Astron. Astrophys. 323, 963–965 (1997)

ASTRONOMY
AND
ASTROPHYSICS

Research Note

New faint planetary nebulae in Centaurus/Musca

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Received 6 August 1996 / Accepted 20 January 1997

Abstract. Three new galactic planetary nebula candidates were discovered as a byproduct of a systematic search for galaxies in a 100 □° region around the nearby Circinus Galaxy. All candidates are very faint, close to the threshold of visibility on the ESO-R film copies. Optical spectra prove that the three sources are genuine planetaries. A short discussion of the spectra and the shapes of the nebulae is provided.

Key words: planetary nebulae: individual: WeKG 1, WeKG 2, WeKG 3 – planetary nebulae: general – surveys

1. Introduction

Planetary nebulae (PNe) are, for a long time, known as representing an inescapable bottleneck in late stellar evolution for stars of mass $M \leq 8 - 10M_{\odot}$. Quite recently, a number of the most evolved of them are recognized also as excellent probes of PNe-interstellar matter interactions (e.g., Borkowski et al. 1990, Xilouris et al. 1996). - Research on PNe has to face the pronounced heterogeneity of these objects, being both curse and boon; the notorious distance problem on the one side and the wealth of various physical conditions and morphologies on the other side are examples for that. It is not least this very variety which renders the detection of new galactic PNe still a fruitful concern.

The three PNe candidates discussed in this paper were detected on ESO-R film copies during a survey for galaxies in the zone-of-avoidance, in the area $306° \leq \ell \leq 316°$, $-5° \leq b \leq +5°$ (Weinberger 1996). In addition to 168 galaxy candidates, several hitherto unknown possible star clusters and nebulae were registered. A few of the nebulae were supposed to be PNe due to their shapes and colours.

The present paper is a further contribution to our rather long tradition of detecting and investigating new (evolved) planetary nebulae that started two decades ago (Weinberger 1977a, 1977b) and is quite living also most recently (e.g., Kerber & Weinberger 1995, Kerber et al. 1996, Kerber & Claeskens 1996).

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2. Observations

The three PNe have been observed in April 1996 with the 2.5-m duPont Telescope at Las Campanas Observatory, Chile. Operating the modular spectrograph we covered the spectral range from 4800 Å to 6800 Å. Using the TEK 1 CCD detector we obtained a spectral resolution of 2 Å/pixel. The exposure time was between 600 and 900 sec. The raw data were calibrated using the standard stars LTT 3218 and 3864 from the lists of Hamuy et al. (1992 and 1994). The resulting spectra are presented in Figs. 1 – 3.

3. Results and discussion

First, all three objects studied can be confirmed to be true PNe by virtue of their spectrum. Some basic data for the three new PNe is listed in Table 1. In the first column we give the common name, in the second the designation following the IAU recommendations outlined in the Strasbourg-ESO Catalogue of Planetary Nebulae (Acker et al. 1992). Columns 3 and 4 give equatorial coordinates, measured from the ESO/SERC films given in column 6, accurate to about 6 arcsec. The coordinates have been measured using a high resolution digitizer and software developed at the institute. In column 5 a diameter is given as measured on the ESO-R film. Columns 7 and 8 give x and y positions on the ESO-R films measured from the lower left corner of the field in mm.

All three objects are in an evolved state and no IRAS counterparts have been found. We will now shortly discuss the objects individually. In all images north is up and east to the left.

WeKG 1 is an elliptical PN of rather homogeneous brightness distribution in a dense stellar field as seen on the ESO-R film. At least two stars are superimposed on the nebula, none of which is the central star (CS). The spectrum (Fig. 1) reveals a PN of medium excitation, 4 to 5 according to Aller's (1956) scheme. From the Balmer decrement we find considerable interstellar reddening, c = 1.0 as is not unexpected for the low galactic latitude of the object. The ratio of the [SII] doublet yields a density of $< 300\ \mathrm{cm}^{-3}$ clearly showing that the object is in an advanced stage of evolution.

