

Research Note

DHW 1-2: a mislaid planetary nebula of peculiar morphology

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Received 3 July 1996 / Accepted 10 March 1997

Abstract. The planetary nebula (PN) candidate DHW 1-2 was found to be mistaken for the object K 2-8. On the Palomar Observatory Sky Survey DHW 2 shows a strange morphology and is accompanied by a strikingly blue star. We obtained both a spectrum and deep direct images in H_α + [NII] and [OIII] that prove DHW 1-2 to be a peculiar planetary nebula in its later stages of evolution.

Key words: ISM: planetary nebula; individual: DHW 1-2

1. Introduction

The object in question was discovered almost two decades ago (Dengel et al. 1979) and termed a planetary nebula candidate. From its appearance on the red-sensitive Palomar Observatory Sky Survey (POSS) alone it could, however, be easily mistaken for a galaxy, with a possible chance projection of a faint blue star a couple of arcsec eastwards of the object. Its morphology is striking: if indeed a PN, it is one of the few cases showing a quite pronounced asymmetry in surface brightness with respect to the central star.

At the very position of the object (DHW 1-2) (2000: $\alpha = 17^{\text{h}}06^{\text{m}}55^{\text{s}}$, $\delta = -09^{\circ}47'04''$) there is an entry in the wide-spread Catalogue of Galactic Planetary Nebulae (Acker et al. 1992; their tables 2 and 4), reading K 2-8. This compact object is in fact located at $\alpha = 17^{\text{h}}05^{\text{m}}30^{\text{s}}$, $\delta = -10^{\circ}05'42''$ (epoch: 2000; almost $0^{\circ}.5$ away from DHW 1-2) K 2-8 was originally suspected as a PN (Perek & Kohoutek 1967), but is, on the other hand, listed as an object rejected as a PN according to table 3 in Acker et al. (1992). According to the references given by SIMBAD it is not an IRAS source, nor has it been detected at 6 cm in the radio (Aaquist & Kwok 1990). A very faint source found by the abovementioned authors is off by about 3 arcmin. No detection is also reported in the IR by Kwok et al. (1986). Narrow-band images (Schwarz et al. 1992) show a point source

and Johnson & Jones (1991) suggest that it might be a red giant or an AGB-star based on their polarisation measurements. Acker et al. (1987) found no emission-line object. In conclusion we can state that K 2-8 exists but in all likelihood it is not a PN.

Due to this confuse situation, there was a danger that the intriguing nebula DHW 1-2, or PN G011.4+17.9 according to the recommendations of the IAU, will sink into oblivion. Indeed, very little is known about it: only one radio measurement at 6 cm is reported by Mross et al. (1981) and short exposure narrow-band images can be found in Schwarz et al. (1992). The other PN in Dengel et al. (1979), DHW 1-1 is PN G019.4–13.6; we hope that with this clarification of the nomenclature the names are unambiguous and the problem of identity is resolved for good.

2. Observations

In the course of a back-up program DHW 1-2 was observed with the ESO 3.6 m telescope by use of the EFOSC 1 instrument. On June 25, 1995, two direct narrow-band CCD images in H_α + [NII] (ESO filter # 691, bandwidth 60 Å) and [OIII] (# 686, 59 Å), of 10 min each, were obtained and reduced in the usual way; the spatial resolution is $0''.61/\text{pixel}$. A first optical spectrum was secured on June 27, 1995 at the observatory of the University of Padova located in Asiago. We observed with the 1.82 m Copernico telescope and a B&C spectrograph. A grating of 300 lines/mm (blazed at 5000 Å) was used, yielding a dispersion of 169 Å/mm corresponding to ca. 4 Å/pixel. The usable spectral range is 4700 to 6900 Å. A TH 7882 CCD camera (580 by 388 pixels, UV-coated) with a pixel size of 23 μm was used as detector. The slit width was 250 μm .

