A&A 378, 843–846 (2001)
DOI: 10.1051/0004-6361:20011162
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Astronomy & Astrophysics

Version 2000 of the Catalogue of Galactic Planetary Nebulae*

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Received 18 June 2001 / Accepted 13 August 2001

Abstract. The "Catalogue of Galactic Planetary Nebulae (Version 2000)" appears in Abhandlungen aus der Hamburger Sternwarte, Band XII in the year 2001. It is a continuation of CGPN(1967) and contains 1510 objects classified as galactic PNe up to the end of 1999. The lists of possible pre-PNe and possible post-PNe are also given. The catalogue is restricted only to the data belonging to the location and identification of the objects. It gives identification charts of PNe discovered since 1965 (published in the supplements to CGPN) and those charts of objects discovered earlier, which have wrong or uncertain identification. The question "what is a planetary nebula" is discussed and the typical values of PNe and of their central stars are summarized. Short statistics about the discoveries of PNe are given. The catalogue is also available in the Centre de Données, Strasbourg and at Hamburg Observatory via internet.

Key words. ISM: planetary nebulae: general

1. Catalogue

I would like to announce the "Catalogue of Galactic Planetary Nebulae (Updated Version 2000)" which appears in Abhandlungen aus der Hamburger Sternwarte, Band XII in the year 2001. This catalogue, CGPN(2000), is a continuation of CGPN(1967) (Perek, Kohoutek 1967) and also includes objects given in Supplements S1–S6:

S1 – period 1966–1977,
S2 – period 1978–1981,
S3 – period 1982–1986,
S4 – period 1987–1990,
S5 – period 1991–1994,
S6 – period 1995–1999.

Supplements S1–S5 to CGPN(1967) have been published (Kohoutek 1978, 1983, 1989, 1992, 1997), whereas the last Supplement 6 is only available from the author.

This catalogue contains 1510 objects classified as galactic PNe up to the end of 1999.

The catalogue is divided into two parts:

Part 1 – text and lists of objects (with corresponding remarks) given in the following tables:
Table 1: general list of PNe according to galactic longitude (including also misclassified PNe),
Table 2: list of PNe according to right ascension,
Table 3: list of misclassified PNe,
Table 4: accurate coordinates of PNe,
Table 5: list of possible pre-PNe,
Table 6: list of possible post-PNe,
Table 7: index of discovery lists;

Part 2 – finding charts of objects listed in S1-S6 and of some objects from CGPN(1967) (not the charts given correctly in CGPN(1967)),
Table 8: list of finding charts.

The PK designation as well as the IAU PN G designation is indicated (Tables 1 and 2), and equatorial coordinates for both the Equinox 1950 and 2000 are presented (Tables 2 and 4).

In the elementary statistics of the present data of PNe we give the galactic distribution as well as the distribution on the sphere, the occurence of coordinates in different accuracy categories, the existence of finding charts and also the frequency of discoveries.

We also present some summarized lists of PNe: individual distances, binary and variable objects, the occurrence in clusters and X-ray sources. The summary of misclassified PNe is added.

The errata to CGPN(1967) and to the Supplements are summarized.

This version has in addition to CGPN(1967) two new lists which appeared in Supplements 4, 5 and 6 only: the list of possible pre-PNe (Table 5, $n = 334$) and the list of possible post-PNe (Table 6, $n = 86$). They deal with objects which have not been classified as regular PNe, but which are as we believe in the evolutionary stage before PNe (pre-PNe) and after PNe (post-PNe), respectively.

* The Catalogue is only available in electronic form at the CDS via anonymous ftp to
`cdsarc.u-strasbg.fr (130.79.128.5)` or via
`http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/378/843`

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Article published by EDP Sciences and available at http://www.aanda.org or http://dx.doi.org/10.1051/0004-6361:20011162

These lists are incomplete and reflect the opinion of their authors.

We still use equinox 1950.0 of coordinates in all tables for various reasons. But rough coordinates of all PNe given in equinox 2000.0 are also listed (Table 2).

As in CGPN(1967) the definition of a planetary nebula has been taken in a rather wide sense. The total number of PNe is at present 1510 (classified till the end of 1999): 1183 objects classified more or less reliably as planetary nebulae; in addition 327 possible planetaries (denoted in the tables with an"*"). Meanwhile 245 objects have been removed for different reasons from the CGPN(1967) and from the Supplements as misclassified PNe; there certainly exist also objects in the present version of the catalogue which do not belong here. The definitive classification of the objects is not at all simple.

Planetary nebulae are presented in this catalogue independently of the fact whether the objects are confirmed PNe or possible PNe (asterisk behind the designation), which fact may change already in the near future.