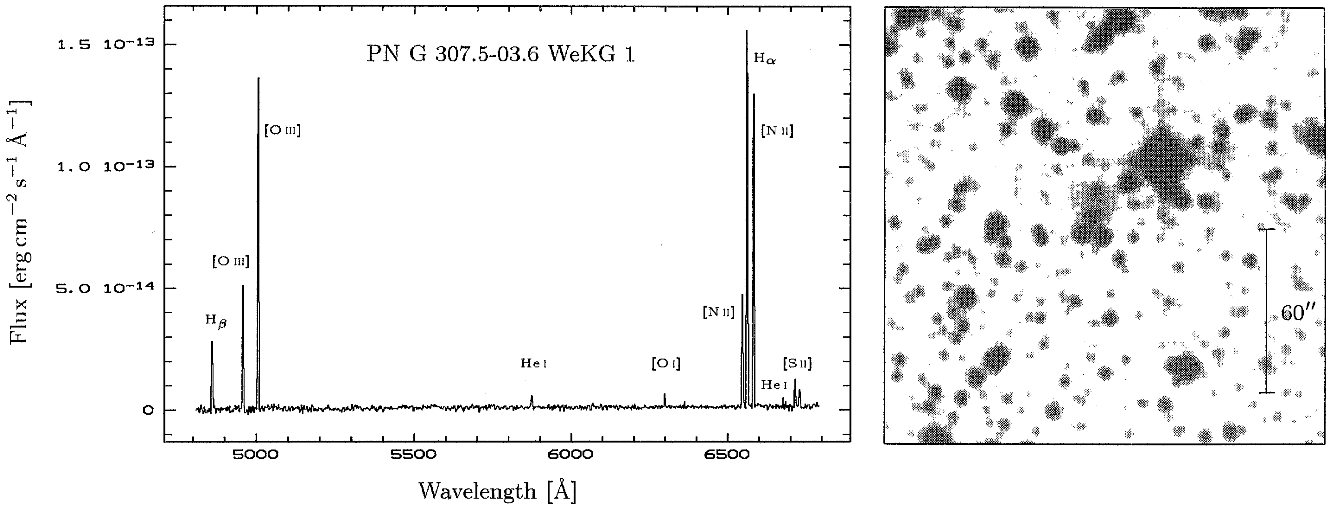

Fig. 1. Spectrum and ESO R-image for WeKG 1, PN G307.5−03.6

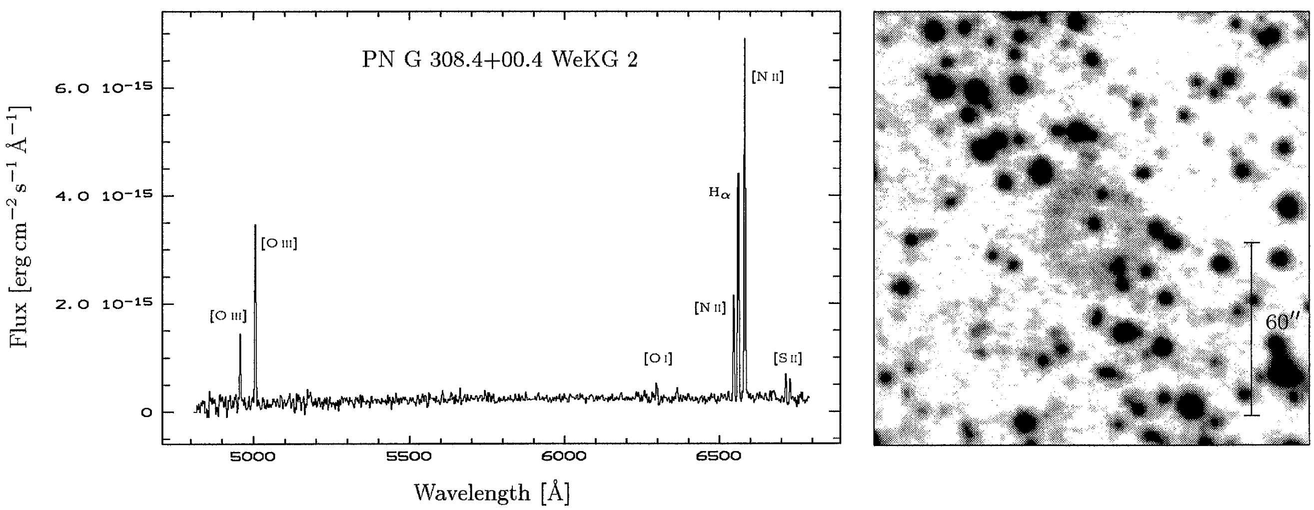

Fig. 2. Spectrum and ESO R-image for WeKG 2, PN G308.4+00.4

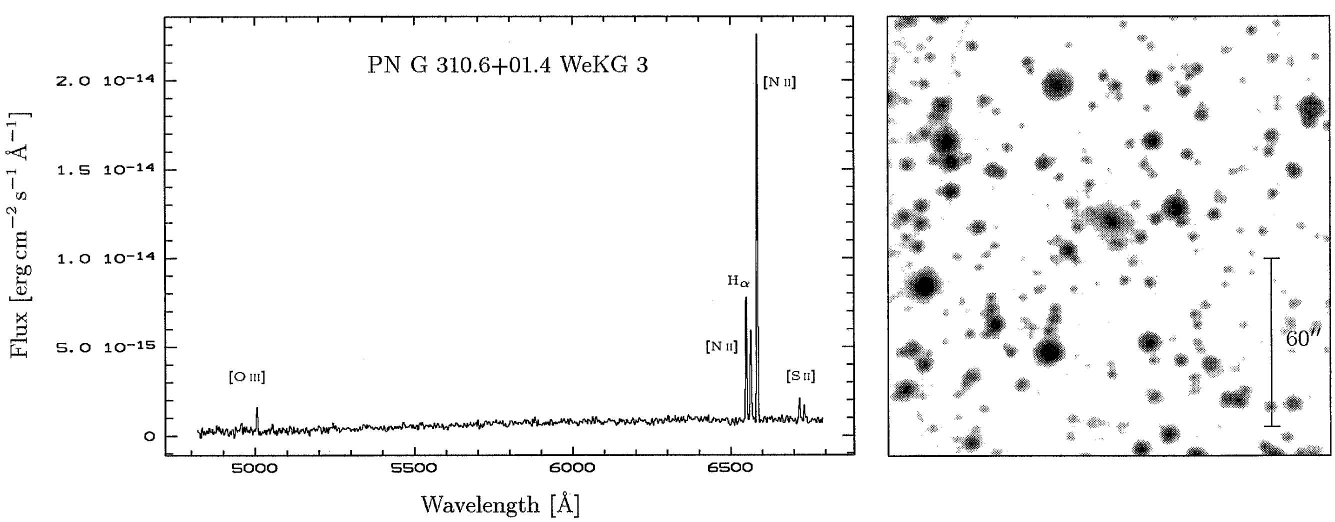

Fig. 3. Spectrum and ESO R-image for WeKG 3, PN G310.6+01.4

Table 1. Basic data for the PNe investigated

Name	Designation	RA (2000.0)	DEC (2000.0)	⌀[″]	ESO-R	x [mm]	y [mm]	Remarks
WeKG 1	PN G307.5−03.6	$13^h\ 37^m\ 32\overset{s}{.}7$	$-66°\ 08'\ 28''$	14	096	20	97	
WeKG 2	PN G308.4+00.4	$13^h\ 38^m\ 41\overset{s}{.}7$	$-61°\ 55'\ 51''$	35	133	33	56	CS $m_r \approx 18^m$
WeKG 3	PN G310.6+01.4	$13^h\ 54^m\ 25\overset{s}{.}6$	$-60°\ 27'\ 20''$	13×20	132	269	102	ESO-R only

