synthesis image directly shows both the rim of the disk and was invisible at the time of our AMBER and ZIMPOL instrument. However, we do not see a signature of the companion in the AMBER imagery. In the convolved image of the RT model, the closure phase at long baselines, at spatial frequencies of (7 × 10^−1 rad), explains that the model visibilities are higher than the observed visibilities or closure phase. Or the companion might have been that the companion is too faint at 2.2 µm, not in the CO bands. This makes

spatial frequencies of (7 × 10^−1 rad).

Ohnaka et al.: AMBER-NACO imaging of the half-obscured central star and the edge-on disk of L2–2.4 µm interferometric data of L32+6 AU. This can be the reason for the disagreements. Also, while they adopted an axisymmetric model, their

component (or that of the central star) was smaller (or larger) at the different data. The model image differs from our observations. Kervella et al. (2015) have found a companion at a different position at the time of our observations. Kervella et al. (2014, A&A, 564, A88) estimated the orbital period to be 1.4–4.6 years. It is possible that the companion is too faint at 2.2 µm convolved with the beam of our NACO

spatial coverage is too sparse in the E-W direction, and therefore, we can be that the companion is too faint at 2.2 µm, and March 2012. The disk model by the adaptive optics of Ohnaka et al. 2015, A&A, submitted

VLTI/VINCI instrument are better fitted with an ellipse with an axis ratio of 1.5 with the major axis at a position angle 106° (i.e., nearly in the E-W direction). This is naturally explained by the direction (note, however, that the elongated appearance of the

northern half of the central star in Fig. 2b is simply due to the orientation of the elongated beam, which is shown in the figure).
0.65 µm (SPHERE/ZIMPOL)
Kervella et al. 2015, A&A, 578, A77
Degree of linear polarization

N\textsubscript{R} band (646 nm)

N\textsubscript{R} band p\textsubscript{L}

Kervella et al. 2015, A&A, 578, A77
L2 Pup evolution

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• What creates the plumes?
• How does the AGB wind interact with the disk?
• How do the streamers form?
• What is the nature of the companion? Is it real?