There are several objects called proto-planetary nebulae (PPNe). One of the first lists of such objects was compiled and published in S1. The particular list of PPNe does not exist in this catalogue: PPNe can be found either in the main list of PNe (Table 1), or in the list of possible pre-PNe (Table 5). The separation of these two categories is not reliably defined.

At present we include in the list of PNe several objects which also appear in the lists of symbiotic stars (SS). In our opinion it is not advisable to classify the objects either as SS or as PNe, and therefore some of them can appear simultaneously in both lists. We point out that the hot components of symbiotic stars resemble the central stars of PNe (luminosity, temperature, mass, diameter), being also on the post-AGB tracks, which means in the region of the HR diagram occupied by PNe. Allen's list of SS (Allen 1984) contains 144 objects and 44 of them are simultaneously classified as PNe. Also the new catalogue of SS (Belczyński et al. 2000) contains 53 objects (24% of known SS), which are simultaneously classified as PNe.

Our criteria for excluding objects from the list of PNe as SS are more narrow than the conventional definition of SS is. We exclude only such objects from the list of PNe which show

1) strong HeIIλ4686 emission line and simultaneously no (or nearly no) [OIII]λ5007, λ4959 lines, and
2) the presence of a 6825A emission feature, as in M 1-21 (006+07.1), He 2-417 (012−07.1) and He 2-374 (009−02.1).

Both criteria are empirical and reflect the appearance of some bright emission features in the optical region (visible also for faint objects). As to absorption features and the presence of the continuum of a late-type star, these are according to our opinion not sufficient criteria which distinguish necessarily between the SS and the (binary) central stars of PNe.

This updated version does not contain identification charts of all objects. We do not repeat those charts which have already been published in CGPN(1967), except some charts having wrong or uncertain identification. Concerning the correct charts, which is the large majority, the user of the updated version is referred to CGPN(1967). In CGPN(2000) the identification charts are mostly of objects discovered after 1965 which were included in the Supplements.

We intentionally use the same designation of PNe in CGPN(2000) as in the edition CGPN(1967), i.e. in the system: $lll \pm bb.n$, where $n = 1, 2 \ldots$ is the number of the object in the respective area $1^\circ \times 1^\circ$. This designation (and not the more detailed one) was used in CGPN(1967) also in order to avoid a possible confusion due to the sometimes approximate coordinates (the positional accuracy of 26% of the objects in CGPN(1967) was not better than 1 arcmin). At present the positional accuracy has been improved, and the designation could therefore be more detailed. We also give (Table 2) the IAU designations of galactic planetary nebulae, PN G $lll.l \pm bb.b$, recommended by IAU Commission 5 (Astronomical Nomenclature) and also used in SECGPN. In order to avoid possible confusion we use the same PN G designation of objects as given in SECGPN; this is also in case our galactic coordinates would differ slightly from those of SECGPN due to improved equatorial coordinates. CGPN(1967) included all observational data on the objects. The amount of such data increased to such an extent in the last thirty years that we found it necessary to restrict ourselves in CGPN(2000) only to the data belonging to the location and identification of the objects, i.e. to coordinates as well as to finding charts. For the remaining data one may refer to SIMBAD (CDS, Strasbourg, France) as well as to the literature concerning the individual objects.

Valuable information about the objects including their identification charts can be found in the Strasbourg-ESO Catalogue of Galactic Planetary Nebulae (Acker et al. 1992 – SECGPN) and in its First Supplement (Acker et al. 1996 – S1 to SECGPN), where also the lists of publications are given. The classification criteria are somewhat different in SECGPN compared with CGPN, so that the objects included in both catalogues slightly differ.

We are of the opinion that the confusion concerning the PK designation which sometimes occurred in the literature was avoidable. We would have expected that the discoverer would publish the new objects either together with their galactic coordinates only, or with the first part of the designation, containing the galactic longitude and latitude and not with the number of the object in the respective area $1^\circ \times 1^\circ$ (e.g. 255−15 only). This procedure has not been explicitely mentioned in CGPN(1967), but it was assumed to be self-evident; in reality it was sometimes not. For this reason we write about this matter in more detail in CGPN(2000).

The idea of publishing the new version of CGPN arose in the year 1976, and this was mentioned in Supplement 1. We remind the reader that the publication of CGPN was discussed already at the meeting of Commission 34 at the XII General Assembly of the IAU in Hamburg,

August 1964. This has been described in more detail in CGPN(1967).

