Astron. Astrophys. 87, L5–L6 (1980)

ASTRONOMY AND ASTROPHYSICS

Letter to the Editor

A Huge New Nearby Planetary Nebula

A. Purgathofer[1] and R. Weinberger[2]

[1] Institut für Astronomie der Universität Wien, Türkenschanzstrasse 17, A-1180 Wien, Austria
[2] Institut für Astronomie der Universität Innsbruck, Universitätsstrasse 4, A-6020 Innsbruck, Austria

Received April 15, accepted May 29, 1980

SUMMARY. A giant, circular (20'x20') new planetary nebula of low surface brightness has been discovered on a Palomar Sky Survey print. As to the angular diameter, it is the second largest ever found and competes with the Helix nebula for being the closest planetary to the solar system. The object is of low excitation and shows a pronounced ionization stratification; the central star exhibits an sdO spectrum.

KEY WORDS: new nearby planetary - spectroscopy

At present, ∿1500 galactic planetary nebulae (PN) are registered. The close ones are of particular interest: (i) their proximity eases investigations of their generally very weak infrared and radio emission. (ii) the "local space density" of PN should be reliably known, since it is a quantity of interest in the study of stellar evolution, especially in connection with death rates of main-sequence stars and the formation rate of white dwarfs. (iii) the local population is a basis for estimating the entire galactic PN population, thus allowing an insight e. g. into their total mass return to the interstellar medium.

There are 41 (optically-thin) PN known within 1 kpc of the sun (Cahn and Wyatt, 1976). Planetaries detected originally on the Palomar Observatory Sky Survey (POSS) play a major role here. Whereas they amount to only 10 per cent of the total number of listed galactic PN, they comprise 50 per cent of the "local" PN.

The object under discussion was found on the POSS when R. W. was looking for possible flare star regions suitable for photography with a small telescope. This discovery represents a further confirmation for the suspicion that the POSS surprisingly is still a rich source for new PN: although this famous atlas has been thoroughly searched (e. g. by Abell, 1966), a number of new PN has been detected there recently (Weinberger 1977a, b, 1978; Purgathofer 1978, 1980; Dengel et al. 1980).

THE NEBULA

On the POSS E (red-sensitive)-print no. 984 (6^h20^m, +54°), at x∿267, y∿267 mm from the lower left corner, the new PN is visible as a circular (20'x20', ±0'.5) weak spot of rather uniform surface brightness (fig. 1). On the blue (O)-print the nebula is just above the visibility threshold. The 1950.0 coordinates (referring to the central star) are $\alpha = 6^h15^m23^s.1$, $\delta = 55°38'01''$, ±5"; $\ell = 158°.92$, $b = 17°.86$. In the Catalogue of Galactic Planetary Nebulae (Perek and Kohoutek, 1967) this object would be designated 158 +17°1. The nebula is embedded in a homogenous star background, a few faint galaxies shine through its body.

By comparison with surface brightnesses of Abell's (1966) PN, the red and blue surface brightnesses were

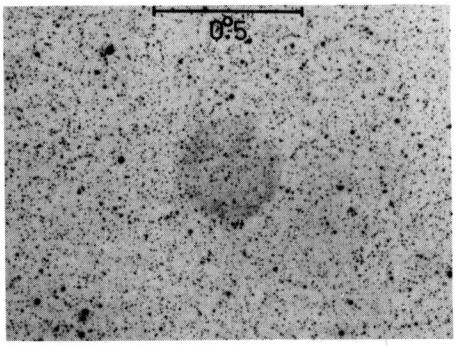

FIG. 1. The new planetary nebula as it appears on the red-sensitive POSS print. North is at the top, east to the left. Copyright by National Geographic Society - Palomar Observatory Sky Survey. Reproduced by permission from the Hale Observatories.

estimated to be m_r^s = 23.7 mag/arc sec^2, and m_b^s = 26.3 mag/arc sec^2 (±0.5 mag/arc sec^2). The corresponding integrated magnitudes are m_r^i = 8.6, and m_b^i = 11.2 (±0^m.5). The volume v (arc sec^3) can be evaluated by assuming the three-dimensional form of a uniform disk to be a sphere (after Abell). Using his distance formula (which is based on the assumption that PN are optically thin and have a mass of 0.2 $M_\odot$) we find 125pc ≤ r ≤ 150pc, i. e. r ≃ 140pc; unfortunately, the total error inherent in our distance estimate remains uncertain. This distance places our object in a similar distance as the nearest known planetary, the Helix nebula. Photometric distance estimates for the latter are 0.15, 0.15, 0.13, 0.11, and 0.09 kpc (table 1 and 3 of Cahn and Kaler, 1971); however, Cudworth (1974) calculated r = 0.21 kpc with the method of statistical parallaxes. The average distance for the Helix nebula thus amounts to 140 pc too.

At this distance, the linear diameter of our PN correspondingly is d = 0.8pc; it is therefore a remarkably old nebula and may perhaps be radiation bounded. The derived distance would then be an upper limit. Besides, when Abell's (1966) mean absorption $\overline{\Delta m}_r^i$ = 0.6 for his nebulae with $|b| \geq 15°$ is used, the distance is reduced by 10 per cent. A maximum distance, moreover, is 210 pc, provided we use a maximum observable linear diameter of 1.2 pc, as is usually assumed. The distance above the galactic plane consequently is 40 pc (r = 140 pc) and 60 pc, respectively.

Taken the angular diameter, only the Helix nebula surpasses our object, that is, when the 28'x18' large, extremely faint outer halo is taken into account. Our PN obviously represents no halo phenomenon.

