
Identification of new planetary nebulae

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Summary. We have carried out a spectroscopic program in order to determine the true nature of sources with IRAS colours similar to these of planetary nebulae. In this work we present narrow-band H α , [NII] and [OIII] images and low-dispersion optical spectroscopy of five confirmed planetary nebulae identified in our program: PM 1-242, PM 1-253, PM 1-318, PM 1-322 and PM 1-333. In PM 1-242, PM 1-253 and PM 1-333, point-symmetric structures and/or low-excitation polar regions are observed. PM 1-318, PM 1-242 and PM 1-333 are high-excitation planetary nebulae. PM 1-253 shows a relatively high-excitation compact central region and very low-excitation bipolar lobes. PM 1-322 presents high electron density ($> 10^6 \text{ cm}^{-3}$).

Key words: planetary nebulae: individual (PM 1-242, PM 1-253, PM 1-318, PM 1-322 and PM 1-333) – ISM: jets and outflows

1 Introduction

The IRAS [12]–[25] vs. [25]–[60] colour–colour diagram has been very useful to identify new candidates to planetary nebulae (PNe) (Preite-Martínez 1988, see also García-Lario et al. 1997). However, the IRAS colour–colour diagram does not permit by itself to distinguish between PNe and other objects as HII regions, AGB and post-AGB stars and young stellar objects. Recently, we have started a spectroscopic program to establish the true nature of sources that present IRAS colours similar to PNe (Pereira & Miranda 2007). Here, we present optical spectra and narrow-band images of five confirmed PNe identified in our program: PM 1-242, PM 1-253, PM 1-318, PM 1-322 and PM 1-333.

2 Observations

Low-dispersion spectroscopy was obtained using CAFOS at the Calar Alto Observatory 2.2 m telescope on 2004 August and 2005 August. The observed spectral range