Table 2. Line identification

Line [Å]	WeKG 1	WeKG 2	WeKG 3
H_β 4861	100	–	–
[O III] 4959	167	26	–
[O III] 5007	507	69	24
He I 5876	30	–	–
[O I] 6300	24	–	–
[N II] 6548	168	50	113
H_α 6563	604	100	100
[N II] 6584	506	144	312
[S II] 6717	38	7.5	11
[S II] 6731	30	6.0	7
EC	4 – 5	7 – 8	–
c	1.0	> 1	> 1
n_e	< 300	< 300	≤ 100
v_{rad} [km s^{-1}]	− 80	− 58	+ 55
H_β flux	−12.91	–	–

WeKG 2 (Fig. 2) is a ring of extremely low surface brightness. The fine grain of the ESO-R/SERC-J films makes it possible to look at this shell in more detail: the ring shows a knotty structure that is most apparent in the NE section. The thickness of the ring varies along its circumference, in the SW some stars are superimposed on the ring. An apparently blue star is located close to, but not quite in the geometric center of the ring. A thorough inspection of the spectrum reveals a pronounced ionisation stratification within the object. In the inner part of the nebulae – that seemed to be devoid of emission on ESO-R/SERC-J – the ratio of [OIII]/$H_\alpha \approx 1$ and H_α/[NII] = 2.5, while in the ring [OIII]/H_α = 0.7 and H_α/[NII] = 0.65. Using a flux limit for H_β a high reddening and a rather high excitation class of 7 – 8 can be inferred. A very low density of ≤ 100 cm^{-3} for the ring can be derived from the [SII] lines; no such measurement is possible for the inner part. A spectrum of the presumed CS – despite its poor signal to noise ratio – gives an indication of broad Balmer absorption lines partially filled in by nebular emission, supporting the identification as a central star. With its low density, knotty ring structure, a CS that is slightly shifted towards the North and its strongly varying H_α/[NII] ratio we consider WeKG 2 a candidate for interaction with the interstellar medium (ISM), as seen in A 34 and A 61, (Tweedy & Kwitter 1994 and Borkowski et al. 1990).

WeKG 3 is a highly elliptical (axis ratio ≥ 2) PN with a bright central region on the ESO/SERC film. It looks somewhat like a faint galaxy at first sight. The same degree of ellipticity applies to the central part as well as to the outer extensions. The spectrum (Fig. 3) reveals very strong [NII] emission compared to H_α. [OIII] is weak and no H_β is detected so no information on the reddening – that seems to be substantial – or excitation class has been derived. A density of ≤ 100 cm^{-3} results from the observed [SII] line ratio. A high [NII]/H_α ratio like the value of 4 observed here are known from bipolar PNe (Type I PNe) but are rather unusual for elliptical PNe; one notable exception is the peculiar ”nitrogen nebula“ described by Ruiz (1983). Deep narrow-band images and spectroscopy will be needed to clarify this situation.

4. Conclusion

We have spectroscopically confirmed the nature of three PN candidates discovered as a byproduct of a systematic search for galaxies around the Circinus Galaxy. This demonstrates again that many more galactic PNe can still be discovered. Even this small sample also shows that every PN has its individual identity that makes it well worth studying. In particular the old, extended PNe found on the optical surveys tend to be highly individual due their late evolutionary stage; for an ever increasing number of these PNe signs of an interaction with the ISM are being discovered.

Acknowledgements. It is a pleasure to express our gratitude to M. Roth, Director of the Las Campanas Observatory, Chile for his support. This research was partially supported by the “Fonds zur Förderung der wissenschaftlichen Forschung”, project no. P10279-AST and by a travel grant fron 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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