IRAS12316−6401: a new symbiotic Mira?

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Summary. Current observations indicate that IRAS12316-6401 is a new addition to the rare class of resolved symbiotic Miras. There are tentative indications for the existence of a circumstellar or circumbinary disk and a jet aligned roughly with the line of sight. However, no direct evidence exists for the presence of a binary companion, which could be hidden due to strong dust obscuration. Future observations will be needed to confirm this classification.

Key words: Stars: winds, outflows — binaries: symbiotic — planetary nebulae: general — Stars: individual (IRAS12316−6401)

1 Introduction

In the past 15 years we have been searching for new obscured planetary nebulae (PNe) as well as post-AGB stars by selecting candidates from the IRAS Point Source Catalogue based on infrared colors typical of PNe. When we observed these candidates in the radio continuum at 6 cm, on average 20 % of the objects were detected ([3] and [4]). Subsequent optical spectroscopy showed that most of the PN candidates detected in the radio have emission line spectra typical of PNe ([5] and [6]). However, two objects showed spectra that are special. One of these objects, IRAS12316−6401, will be discussed in more detail in this paper.

2 Discussion

An Hα+[N II] image of the object obtained with EMMI on the NTT at ESO is shown in Fig. 1. The morphology is typical of bipolar PNe at low resolution: an elongated inner nebula surrounded by a spherical circumstellar shell. The Hα+[N II] image yielded a FWHM size of $1\farcs2\times1\farcs0$ at 30° PA ($0\farcs96$ FWHM seeing). The surrounding shell is much larger: $4\farcs6$ diameter in RA and $4\farcs5$ in DEC at 20% of the peak flux. The source was also detected in the radio at 6 cm using the ATCA; the flux was 14 mJy. The position of the source is RA = $12^{\rm h}\ 34^{\rm m}\ 36\fs063$, DEC = $-64°\ 18'\ 17\farcs20$ (J2000).

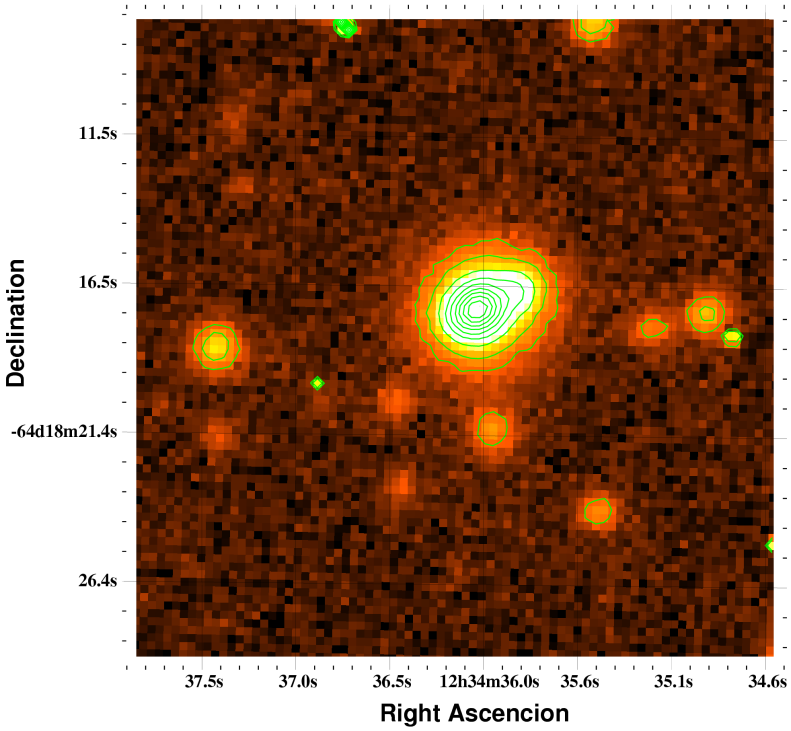

Fig. 1. The EMMI Hα+[N II] image of IRAS12316−6401 (shown on a square-root stretch).

