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X-ray Aureola of Central Stars

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Abstract. We report discovery of correlation between X-ray luminosity of PN and bolometric luminosity of central stars from CHANDRA data and discuss briefly its interpretation.

1. X-ray properties of the PNe enssemble

The ROSAT All-Sky Survey indicated that about 25% of all PN were X-ray sources. Non-detections were explained away as selection effects. Discovery by CHANDRA observatory X-rays from NGC 7027 which had not been detected previously demonstrated that *all* PN may generate X-rays (Guerrero et al. 2000, Kastner et al. 2000). "Hot bubble" when the recent supersonic (1000 km sec^{-1}) wind rams into the ejected slowly moving (10 km sec^{-1}) red giant envelope is presumably responsible for a diffuse X-ray source (Kwok et al., 1978) with characteristic temperatures of a few MK. The point X-ray sources with the similar temperatures may be produced by the fast radiatively driven stellar wind of central stars (CS). On the other hand the photospheric emission of central white dwarf would result in much lower (10^5K) temperatures of X-ray emission. To date CHANDRA X-ray observatory has pointed observations of only four PN and NGC 7009 was observed with XMM-NEWTON recently (see these proced.). All of those PNe possess rather hard X-ray spectra.

Table 1. CHANDRA obseravtions of PN

PN (NGC)	$N_H (10^{21}\,\mathrm{cm}^{-2})$	cps[1]	CS[2] (cps)	$\mathrm{Log}(L_\mathrm{X}/L_*)$
6543		0.042	0.002	-5.55
7027	6.0	0.014	—	-5.64
7293		0.044	0.044	-5.79
BD+303639	0.99	0.244	—	-5.22

[1] counts per second [2] central star detections

For any mechanism of X-ray production involving the interaction with the fast radiatively driven wind from the CS the correlation of X-rays and wind momentum may be expected. The wind momentum–luminosity relation for cenral stars of PNe (see Pauldrach's paper in these proc.) provides the rationale for the exploration of possible correlations between X-ray luminosity of a nebula and bolometric luminosity of a central star. Table 1 summarizes the results of CHANDRA's PN pointings (Kastner et al. 2000; Kastner et al. 2001; Guerrero et al. 2001; Chu et al. 2001). The errors are small and comparable for all measurements (∼0.002 cps) and L_X are calculated using the same distance as L_* making their ratio distance independent. Though only four in number these

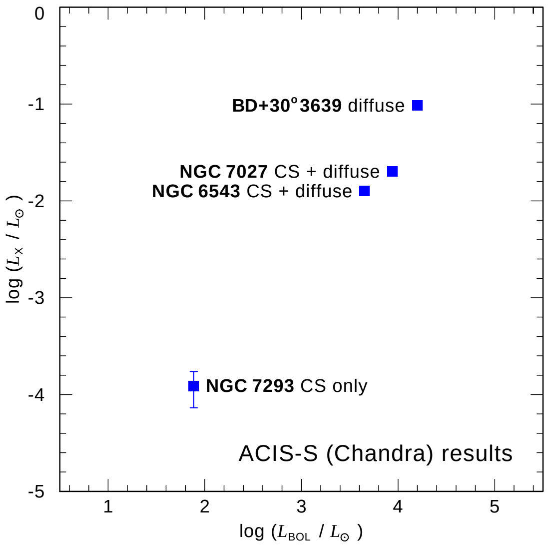

Figure 1. Plot of X-ray luminosity versus Bolometric luminosity for the sample of PN observed so far with CHANDRA. At each data point we indicate whether diffuse emission and central star are spatially resolved.

objects clearly demonstrate a tight correlation of total X-ray luminosity with central star luminosity $L_X \sim 10^{-5.5} L_*$, despite their different X-ray morphology (Fig. 1). This is especially intriguing because of the different nature of the central stars in this sample including [WC] stars (NGC 6543 and BD+303639) and a WD (NGC 7293) where no strong stellar wind is detected. Clearly, more observations are needed.

2. Possible detection of X-ray emission of a PN in the SMC

During 100 ksec CHANDRA's ACIS-S exposure of a stellar cluster in Small Magellanic Cloud the X-ray emission of an area coinciding with the location of PN LHA 115-N 70 is detected. There are a total of 18 counts from two illuminated pixels. The average size of a PN in SMC derived according to the review of Jacoby et al. (1990) is 0.73 arcsec. The ACIS-S's pixel size is 0.49 arcsec. The estimated luminosity is $L_X \approx 0.28 \pm 0.28 L_\odot$ applying $N_H = 2 \times 10^{21}\mathrm{cm}^{-2}$ when $D = 65\,\mathrm{kpc}$.

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