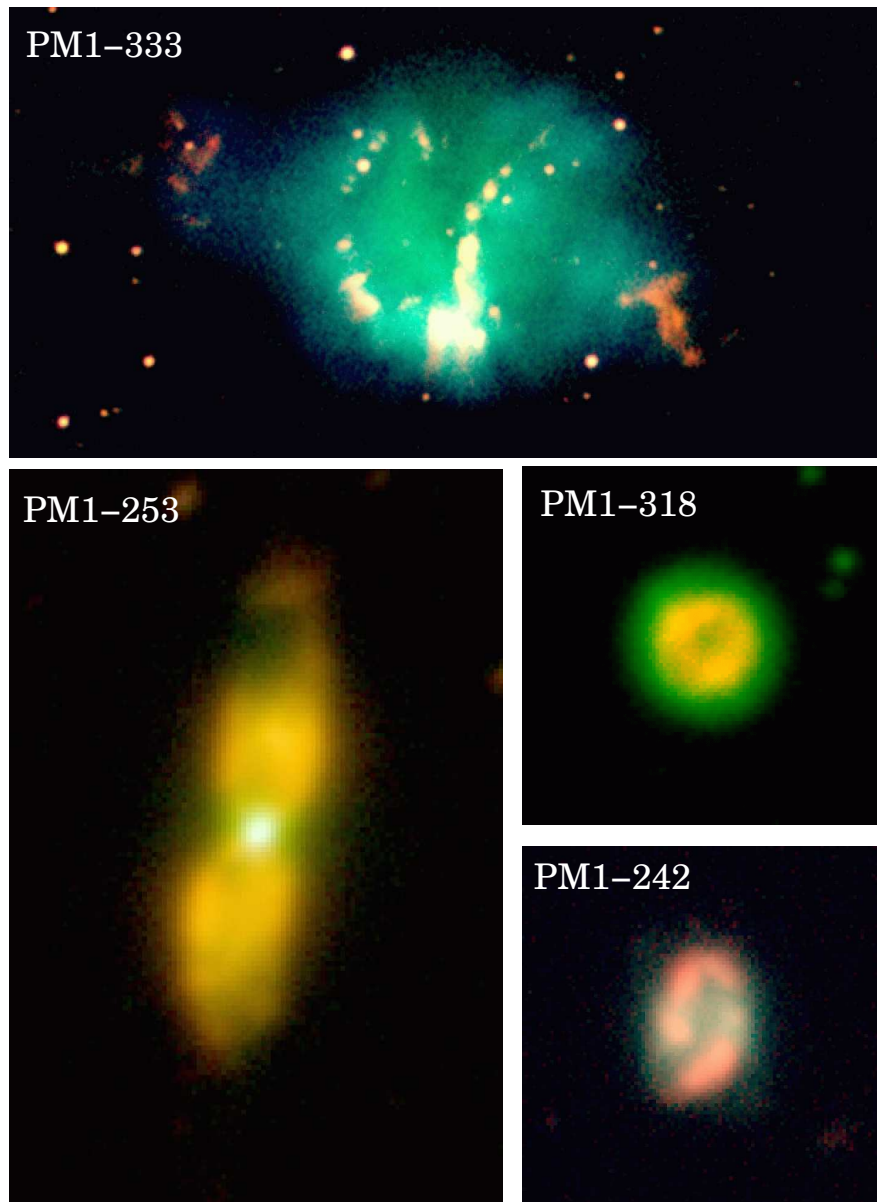


Fig. 1. Three-colour images of PM 1-333 (field size $120'' \times 60''$), PM 1-253 (field size $19'' \times 28''$), PM 1-318 (field size $19'' \times 19''$) and PM 1-242 (field size $19'' \times 19''$). Red corresponds to [NII], green to $H\alpha$ and blue to [OIII], except for PM 1-318 where red is $H\alpha$ and green is [OIII] ([NII] emission from PM 1-318 is extremely faint). North is up and east is to the left in each image.

is 3200–9300 Å. In all cases, the slit was oriented N–S and centered on the nebula, except in PM 1-333 (see below). H α , [NII] and [OIII] narrow-band images were obtained using ALFOSC at the Roque de los Muchachos Observatory 2.5 m Nordic Optical Telescope on 2005 August and 2006 June.

3 Results and discussion

Figure 1 shows colour pictures of PM 1-333, PM 1-318, PM 1-253 and PM 1-242. The images of PM 1-322 are not shown because the object appears unresolved (at 1.8'' resolution). Figure 2 shows a portion of the blue spectral region of PM 1-333, PM 1-318, PM 1-242 and PM 1-322, and Figure 3 displays representative spectral regions for two different nebular regions of PM 1-253 (see below).

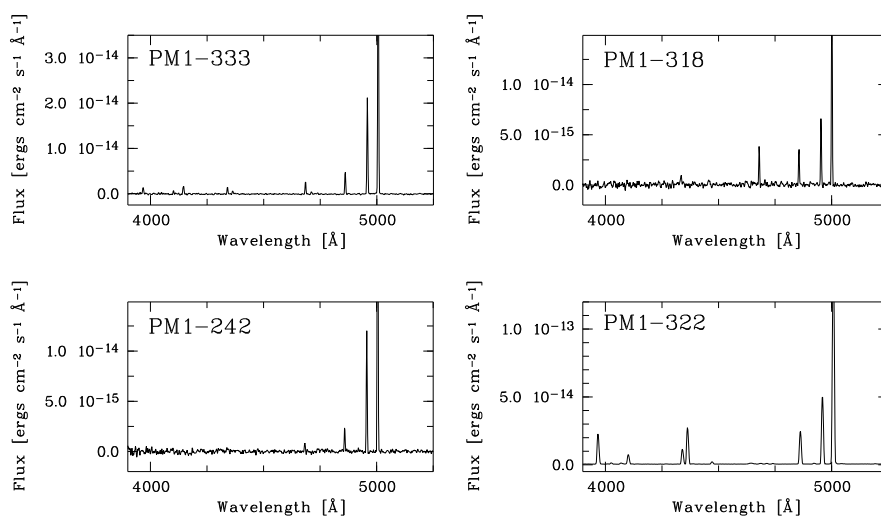


Fig. 2. CAFOS blue spectra of PM 1-333, PM 1-318, PM 1-242 and PM 1-322 between 3900 and 5250 Å.

PM 1-333 is a large, elliptical PN of size 100'' \times 50'' with major axis at PA \sim 75° (Fig. 1). The nebula presents high excitation (HeII4686/H β = 0.54) (Fig. 2). [NII] emission is detected in two bright arcs in the main nebula and at the tips of the major nebular axis in the form of two clumpy polar structures of low-excitation. In the main nebula, the electron density is low (N_e ([SII]) \sim 350 cm $^{-3}$) and the electron temperature is T_e ([OIII]) \simeq 14200 K and T_e ([NII]) \simeq 16700 K. A spectrum of the SW low-excitation structure was also obtained (not shown here). In this structure, the [NII]/H α and [SII]/H α line intensity ratios are \simeq 1.53 and \simeq 0.44, respectively, a factor \simeq 3.2 higher than in the main nebula. The electron density in the SW low-excitation structures is \simeq 200 cm $^{-3}$.