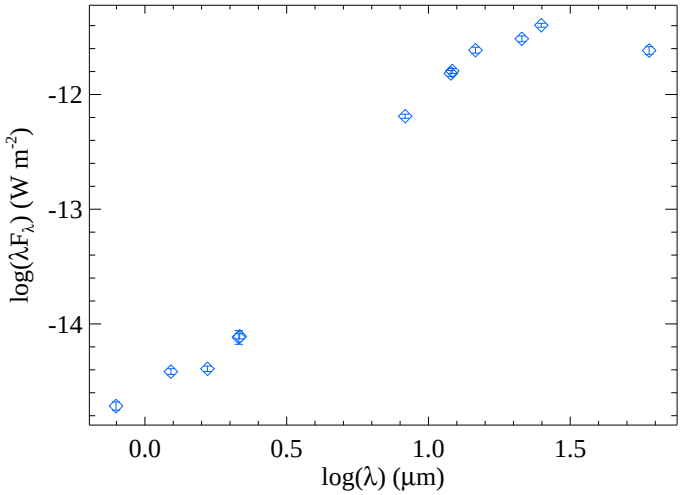

Fig. 2. The spectral energy distribution of IRAS12316−6401 (not corrected for reddening).

The evolutionary status of IRAS12316−6401 still needs to be determined. The infrared spectral energy distribution (SED) is shown in Fig. 2. From the IRAS and MSX photometry it is clear that it has an extended circumstellar envelope containing cool dust, which is typical for young PNe. The dereddened (I-J) and (J-K) colors are 0.56 mag and 1.70 mag, resp. (based on A_V=3.8 mag from the Balmer decrement). It places this object inconclusively between regular PNe and symbiotic Miras in the color-color diagram proposed by [1]. From inspection of the SED in Fig. 2 it appears that that the K-band emission is dominated by hot dust emission, which would argue in favor of the presence of a symbiotic binary system.

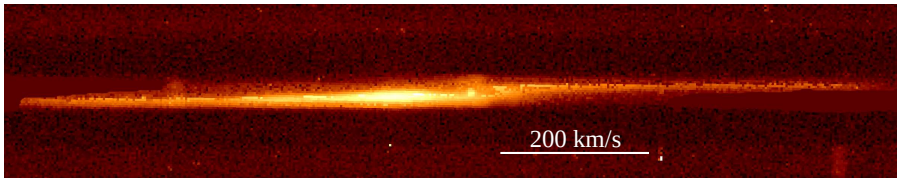

Fig. 3. The position-velocity diagram of the Hα line extracted form the raw spectral image. The neighboring [N II] lines have been erased for clarity. The image is on a logarithmic stretch. Wavelength increases from left to right. A small part of the source has been missed because the slit was too short, mostly at the top of the image.

In the optical high resolution echelle spectrum obtained with EMMI on the NTT, the Hα line shows evidence of a stellar wind which is clearly not spherically symmetric (see Fig. 3). It suggests that the system is driving a powerful jet approximately aligned with the line of sight. The spectrum shows broad emission lines with velocities up to 600 kms^{-1} (see Fig. 4). Such velocities are seen in [WC]-type PNe. However, such an identification is ruled out since we haven't detected any C III or C IV emission lines. This spectrum shows analogies with symbiotic stars and strongly bipolar PNe: H I profiles with extended wings, rich Fe II and [Fe II] emission, and strong [N II]. In normal PNe iron lines are faint and usually not observed, because this element is strongly depleted in dust. Hence these broad emission lines are likely formed in dust-free gas and not in the dusty circumstellar envelope, which expands more slowly as indicated by the CO expansion velocity of 25 kms^{-1}. The object shows the [Fe VII] 608.7 nm line with a sharp red edge, which is typical of symbiotic nebulae (see Fig. 5). There is no direct evidence of a binary system, since no red or yellow giant has been observed yet. This could be caused by strong dust obscuration in the optical. The He II 468.6 nm line was detected as well (Fig. 6). This indicates that the temperature of the white dwarf must be at least 60,000 K. The fact that the optical emission lines are not significantly obscured by dust implies that either we are looking down a dust-free jet or they are reflected by dust into the line of sight. The list of detected lines fairly closely follows that of the prototypical symbiotic star Z And and the observed velocities agree fairly well with those reported by [2]. However the spectrum doesn't show the Raman scattered O VI 682.5 nm line which is often observed in symbiotics. This could imply that the white dwarf has a relatively low stellar temperature ($<$ 100,000 K), and thus is still in an early post-AGB phase.

