

The X-ray Planetary Nebulae Database

Martín A. Guerrero¹, You-Hua Chu² and Robert A. Gruendl²

¹Instituto de Astrofísica de Andalucía, IAA-CSIC, Apdo. Correos 3004, 18080 Granada, Spain
email: mar@iaa.es

²Department of Astronomy, University of Illinois, 1002 W. Green St., Urbana, IL 61801 USA
email: chu@astro.uiuc.edu, gruendl@astro.uiuc.edu

Abstract. Diffuse X-ray emission from hot gas in planetary nebulae (PNe) was hinted by *ROSAT* and *ASCA*, but only the improved sensitivity and spatial resolution of *XMM-Newton* and *Chandra* have allowed detailed studies of the hot gas in PNe. These studies are helping us to better assess the effects of fast stellar winds and collimated outflows in the shaping and evolution of individual PNe, but a comprehensive picture is lacking, because the X-ray analysis of different PNe is not homogeneous and, therefore, cannot be intercompared. Furthermore, a significant number of X-ray observations of PNe that did not detect X-ray emission have not been reported. We have undertaken a systematic study of all *XMM-Newton* and *Chandra* observations of PNe benefiting from a homogeneous analysis using the most up-to-date versions of SAS and CIAO, respectively, and the recently released calibration files with greater accuracy for energies below 1.0 keV. We present reprocessed event files, derived data products (X-ray images and spectra), supporting observations at other wavelengths, and analysis results in a database, the XPN Database, that can be accessed at <http://www.iaa.csic.es/xpn>

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1. X-ray Observations of Planetary Nebulae

XMM-Newton and *Chandra* observations of planetary nebulae (PNe) have finally detected diffuse X-ray emission from shocked fast winds in PNe interiors and from bow-shocks of fast collimated outflows impinging on nebular envelopes. These X-ray observations have produced exquisite images and invaluable spectra of PNe that allow us to examine the spatial distribution and physical properties of hot gas in their interiors. The results are helping us to better assess the relative importance of fast stellar winds and collimated outflows in the shaping and evolution of individual PNe. However, X-ray observations of PNe have not been optimally used, as papers reporting X-ray analysis of PN emission applied preliminary calibrations and methods which have since been significantly improved, and X-ray observations of PNe resulting in non-detections are often left in the archive without appearing in the literature.

2. The XPN Database

We have undertaken a systematic study of all *XMM-Newton* and *Chandra* observations of PNe. This study will benefit from a homogeneous analysis using the most recent versions of SAS and CIAO (the software packages for analysis of *XMM-Newton* and *Chandra* observations, respectively). Furthermore, the available observations are being reprocessed using the recently released calibration files that have much greater accuracy for energies below 1.0 keV, where most of the X-ray emission from PNe is found. Systematic comparisons with observations at other wavelengths will help determine the physical

Table 1. *XMM-Newton* and *Chandra* Database of PNe

PN	Observatory	Count Rate (cnts s ⁻¹)	$f_{0.45-2.5 \text{ keV}}^{\text{obs}}$ (ergs cm ⁻² s ⁻¹)
BD+30°3639	Chandra	0.242±0.004	6.8×10 ⁻¹³
CRL 618	Chandra	<0.00025	<8.3×10 ⁻¹⁶
CRL 2688	Chandra	<0.0013	<4.4×10 ⁻¹⁶
Hen 2-90	Chandra	<0.0010	<3.4×10 ⁻¹⁵
Hen 2-99	Chandra	<0.00076	<3.0×10 ⁻¹⁵
Hen 2-104	Chandra	<0.00058	<2.0×10 ⁻¹⁵
Hen 3-1475	Chandra	0.0017±0.0003	5.1×10 ⁻¹⁵
M 1-16	Chandra	<0.0010	<3.6×10 ⁻¹⁵
M 2-9	Chandra	<0.0017	<5.9×10 ⁻¹⁵
MyCn 18	Chandra	<0.0004	<1.4×10 ⁻¹⁵
Mz 3	Chandra	0.0022±0.0003	7.0×10 ⁻¹⁵
NGC 40	Chandra	0.0029±0.0008	1.7×10 ⁻¹⁴
NGC 246	Chandra	<0.011	<6.4×10 ⁻¹⁴
NGC 2346	XMM-Newton	<0.0045	<5.0×10 ⁻¹⁵
NGC 2392	XMM-Newton	0.0534±0.0026	6.0×10 ⁻¹⁴
NGC 3242	XMM-Newton	0.0384±0.0021	6.7×10 ⁻¹⁴
NGC 4361	Chandra	<0.00009	<4.2×10 ⁻¹⁵
NGC 6543	Chandra	0.0316±0.0009	1.0×10 ⁻¹³
NGC 7009	XMM-Newton	0.0615±0.0017	7.2×10 ⁻¹⁴
NGC 7026	XMM-Newton	0.0083±0.0011	8.8×10 ⁻¹⁵
NGC 7027	Chandra	0.015±0.001	3.1×10 ⁻¹⁴
NGC 7293	Chandra	<0.020	<1.0×10 ⁻¹³
OH 231.8+4.2	Chandra	<0.00054	<2.4×10 ⁻¹⁵

structure of these PNe, and statistical analyses of the X-ray and physical properties of PNe can yield crucial constraints on the formation and evolution of PNe.

To make the X-ray data and its analysis available to the astronomical community, we introduce the XPN Database webpage, <http://www.iaa.csic.es/xpn>. Event files at different reprocessing levels, data products (X-ray images and spectra), and the analysis results can be accessed at this webpage. All available *XMM-Newton* and *Chandra* observations of PNe are listed in different tables that present both the PNe with X-ray detections and those that are not detected. Here, we present in Table 1 the PNe included in the XPN Database. For the non-detections, the 3- σ upper limits of the count rate and flux are given, often for the first time. For the X-ray detections, the tables include the X-ray size, count rate and observed flux. The *XPN Database* webpage also offers links to webpages of individual PNe with detected X-ray emission. The webpages of individual PNe provide further information on these objects and link to data at different processing levels (event files, X-ray images and spectra). Count rates and fluxes in different energy bands are also given, along with further links to detailed spectral and imaging analyses.

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