PM 1-318 presents a ring-like morphology of size 3.5'' slightly elongated at PA \sim 310°. Two bright knots are observed in the ring oriented at PA \sim 230°. The

ring is surrounded by an attached circular shell (size $10''$) of high-excitation. The spectrum (Fig. 2) shows strong high-excitation emissions (e.g., $\text{HeII}4686/\text{H}\beta \simeq 1.1$) and extremely weak low-excitation emissions.

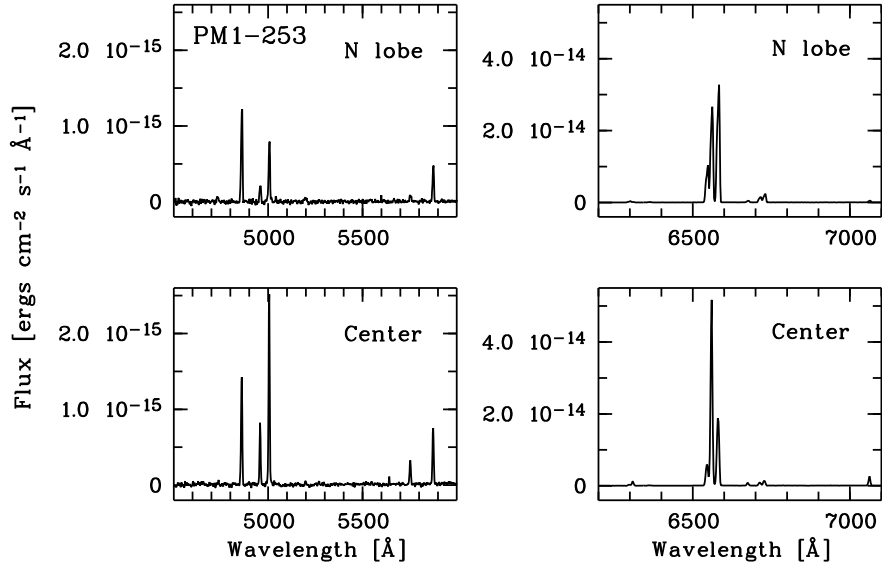


Fig. 3. Selected portions of the CAFOS spectra of PM 1-253 for the northern lobe and central region. The spectrum of the southern lobe (not shown here) is similar to that of the northern one. Note the differences between the line intensity ratios in the lobes and in the central region.

PM 1-242 presents an elliptical morphology with a size of $8'' \times 5''$ and major axis at $\text{PA} \sim 0^\circ$. Point-symmetric arcs trace the ellipse in the three filters. At low intensity levels, the $\text{H}\alpha$ and $[\text{OIII}]$ images show elongations along $\text{PA} 50\text{--}230^\circ$ and $\text{PA} 150^\circ$ (Fig. 1). The spectrum (Fig. 2) shows weak low-excitation emissions and relatively strong high-excitation emissions (e.g., $\text{HeII}4686/\text{H}\beta = 0.42$). For this nebula we derive $N_e([\text{SII}]) \simeq 2100 \text{ cm}^{-3}$ and $T_e([\text{SIII}]) \sim 7400 \text{ K}$ ($[\text{OIII}]4363$ is not detected).

PM 1-322 is a newly identified PN by Pereira & Miranda (2005). The main spectral characteristic of PM 1-322 is the presence of a strong $[\text{OIII}]4363$ emission line ($[\text{OIII}]4363/\text{H}\beta = 1.20$) (Fig. 2) indicating high electron density ($> 10^6 \text{ cm}^{-3}$). Although the spectrum strongly suggests that PM 1-322 is a young PN, the high electron density and the $[\text{OIII}]4363/\text{H}\gamma$ and $[\text{OIII}]5007/\text{H}\beta$ line intensity ratios (see Pereira & Miranda 2005) do not allow us to rule out the possibility of a symbiotic nature.

In the case of PM 1-253, we confirm its identification as a bipolar PN (Van de Steene et al. 1996). In addition, our images show that PM 1-253 presents point-symmetric structures in the lobes, a very narrow waist and a compact central region (Fig. 1). The $\text{HeII}4686$ line is not detected in the nebula, while the $[\text{OIII}]4363$ emission is detected only in the central region. The $[\text{NII}]/\text{H}\alpha$ and $[\text{SII}]/\text{H}\alpha$ line intensity

ratios are $\simeq 2.8$ times higher in the lobes than in the central region, while the $[\text{OIII}]/\text{H}\beta$ line intensity ratio is $\simeq 2.5$ times higher in the central region than in the lobes (see Fig. 3). The spectrum indicates the existence of different physical and excitation conditions in the lobes and in the central region.

Acknowledgement. This work is funded by grant PNAYA2005-01495 of the Spanish MEC and by grant FGM-1747 of the Junta de Andalucía.

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