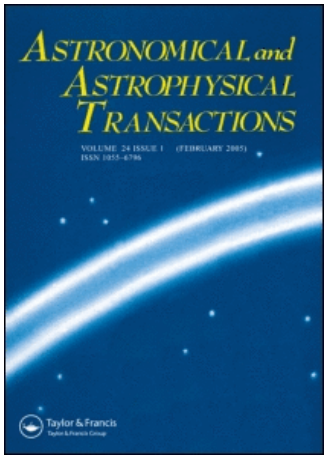

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SPECTRAL INVESTIGATION OF SOME NEW PLANETARY NEBULAE

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The major purpose of this paper is to prove or disprove the nature of planetary nebulae (PNe) candidates in the Northern Hemisphere. We present spectroscopic observations of nine PNe, identified for the first time. Another two candidates turned out to be an emission-line galaxy and an H II region. All observed PNe represent evolved stages, their angular diameter ranging from 8 to 20 arcsec, and exhibit very low surface brightnesses.

KEY WORDS Methods: observational; techniques: spectroscopic; (ISM) planetary nebulae: general

1 INTRODUCTION

Members of our institute have, for a long time, been successfully engaged in the detection (more than 10% of the registered galactic PNe) and investigation of extended PNe (e. g. Weinberger *et al.*, 1983; Hartl and Tritton, 1985; Ishida and Weinberger, 1987; Melmer and Weinberger, 1990; Tamura and Weinberger, 1995). Some of our objects proved to be among the largest planetary nebulae known to date (e. g. Liebert *et al.*, 1994) or turned out to be intriguing in various other respects like harbouring one of the most evolved stars ever identified within a PN (Bruhweiler and Feibelman, 1993).

The PNe discussed in our paper represent – with one exception (Tamura and Weinberger, 1995) – newly discovered objects not mentioned before except in two meetings (Kerber *et al.*, 1994; Kerber and Weinberger, 1995). There only a list with coordinates and diameters was given. Now we are able to confirm the nature of these objects as PNe by means of their spectra.

The objects observed have all been discovered on POSSI paper copies by visual inspection. They have been found both during dedicated searches for PNe as well as a by-product of a search for galaxies near the galactic plane, the so-called Zone of Avoidance (ZoA) (see, e. g. Lercher *et al.*, 1996).

It may seem odd that new objects can still be found on this survey after so many years of intense searches but the discovery of new PNe on the POSS has been continuing at a more or less constant rate for many years now. There are two main reasons for this. First, many objects discovered in recent years do not look like a textbook PN but come in a variety of shapes and second, most are non-descript objects of low surface brightness. Therefore, these objects can easily be overlooked or be mistaken for plate defects (e. g. Weinberger *et al.*, 1994).

It is particularily noteworthy that this kind of PNe will likely elude most automatic search algorithms on digitized versions of the POSS, since their surface brightness is too close to the background to be successfully found and classified. This is why visual inspection of POSS or ESO/SERC plates will remain a valid approach to finding new objects in years to come.

Despite the very limited spectral information provided by its two colours the POSS can also be used for classification of new objects with a very acceptable rate of success. This is illustrated by the fact that nine out of 11 candidates spectroscopically investigated turned out to be PNe with the remaining two being an H II region and an emission-line galaxy.

2 OBSERVATIONS

The observations were made during two runs in April and June, 1995 at the observatory of the University of Padova in Asiago. On both occasions we observed with the 1.82 m Copernico telescope and a B&C spectrograph. Gratings of 150 and 300 lines mm^{-1} (both blazed at 5000Å) were used, yielding dispersions of 339Å mm^{-1} and 169Å mm^{-1} corresponding to ca. 8 and 4Å $pixel^{-1}$, respectively. Exposure times ranged from 900 to 2700.

Table 1 summarizes some basic data of the PNe. In the first column we give a running number, in the second the galactic coordinates. Columns 3 and 4 give equ-

Table 1. Basic data for the PNe investigated

No.	*Designation*	*RA (2000.0)*	*DEC (2000.0)*	⌀ (″)	*POSS*	*Remarks*
1	G051.6+00.2	$19^h\ 25^m\ 37.0^s$	+16° 36′ 18″	12	793	
2	G053.1+01.8	$19^h\ 22^m\ 54.9^s$	+18° 42′ 13″	20	793	
3	G055.1+01.8	$19^h\ 26^m\ 39.9^s$	+20° 29′ 21″	15	793	
4	G066.2+02.0	$19^h\ 48^m\ 01.9^s$	+30° 16′ 05″	12	275	
5	G070.8+03.7	$19^h\ 54^m\ 17.3^s$	+35° 07′ 08″	8	200	TaWe 4
6	G071.0+02.5	$19^h\ 59^m\ 55.5^s$	+34° 36′ 04″	20	200	
6	G071.0+02.5	$19^h\ 59^m\ 55.5^s$	+34° 36′ 04″	20	200	
7	G083.8+05.7	$20^h\ 22^m\ 15.9^s$	+47° 03′ 53″	15	1099	
8	G104.2−01.4	$22^h\ 30^m\ 10.4^s$	+56° 11′ 43″	15	588	
9	G124.1+02.9	$01^h\ 02^m\ 24.7^s$	+65° 46′ 36″	15	1234	
	G083.0−08.3	$21^h\ 18^m\ 40.7^s$	+37° 34′ 49″	13	269	Galaxy
	G104.9+11.2	$21^h\ 30^m\ 55.5^s$	+66° 49′ 06″	100	1165	H II region