Send offprint requests to: R. Weinberger

Several spectra of the nebula, in two brighter regions to the south and one close to the centre, were obtained with the 60 inch Ritchey-Chretien telescope of the L. Figl Observatory and an image tube spectrograph using a Carnegie system. The dispersion used was about 130 Å mm^{-1} and the spectral range was 3200 to 7000 Å. Table 1 shows the lines visible on at least two spectrograms, the suggested identifications and rough relative line intensities (3 = strongest) adjusted for instrumental sensitivity.

Table 1. Detected emission lines

λ(Å)	Element	Rel. line intens. centre	south.part
3727	[O II]	1	3
5007	[O III]	1	0

Due to the faintness of the object no Balmer lines are seen on our sky limited image tube spectra (on Kodak II a O). The relative intensities given in table 1 can be explained by stratification effects.

THE CENTRAL STAR

At the centre of the nebula an optical double star (ρ = 5.″1) can be found (fig. 2).

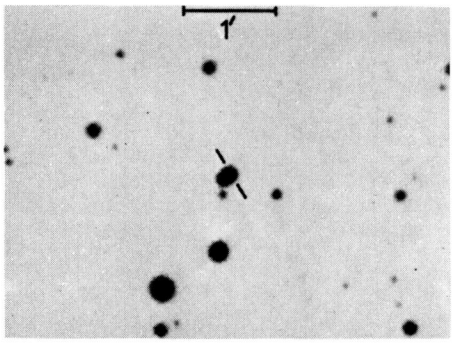

FIG. 2. The central star, reproduced from the blue-sensitive POSS print. North is at the top, east to the left. Copyright as in fig. 1.

Whether we deal with a physical pair cannot be decided at the moment. The southerly component (P.A. = 120°) is red (B-V ∿ 1.5 as estimated from the POSS), the northerly one is of distinctly blue colour; we consider the latter as the central star. It does not seem to be contained in lists of single or double stars with known proper motions or in lists of faint blue stars.

The central star has m_b = 15.4 (± 0.m5), derived from a recently published magnitude-diameter relation (Hayman et al., 1979) using the photoelectric sequence near 3C 147 (Penston et al., 1971) on a neighbouring POSS print. The same sequence was used for a brightness estimate based on 5 blue plates (103 a O, no filter) taken with the 15 cm refractor of the Innsbruck observatory, resulting in m_b = 15.2 (± 0.m5) and for one blue plate, taken with the 60 inch telescope, yielding m_b = 15.3 (± 0.m1). We shall use $\overline{m_b}$ = 15.3. At 140 pc, assuming A_b = 0, M_b = +9.6 follows; as to its absolute magnitude, the star therefore resembles a white dwarf.

Widened spectrograms of the central star and of the spectrophotometric standard star Feige 34 (Stone, 1977) permitted the determination of the relative energy distribution. Feige 34 is ideally suited for this purpose, since its sd0 spectrum matches closely that of the central star. The differences are a somewhat less steep continuum and less deep Balmer lines for the latter. Fig. 3 shows the energy distribution of the central star corrected for differential extinction in the usual way.

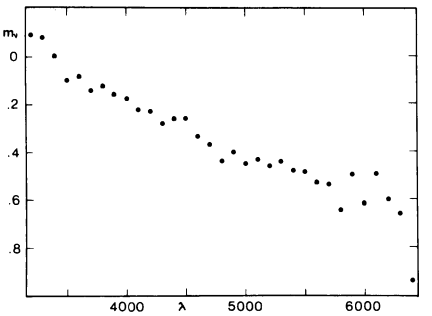

FIG. 3. Observed relative continuous energy distribution for the central star. The units are magnitude per unit frequency for the energy and Ångstrom's for the wavelength.

Since there are UBV data available for Feige 34 (Klemola, 1962; Eggen and Sandage, 1965), the U-B and B-V colours could be determined by simple integration using the sensitivity functions given in Landolt-Börnstein (Lamla, 1965). The results are: B-V = -0.04, U-B = -1.11.

CONCLUSION

A giant, low-excited, old planetary nebula of the galactic disk has been found. This object, the central star of which is probably just beyond the reach of today's best trigonometric parallax measurements, should be a rewarding objective for various investigations.

REFERENCES

Abell, G. O.: 1966, *Astrophys. J.* 144, 259
Cahn, J. H., Kaler, J. B.: 1971, *Astrophys. J. Suppl.* 22, 319
Cahn, J. H., Wyatt, S. P.: 1976, *Astrophys. J.* 210, 508
Cudworth, K. M.: 1974, *Astron. J.* 79, 1384
Dengel, J., Hartl, H., Weinberger, R.: 1980, *Astron. Astrophys.* 85, 356
Eggen, O. J., Sandage, A. R.: 1965, *Astrophys. J.* 141, 821
Hayman, P. G., Hazard, C., Sanitt, N.: 1979, *Monthly Notices Roy. Astron. Soc.* 189, 853
Klemola, A. R.: 1962, *Astron. J.* 67, 740
Lamla, E.: 1965, in *Landolt-Börnstein*, 345
Penston, M. J., Penston, M. V., Sandage, A.: 1971, *Publ. Astron. Soc. Pacific* 83, 783
Perek, L., Kohoutek, L.: 1967, *Catalogue of Galactic Planetary Nebulae*, Academia Prague
Purgathofer, A.: 1978, *Astron. Astrophys.* 70, 589
Purgathofer, A.: 1980, *Astron. Astrophys.* (in press)
Stone, R. P. S.: 1977, *Astrophys. J.* 218, 767
Weinberger, R.: 1977a, *Astron. Astrophys. Suppl.* 30, 343
Weinberger, R.: 1977b, *Astron. Astrophys. Suppl.* 30, 335
Weinberger, R.: 1978, *Observatory* 98, 137