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High spatial resolution observations of OH 231.8+4.2

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Abstract. We have observed the bipolar post-AGB candidate OH 231.8+4.2, using the mid-infrared interferometer MIDI and the infrared camera with the adaptive optics system NACO on the Very Large Telescope. The NACO images at 2.12 and 3.8 μm show a bipolar outflow and a flared disk or torus. An unresolved core (<200 mas in FWHM) is found at the centre of OH 231.8+4.2 in the 3.8 μm image. This compact source is resolved with the interferometer. The fringes from the four baselines consistently show the presence of a compact circumstellar material with an inner radius of 30–40 mas, which is equivalent to 40–50 AU at 1.3 kpc. This clearly shows that the mid-infrared compact source is not the central star (3 AU) but circumstellar material.

Keywords. stars: AGB and post-AGB, (stars:) circumstellar matter, infrared: stars, infrared: ISM, stars: imaging stars: mass loss

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Among post-AGB stars and planetary nebulae, a high fraction of stars show asymmetric circumstellar envelopes, while typical AGB winds are spherical symmetric. The most extreme shape of a nebula is a bipolar one. One of the hypotheses about the formation of the bipolar shape invokes a binary-disk scenario (Balick & Adams 2002). Part of the material lost during the intensive AGB wind is trapped in the binary system, and a disk is formed around the companion or around the binary system. The disk restricts the (low density but high velocity) post-AGB and PN wind in the equatorial plane, and focusses the wind towards the two poles.

OH 231.8+4.2 (hereafter OH 231) is the best-known bipolar post-AGB candidate. It is probably associated with the open cluster, M 46 (Jura & Morris 1985), so that its distance is relatively well determined (1.3 kpc), and also the initial mass (about 3 $M_{\odot}$).

To search for evidence of a compact, constraining disk, we observed OH 231 with the Very Large Telescope (VLT), using both the infrared adaptive optics cameras NACO and the VLTI mid-infrared interferometre MIDI. MIDI was used on 2005 March 2nd, using the telescopes Melipal (UT3) and Yepun (UT4). We obtained four baselines with a difference of 21 degree position angle, and with a length range of 47–62 meters. NACO observations were obtained on 2004 March 6th. Narrow band (NB) 2.12 and L'-band filters are used, both measuring continuum emission. Details of the observations are described in Matsuura *et al.* (2006).

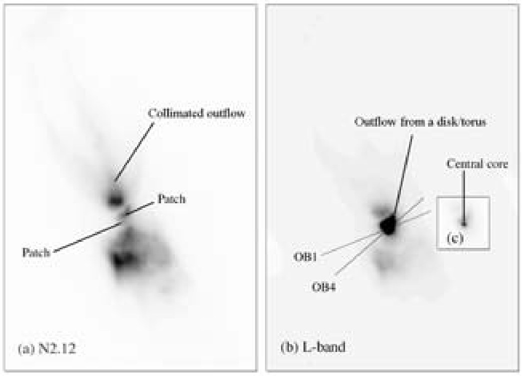

Figure 1. NACO 16.2×23.5 arcsec^2 images (a: NB-band and b: L'-band). Lines in image (b) show the approximate baseline position angle for MIDI observations (OB1 and OB4). Insert (c) shows the brightest region of L-band image in a different colour scale so as to clearly show the unresolved compact object inside. North is up and east is to the left.

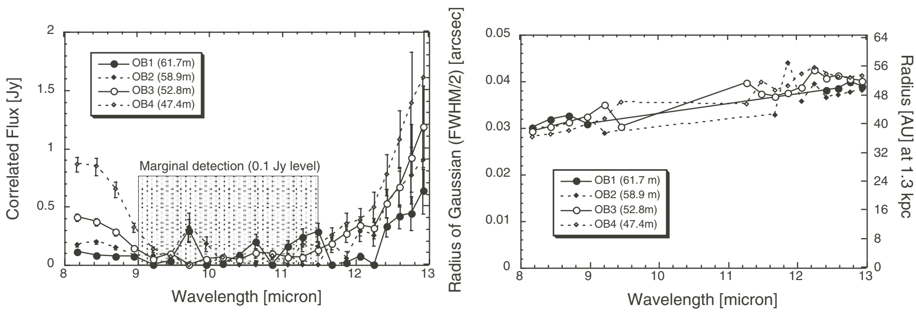

Figure 2. Left: correlated flux of the mid-infrared 'core' (unresolved source in NACO image). The vertical axis gives the radius needed to reproduce the visibilities.

Fig. 1 shows the NACO NB2.12 and L'-band images of OH 231. The central region is still obscured in the NB2.12 image and the bipolar outflow is brighter. On the other hand, in the L'-band the central region is brighter than the outflow. The central region has a very red color, indicating obscuration by a very high optical depth. There is an unresolved core in the centre of the L'-band image with a size $<$ 200 mas (FWHM).

This compact core produced fringes with the interferometer. The left panel in Fig. 2 shows the correlated flux obtained with the MIDI. The visibility data are interpreted assuming a smooth Gaussian profile, as described by Leinert *et al.* (2004). Fig. 2 shows the radii (HWHM) of the Gaussians which reproduce the observed visibilities. These are typically 30–40 mas. At the distance of 1.3 kpc, the radii are about 40–50 AU, as displayed on the right side of the y-axis in the right panel Fig. 2. The mid-infrared compact source is not the central star (3 AU) but is circumstellar. In Matsuura *et al.* (2006) we discuss the possibility that this represents the confining disk.

References

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