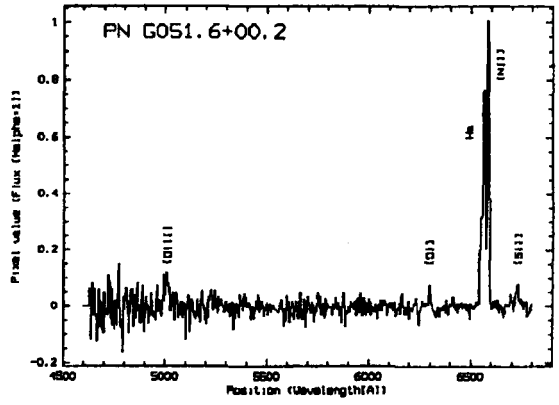

Figure 1 Spectrum of object No. 1, PN G051.6+00.2.

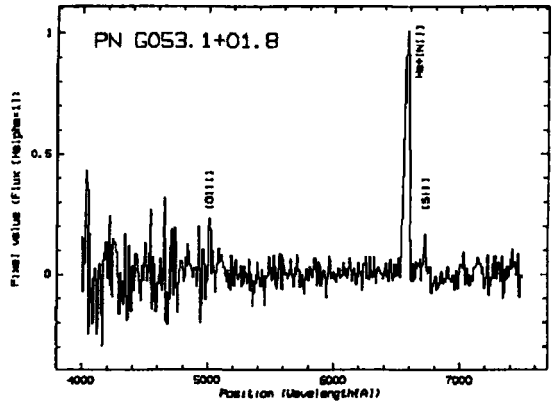

Figure 2 Spectrum of object No. 2, PN G053.1+01.8.

atorial coordinates, measured from the POSS prints given in column 6, accurate to about 6 arcsec. In column 5 a diameter is given as measured on the POSS-E print.

3 RESULTS

In this section we present the observed spectra with the flux normalized to $H_\alpha = 1$. The lines of H_α 6563Å and [N II] 6584, 6548Å cannot be separated with the 150 lines mm^{-1} grating.

The spectra of objects Nos. 1–3 (Figures 1–3) which are located within only a few degrees of one another all show extremely faint lines of [O III] and almost no H_β most likely due to heavy extinction in this area close to the galactic plane. No. 2 is an object that warrants further investigation: as can easily be seen the blend of

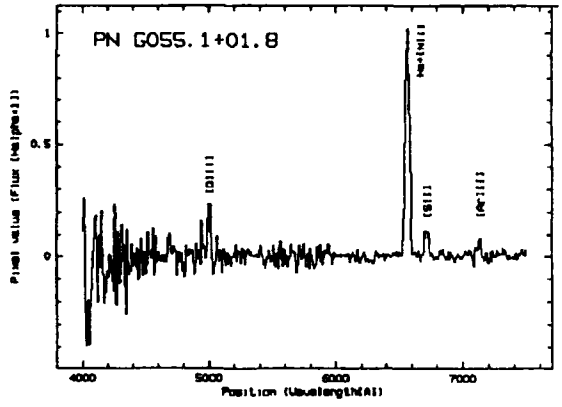

Figure 3 Spectrum of object No. 3, PN G055.1+01.8.

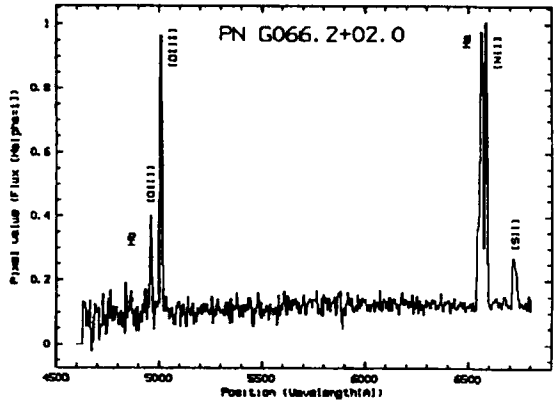

Figure 4 Spectrum of object No. 4, PN G066.2+02.0.