2. Properties of PNe

In order to answer the fundamental question "what is a planetary nebula?" we have compared the properties of various objects considering the current review literature and came to the following conclusion: A planetary nebula is a mainly gaseous object (also containing dust) expanding from its hot central star of intermediate mass in a late evolutionary phase on the way between red giants and white dwarfs. The central stars ionize and illuminate the respective nebulae. Although the parameters of the nebulae change very much during the rapid evolution of their nuclei and are therefore dependent on age, it is possible to summarize their typical values (extreme values are given in parenthesis).

Nebula:

Morphology: objects of mostly symmetrical shape (circular or elliptical discs or rings, sometimes bipolar structure with "equatorial" torus and "pole" condensations), with apparently sharp outer boundaries; often multiple shells (main nebula + faint outer structure or halo). The morphology depends on the wavelength (stratification); it also reflects the intrinsic absorption and the orientation in space.

Some objects have envelopes of neutral hydrogen and molecules.

Angular diameter: $\sim 20''-40''$, depending on the wavelength (limits stellar – $\sim 20'$, Sh 2-216 even larger).

Spectrum:

emission lines:

(a) recombination lines mostly of H and He;

(b) collisionally excited (forbidden) lines of C, N, O, Ne, Mg, Si, S, Cl, Ar;

(c) fluorescent lines (rare) of OIII and NIII.

continuum emission:

free-bound, free-free, two-quantum processes, emission from grains (dust);

spectrum depending on excitation conditions (exc. class), stratification, chemical composition.

Exc. classes: 0–10, main criteria:

$I([\mathrm{OIII}]\lambda 5007 + \lambda 4959)/I(\mathrm{H}\beta)$,

$I(\mathrm{HeII}\lambda 4686)/I(\mathrm{H}\beta)$,

$I([\mathrm{OII}]\lambda 3727)/I([\mathrm{OIII}])\lambda 4959)$.

IR-spectrum: nebular emission lines, dust continuum, IR-emission features.

IR-fluxes: $F_\nu(12\ \mu\mathrm{m})/F_\nu(25\ \mu\mathrm{m}) \leq 0.35$, $F_\nu(25\ \mu\mathrm{m})/F_\nu(60\ \mu\mathrm{m}) \geq 0.3$, H2 (some objects).

Radio emission: continuum, mainly molecules CO, OH.

Dimension: diameter 0.1 pc–0.2 pc (limits ~ 0.005 pc or even smaller, ~ 7 pc) depending on wavelength.

Electron density: 10^3-10^4 cm^{-3} (but also $<10^3$ cm^{-3} for old objects and $>10^4$ cm^{-3} for young objects possible).

Electron temperature: 9000 K–15 000 K (limits 8000 K–23 000 K).

Total mass:

ionized gas: 0.1 $M_\odot$–0.2 $M_\odot$ (limits ~ 0.001 $M_\odot$, ~ 1 $M_\odot$);

neutral gas + dust: sometimes higher, very different; dust mass/gas mass $\sim 2 \times 10^{-4}$ to 3×10^{-2}.

Expansion velocity: non-isotropic, ~ 25 km s^{-1} (limits 4 km s^{-1}, 60 km s^{-1}, outer condensations up to ~ 300 km s^{-1}).

Age: 0–$\sim$100 000 years.

Nucleus:

Spectrum: WR, O, Of, WR+Of, OVI, sdO, cont., peculiar, sometimes variable.

Effective temperature: 40 000 K – 100 000 K (limits ~ 20 000 K–~ 250 000 K).

Luminosity: $\sim 5 \times 10^3$ $L_\odot$ (limits ~ 10 $L_\odot$, $\sim 10^4$ $L_\odot$).

Radius: limits ~ 0.005 $R_\odot$, ~ 1.5 $R_\odot$.

Mass: ~ 0.6 $M_\odot$ (progenitors between 0.8 $M_\odot$ and 6–8 $M_\odot$).

Mass loss: $\sim 10^{-10}$ $M_\odot$/yr–10^{-7} $M_\odot$/yr ($\sim 10^{-5}$ $M_\odot$/yr in late AGB), variable.

Gravity: $\log g \sim 3.0-7.5$.