The exposure time was 1200 seconds. The spectrum was flux-calibrated using the standard star BD 26° 2606 from Oke and Gunn (1983). In addition to that, we obtained a higher resolution spectrum on April 8, 1996 with the 2.5 m duPont Telescope at Las Campanas Observatory, Chile. Operating the modular spectrograph with a 600 lines/mm grating (blazed at 7500 Å) in the second order we covered the spectral range from 6100 to 7100 Å in a 900 second exposure. Using the TEK 1

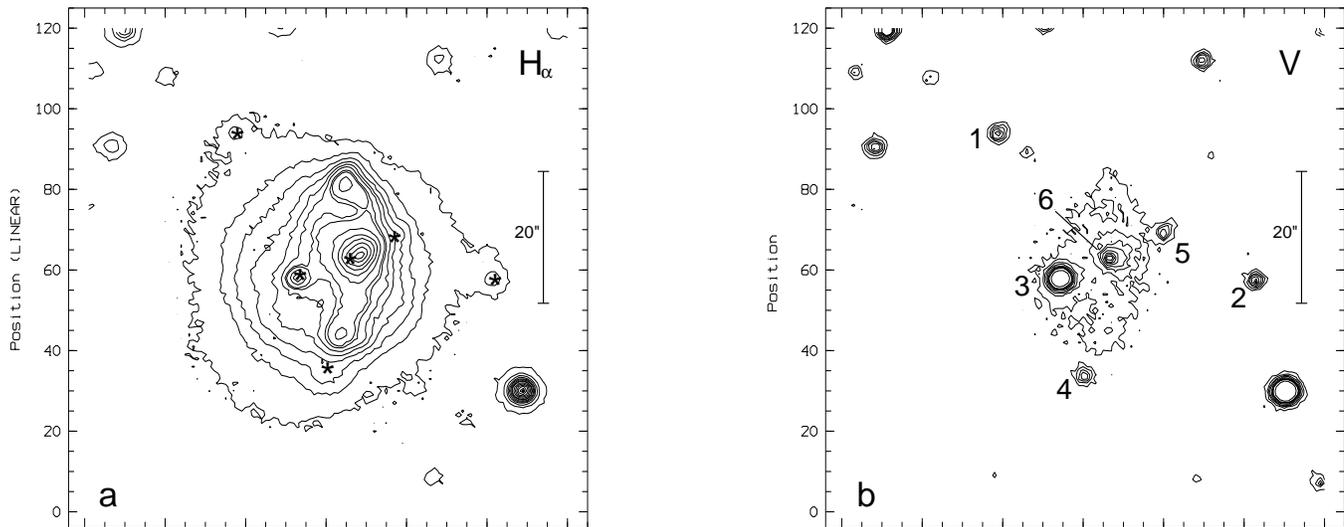


Fig. 1a and b. H_{α} and V-band images of DHW 1-2, North is to the top and East to the left.

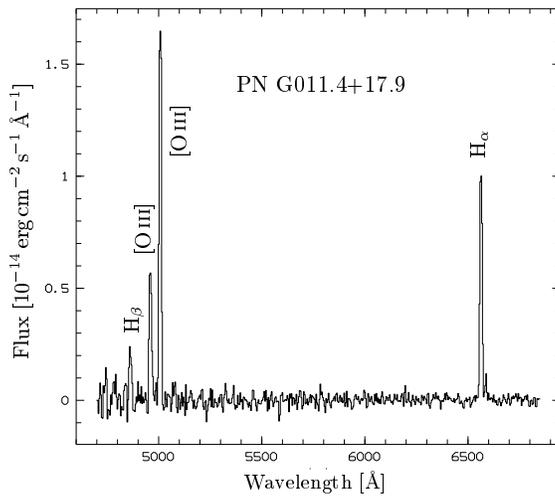


Fig. 2. Spectrum of DHW 1-2 taken at Asiago

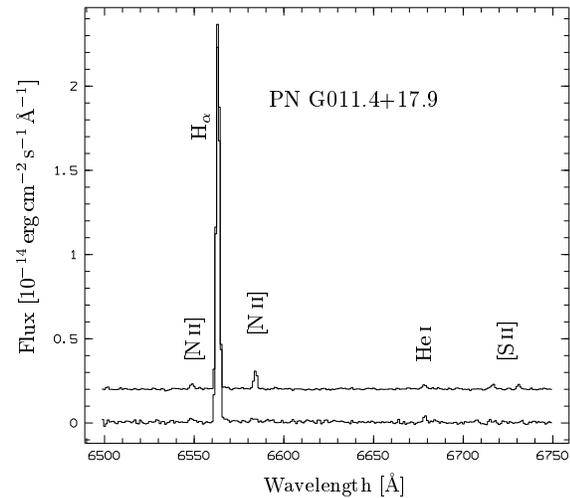


Fig. 3. Spectrum of DHW 1-2 taken at Las Campanas Observatory. Upper spectrum: central knot, only; lower spectrum: remainder of object

CCD detector (1024 by 1024 pixels of $24 \mu\text{m}$) the spectral resolution was about $1 \text{ \AA}/\text{pixel}$. The spectrum was flux-calibrated with the standard star CD-329927 taken from Hamuy et al. (1992, 1994).