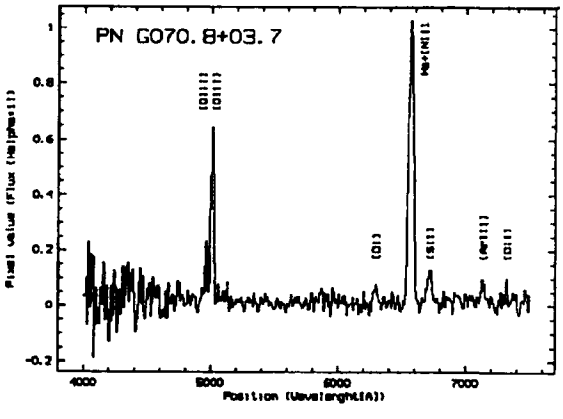

Figure 5 Spectrum of object No. 5 TaWe4, PN G070.8+03.7.

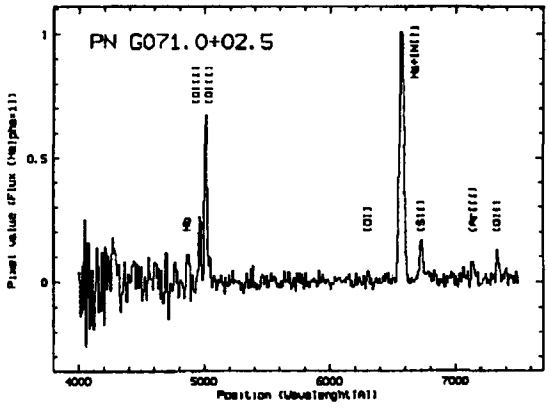

Figure 6 Spectrum of object No. 6, PN G071.9+02.5.

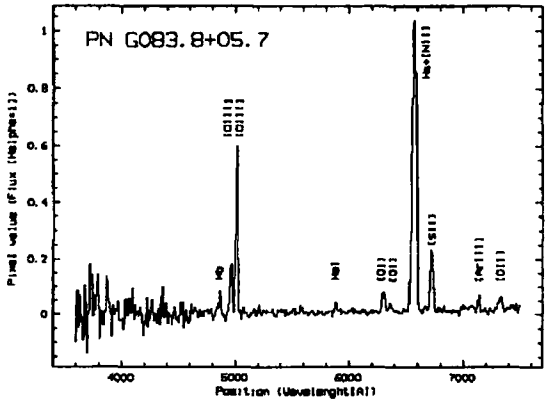

Figure 7 Spectrum of object No. 7, PN G083.8+05.7.

H_α and [N II] is asymmetric, we find a ratio H_α/[N II] of ≈ 0.5. The continuum of object No. 4 (Figure 4) stems from a star – probably not the central star – that is superimposed on the PN.

For object No. 5 (Figure 5) TaWe 4 our spectrum confirms the conjecture by Tamura and Weinberger (1995) that object is markedly reddened; no H_β was detected. The other numbered objects (Figures 6–9) turned out to be ordinary PNe of medium to high reddening with No. 7 showing the largest number of lines of this sample.

It should be noted that new detections of (extended) PNe are not only interesting from a statistical point of view, but are also of considerable significance due to the extreme heterogeneity of the class: each PN is, to a certain extent, unique. Photographic surveys like the (old) POSSI or the ESO/SERC atlas were by far the most fruitful material for searching for evolved PNe and hundreds of new planetaries

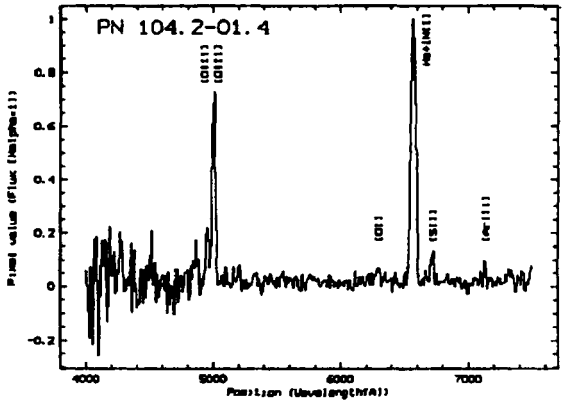

Figure 8 Spectrum of object No. 8, PN G104.2-01.4.

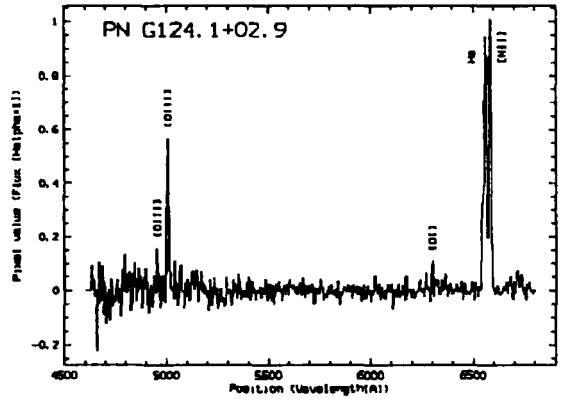

Figure 9 Spectrum of object No. 9, PN G124.1-02.9.

were discovered by scouring them for new candidates. Curiously, although examined and re-examined by several researchers, these surveys are obviously still not exhausted of their riches: this provides compelling evidence for such a statement.

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