X-RAY EMISSION FROM WOLF-RAYET STARS

Pointed ROSAT PSPC observations of nine single WN stars

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Abstract. Results from pointed *ROSAT* PSPC observations of nine single WN-type Wolf-Rayet stars are presented. Spectra of sufficient quality were obtained for two of them (WR1, WR110). The long exposure (35.5 ksec) X-ray spectrum of WR1 is more closely investigated with a semi-empirical model developed by Baum *et al.* (1992).

Among the 48 Wolf-Rayet (WR) stars observed with the IPC of the *EINSTEIN* observatory about one third showed detectable X-ray flux (Pollock 1987). An improvement in sensitivity together with moderate spectral information (4–5 independent energy bands) has been offered recently by the PSPC

TABLE I

Pointed *ROSAT* PSPC observations of 9 single WN-type WR stars.

			ROSAT PSPC				*EINSTEIN*
WR	spectral type	HD	proposal ID	t_{obs} (sec)	counts	rate ($ksec^{-1}$)	IPC rate ($ksec^{-1}$)
1	WN5-s	4004	201272	8399	245 ± 16	29.2	—
			201535	27091	873 ± 30	32.2	
2	WN2-w	6327	200720	9729	60 ± 9	6.1	—
7	WN4-s	56925	200718	7346	17 ± 5	2.3	—
16	WN8	86161	200715	7805	< 2.3	< 0.3	4 (1-8)
46	WN3p-w	104994	201271	826	7 ± 3	8.5	4 (2-7)
			201271-1	7830	66 ± 9	8.4	
78	WN7	151932	200716	10421	$\lesssim 24$	$\lesssim 2.3$	5 (1-8)
110	WN6-s	165688	200717	8430	154 ± 14	18.3	—
152	WN3-w	211564	201275	4960	13 ± 5	2.7	4 (0-8)
157	WN4.5-w	219460	201273	5856	$\lesssim 7$	$\lesssim 1.2$	—

K. A. van der Hucht and P. M. Williams (eds.), Wolf-Rayet Stars: Binaries, Colliding Winds, Evolution, 174–175.

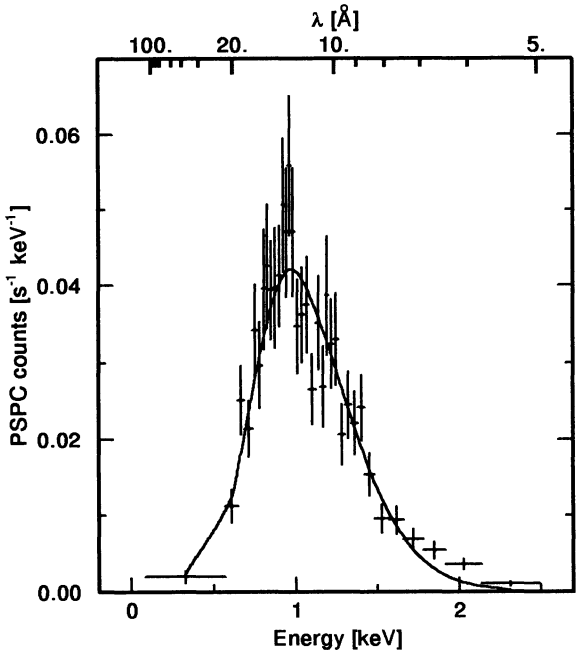

Fig. 1. Merged (35.5 ksec total exposure time, binned to S/N = 5) *ROSAT* PSPC observation of WR 1 (WN 5-s), compared to a semi-empirical two-component model (cf. Baum *et al.* 1992). The hot component producing the X-rays has a temperature of $T_X = 2\,10^6$ K and an exceptionally high filling factor of $X_{fill} = 20\,\%$, while the normal gas component is in radiative equilibrium. Fitting the count rate spectrum with the EXSAS tool FIT/SPECTRUM yields a column density of $N_H = 2.5\,10^{21}$ cm^{-2} for the interstellar absorption.

Results for our sample of nine (putatively) single WR stars covering nearly the whole range of WN subtypes are compiled in Table 1. *Spectra* of sufficient quality were obtained only for WR1 and WR110.

We merged the two pointed observations of WR1 and we investigated the X-ray spectrum with a semi-empirical model developed by Baum *et al.* (1992). The observed spectral distribution of the X-rays can be reproduced with that model for reasonable choices of T_X and X_{fill} (cf. Fig. 1). The set of stellar parameters which simultaneously allows us to fit the observed line spectrum is $T_* = 55$ kK, $R_* = 3.5\,R_\odot$, $\dot{M} = 10^{-4.2}\,M_\odot$/yr, $v_\infty = 2\,000$ km/s, and a nitrogen abundance of $\beta_N = 1.5\,\%$ (by mass).

The "standard model" for WR atmospheres, although neglecting the X-ray emitting hot component, remains valid for describing the visual and UV spectrum.

References

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