NAOS/CONICA Imaging of the Nebula Surrounding IRAS 17340−3757

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1 Introduction

During a program to discover new YSO candidates [1], we have serendipitously discovered IRAS 17340−3757 to be a hitherto unknown carbon star with unique properties. The central star is surrounded by a strikingly symmetric, bipolar, reflection nebula, visible at optical and near-infrared wavelengths. Mid-infrared imaging and spectroscopy show that the central point-source possesses a large infrared excess. Optical spectroscopy reveals the central source to be a highly reddened J-type (i.e. ^{13}C-rich) Carbon star. Curiously enough, we also observe O I in absorption in the optical spectrum of the central source [4].

The spectral energy distribution of IRAS 17340−3757 displays a strong infrared excess, with a pronounced 60 μm hump, reminiscent of O-rich protoplanetary nebulae such as Frosty Leo. SEST spectroscopy shows IRAS 17340−3757 to be the source of a very fast (v_s = 50 km s^{-1}; $\dot{M} > 1.2 \times 10^{-4}$ M$_\odot$ yr^{-1}) outflow. Both the existence of a prominent reflection nebula and the presence of such a strong outflow are highly unexpected, since one would expect the central carbon star to be on the AGB, but one would only expect to see the optically bright nebula after the star has become a protoplanetary nebula.

To shed further light on this peculiar system, we have obtained new Adaptive Optics (AO) near-infrared images of IRAS 17340−3757, for which we present the first results in these *proceedings*.

2 NAOS/CONICA Observations

We have used the NAOS/CONICA system on ESOs Very Large Telescope to obtain imaging of IRAS 17340−3757 in the J, H and K bands (Fig. 1). These new AO observations reveal a large ($\sim 10'' \times 30''$) nebula with a strikingly bipolar appearance. The south-eastern lobe of the nebula is distinctly brighter than the north-western lobe in all three near-infrared bands. Many bright knots and dark regions are visible in both lobes of the nebula, suggesting a very clumpy distribution of matter. More filamentary linear structures, similar to the streamers seen in some planetary nebulae, extend further from the central star and appear to trace the edges of the nebulosity.

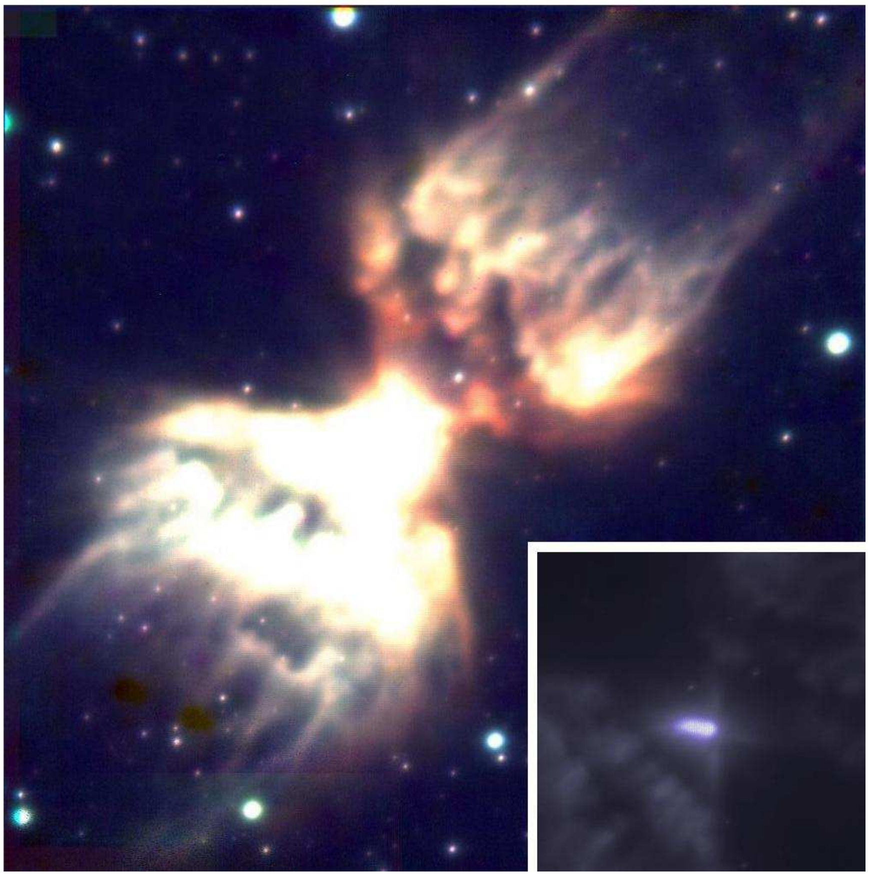

Fig. 1. Composite JHK image of IRAS 17340−3757 obtained with NAOS/CONICA. The total image scale is 27″, with north up, and east to the left. Intensities are scaled logarithmically in the main image. The insert (lower right corner) shows the central 5 × 5″ of the image, with a linear scaling of the intensities.

The morphology of the extensive nebulosity is compatible with that of two cones of material, perhaps moving away from the star. The near-infrared colours of the nebula show that this is a reflection rather than an emission nebula. The outer rim of both lobes appear brighter and can be seen at greater distance from the central source than the central parts of both lobes, suggesting an hourglass-like morphology.

Apart from exposing the structure of the bipolar nebula, the new AO observations have for the first time revealed the structure of the central few arcseconds of IRAS 17340−3757. The central source is no longer a point-source, but shows a linear morphology of $\sim 1.0'' \times 0.2''$. Two linear structures appear to be associated with this compact central source, one parallel to it, and one perpendicular to it. Possibly what we are witnessing here is swept-up material from the strong wind emanating from the central source. Oddly enough, the compact central source does not appear to be centered on the intersection of the two linear structures, but appears offset from it by $\sim 0.5''$.

3 Conclusions

New AO imaging of IRAS 17340−3757 has revealed the structure of its nebula in unprecedented detail. The enhanced resolution offered by AO has allowed us to discover three important new morphological features that were not detected in previous seeing-limited images: (1) the central source is not a point-source, but has an extended, possibly disk- or torus-like, morphology, (2) this compact central source has two linear structures associated with it, possibly swept-up material from the strong stellar wind, and (3) the bipolar nebula shows many small bright “knots” of material; evidence for a highly non-uniform history of mass-loss in this system.

We have most likely detected a disk- or torus-like structure surrounding the central objects(s). If we assume that this structure, in which the central Carbon star is embedded, is oxygen-rich, this new observations explain the detection of O I absorption in the spectrum of the central star and also explain the tentative detection of water ice in the infrared energy distribution of the system. This suggests that IRAS 17340−3757 is related to the group of silicate carbon stars: J-type Carbon stars which show prominent silicate emission features in the infrared [5, 6]. In these systems it is believed that the dust disk is a remnant of a previous phase of mass-loss when the central star was O-rich. However, none of these stars is known to harbour an optically bright reflection nebula, making IRAS 17340−3757 unique.

We note that a binary nature may be essential to generate the non-spherically symmetric winds required to vacate the polar region to create bipolar nebulae around evolved stars (e.g. [2, 3]). Since the nebula surrounding IRAS 17340−3757 is clearly bipolar, this would suggest it to be the product of binary evolution. Further study of this enigmatic object may reveal whether this binarity is peculiar to IRAS 17340−3757, or whether this could be the key to understand the unusual properties of all silicate carbon stars.

References

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