The excitation classes were introduced in order to classify the spectra of planetary nebulae using the level of excitation (excitation potential of the emission lines). The classification criteria are based on the scheme which was developed mainly by Aller (1956), partly already by Page (1942) or even earlier. Only one criterion is sensitive over nearly the whole range of excitation: $I([\mathrm{OIII}]\lambda 5007+\lambda 4959)/I(\mathrm{H}\beta)$. Moreover the ratio $I(\mathrm{HeII}\ \lambda 4686)/I(\mathrm{H}\beta)$ is suitable for high and very high, whereas $I([\mathrm{OII}]\lambda 3727)/I([\mathrm{OIII}]\lambda 4959)$ for low and medium excitation classes. Unfortunately this last criterion should be taken with caution because of possible strong interstellar absorption which might weaken the $\lambda 3727$ line. For low excitation classes the ratio $I([\mathrm{NII}]\lambda 6584)/I(\mathrm{H}\alpha)$ is also useful. We added exc. classes 0–1 and 1 for very-low-excitation (VLE-objects were introduced already by Sanduleak, Stephenson 1973) mostly compact objects: in exc. class 1 the line $[\mathrm{OIII}]\lambda 5007$ is very weak but still visible, exc. class 0–1 is reserved for objects showing no visible $[\mathrm{OIII}]\lambda 5007$ line. In this case some additional indications for PNe (e.g. non-stellar angular diameter, continuous spectrum, infrared fluxes) should be given. The above exc. classes contain mainly objects the star temperatures of which are too low for producing the N1 line, but which are on the evolutionary way to common PNe.

The mean parameters of the nebulae and of their nuclei have been taken over mainly from Supplement 3 (with the extension given in Supplement 5). The summary of the criteria by which PNe are distinguished from several types of objects is given in Supplement 2.

Table 1. Number of PNe listed in different catalogues.

Catalogue or list	Number of PNe	Miscl. PNe
Curtis (1918)	102	
Vorontsov-Velyaminov & Parenago (1931)	121	
Vorontsov-Velyaminov (1948)	288	
Vorontsov-Velyaminov (1962)	591	
Perek & Kohoutek (1967)–CGPN(1967)	1036	
Kohoutek (1978-2000)–Supplements 1–6 to CGPN(1967)	721	247
Acker et al. (1992)–SECGPN	1143*	330
	347**	
Acker et al. (1996)–Supplement 1 to SECGPN	242*	
	142**	
This catalogue–CGPN (2000)	1510	245

* True or probable.
** Possible.

3. Discoveries of PNe

The first object called planetary nebula was named more than two centuries ago (NGC 6720; Messier, Darquier 1779). Due to the work of W. Herschel altogether 13 PNe were known at the end of the 18th century. In addition, further 65 PNe were found in the 19th century.

A substantial increase of new PNe can be registered since 1945 as a result of spectral surveys and of Schmidt cameras. (About 90% of known PNe have been discovered since 1945.) In the last decade the slight increase of new PNe is mostly due to observations in no-visual regions (mainly in infrared) and due to the use of CCD cameras, which are more sensitive than photographic plates. The following catalogues or lists (partly mentioned already in CGPN (1967)) are given in Table 1.

The distribution of the number of PNe discoveries is given in the following figure:

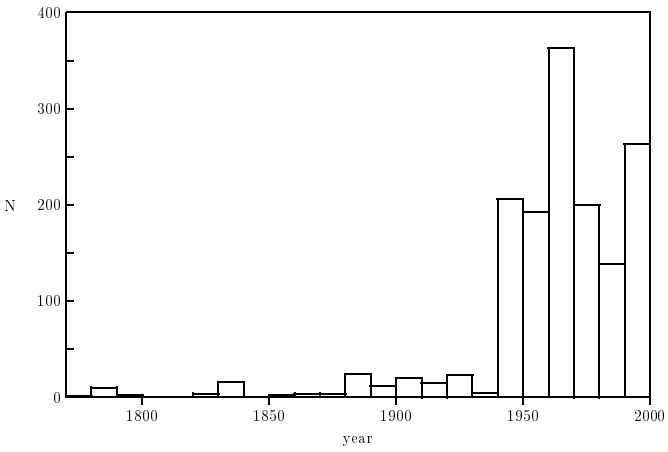

Fig. 1. Dicoveries of PNe until 2000 in the respective decade.

Internet

The catalogue is available in the Centre de Données, Strasbourg under the designation IV/24.
It is also accesible from the Hamburg Observatory homepage:
`www.hs.uni-hamburg.de/EN/catalogs.html` (CGPN2).
The charts given there are of lower quality than in the printed version.

Acknowledgements. I am very much obliged to Mr. D. Kühl for his general help with CGPN(2000), as well as for measuring with me the coordinates of several hundreds of objects. My special thanks are also dedicated to Dr. H. Hagen for the possibility of using his image processing software, especially for coordinate grids on the charts and the options for measuring coordinates. I am very much obliged to Dr. L. Perek for reading the manuscript and for his constant interest concerning the Catalogue. I appreciate the support of CGPN(2000) by many colleagues and last but not least the support by the Directorate of the Hamburg Observatory. I thankfully acknowledge the database SIMBAD operated at CDS (Strasbourg, France).

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