3. Results and discussion

In Fig. 1 we present an H_{α} contour plot accompanied by a short (15 s) V-band image. The [OIII] is not shown, here, since it is virtually identical to the H_{α} image. The H_{α} image clearly shows a complicated knotty structure in the central part of the nebula surrounded by a symmetrical, somewhat elliptical main body which turns into a blunt parabola at low intensity levels. Comparison of the broad- and narrow-band images reveals a

number of stars superimposed upon the nebula. Their positions are indicated by asterisks in the H_{α} image. The two extensions at the western and north-eastern rim are both stars (1 and 2). Star 3, the brightest in the nebula is the central star (CS). The latter was quite recently studied by Saurer et al. (1997) who found $T_{\text{eff}} = 90\,000 \text{ K}$, $\log g = 5.0$, and $M = 0.75 M_{\odot}$.

At first glance it is apparent that this star is located considerably off center in E-W direction, with respect to the nebula. Using the second outermost contour (ca. 15 % above the background) as a reference we find that the star is located $11''.5$ pixels from the eastern rim and $20''$ from the western. This ratio of 1:1.75 is also found for the [OIII] image. Prominent in the H_{α} image are three knots with the middle one being the brightest.

There is also an extension of the middle knot forming a bridge to the CS. It is important to note that a faint red star (6) is located at the eastern edge of this knot. Its position does not coincide with the peak of the nebular emission, but is offset by $\approx 2''$. Its contribution to the narrow-band images is negligible but in the V image this star as well as star 5 can be clearly discerned; in both cases an extended nebulosity elongated to the NW is visible.

The spectra of DHW 1-2 (Figs. 1 and 2) reveal a nebula of medium excitation; from the ratio $[\text{OIII}](4959 \text{ \AA} + 5007 \text{ \AA})/10 \text{ H}\beta$ we derive an excitation class of 5 to 6 according to Aller's (1956) scheme. Using the Balmer decrement we find a logarithmic extinction coefficient $c(\text{H}\beta)$ of 0.6, a rather large value for a PN at a galactic latitude of 18° . Furthermore it's quite remarkable how little $[\text{NII}]$ emission is visible. In Fig. 3 it is obvious that the observed emission is concentrated in the central knot; the two spectra have been shifted by 0.2 for clarity. Note that the total intensity in $\text{H}\alpha$ is very similar for both spectra, therefore the emission of $[\text{NII}]$ and $[\text{SII}]$ is indeed enhanced in the central knot. The radial velocity $v_{hel} \approx 20 \text{ km s}^{-1}$. The lack of a redshift and of broad emission lines excludes the interpretation of the object as an emission-line galaxy, while the identification of the central star as a white dwarf argues against it being an H II region, making DHW 1-2 a genuine but very peculiar PN.

As mentioned above the main intention of this work was to save DHW 1-2 from getting lost in the literature. With the new data it is obvious that this object is much more complicated and interesting than anticipated. For example, we are confronted with a striking example of a decentrally located CS displaced from the geometric center of the nebula by about 25 % of a nebular radius. Decentral central stars are known in a number of PNe, e.g. A 21, Sh 2-216, Sh 2-188 and Sh 2-176, see Borkowski et al. (1990, Tweedy & Napiwotzki (1994) and Tweedy et al. (1995)). All these objects show a highly disturbed - often filamentary - structure and/or an asymmetric brightness distribution. In sharp contrast to this expectation the outline of DHW 1-2 remains basically symmetric out to the faintest contours which are at about 10 % above the background. Usually such a displacement is explained as a result of an interaction of the nebula with the ambient interstellar medium (ISM).

Further accurate measurements of the radial velocities of the CS and the structures in the nebula are needed, as well as high resolution imaging to clarify which stars - if any - are physically associated with the nebula; such observations may then lead to the identification of the mechanisms operating in this peculiar object.

Acknowledgements. We thank K. Werner and W. Saurer for communicating some of their results prior to publication. It is also a pleasure to express our gratitude to M. Roth, Director of the Las Campanas Observatory for his support. We gratefully acknowledge the financial support by the "Fonds zur Förderung der wissenschaftlichen Forschung"; project P10279-AST and a travel grant from the Austrian "Bundesministerium für Wissenschaft, Forschung und Kunst". This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France.

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