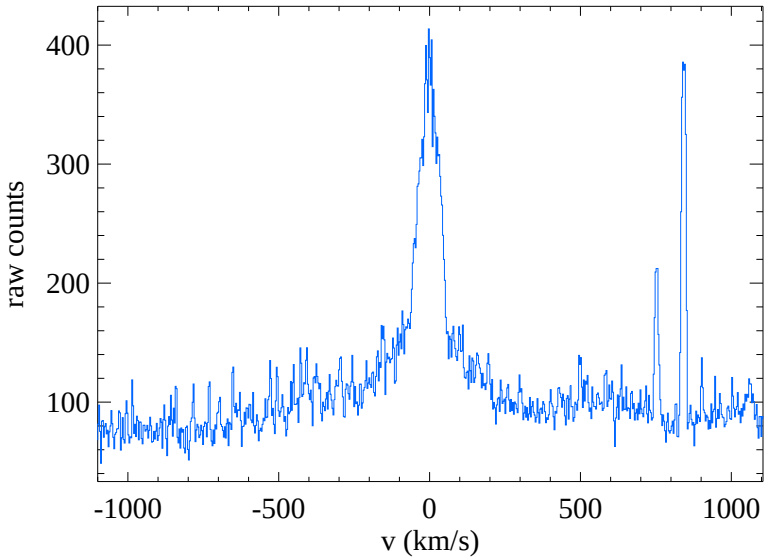

Fig. 4. EMMI echelle spectrum showing the He I 5876 Å emission line. The spectrum is not sky subtracted or flux calibrated. The base continuum is sky emission, not stellar continuum.

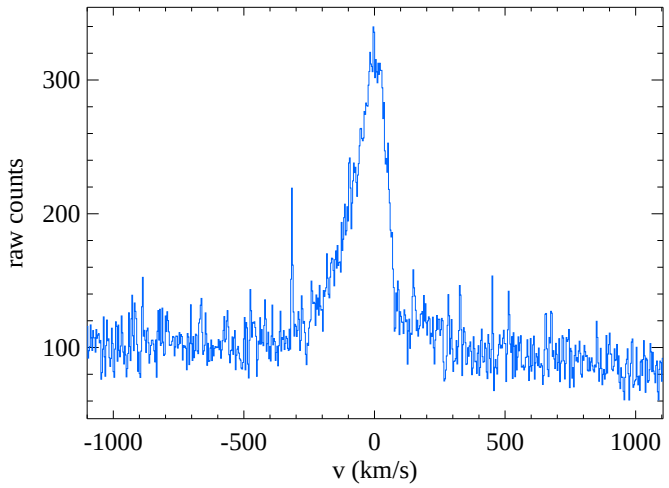

Fig. 5. As Fig. 4, but showing the [Fe VII] 6087 Å emission line.

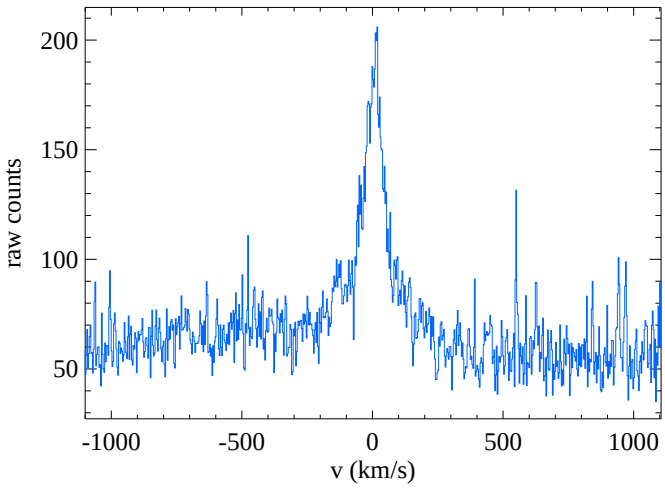

Fig. 6. As Fig. 4, but showing the He II 4686 Å emission line.

3 Conclusions

The evidence is pointing towards the fact that this object belongs to the rare class of resolved, symbiotic Miras. However, so far, the evidence is not conclusive. Only eight spatially resolved symbiotic Miras are currently known, so this object could be a valuable addition to this rare class.

References

1. S. Schmeja, S. Kimeswenger: A&A **377**, L18 (2001)
2. A. Skopal, A. A. Vittone, L. Errico, M. Otsuka, S. Tamura, M. Wolf, V. G. Elkin: A&A **453**, 279 (2006)
3. G. C. Van de Steene, S. R. Pottasch: A&A **274**, 895 (1993)
4. G. C. Van de Steene, S. R. Pottasch: A&A **299**, 238 (1995)
5. G. C. Van de Steene, G. H. Jacoby, S. R. Pottasch: A&AS **118**, 243 (1996a)
6. G. C. Van de Steene, K. C. Sahu, S. R. Pottasch: A&AS **120**, 111 (1996b)