ASCA X-RAY SPECTROSCOPY OF WR140 NEAR PERIASTRON

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Abstract. Analysis of the X-ray spectrum of WR140 seven months after the 1993 periastron passage shows chemical abundances inconsistent with those used to model the earlier, more heavily absorbed, PV phase spectrum.

Key words: stars: Wolf-Rayet – X-rays – chemical abundances

1. Introduction

The binary WR140 consists of an O4-5 star and an WC7 star in a highly eccentric ($e \approx 0.84$) 7.94-yr orbit (Williams *et al.* 1990). It is simultaneously the brightest non-compact stellar X-ray source, the brightest non-thermal early-type radio star and a powerful and highly variable source of infra-red radiation. Since its recent launch with a complement of high-resolution X-ray instruments, the *ASCA* satellite has been used twice to observe WR140, first during the satellite's Performance Verification phase on June 10, 1993, only three months after periastron passage, as described by Skinner *et al.* (these proceedings), and four months later as the first observation of *ASCA*'s Guest Observer Program, on October 26, 1993, for 11 ksec of net observing time. In this preliminary report, we discuss our analysis of the spectrum obtained with the Solid-state Imaging Spectrometer (SIS0).

2. The October 1993 X-ray spectrum of WR140

The resultant spectrum has a wealth of features. As expected, the low-energy absorption is much less important than in Skinner *et al.*'s observation as the X-ray source has emerged after periastron, as seen in the previous orbital cycle by Williams *et al.* (1990) with the comparatively poor energy resolution of *EXOSAT*. Another remarkable feature is how much the Fe emission line at 6.8 keV has weakened. Following the general colliding-winds model schemes, we have attempted to fit the observed spectrum with isothermal X-ray Raymond-Smith plasma emission modulated by a strong component of circumstellar absorption in addition to that suffered passing through the

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interstellar medium, paying particular attention to the chemical composition of both emitting and absorbing material. Solar abundance models give a very poor fit and are thus ruled out. We have tried two non-solar abundance models: first, one in which the emitting and absorbing materials are of identical abundances; and second the Skinner *et al.* model in which the emitting and absorbing material have different abundances. The results are shown in the table, which gives abundances relative to solar values for those elements which were not constrained at their solar abundances. In addition, the interstellar absorption was fixed and X-ray luminosity, L_X, was calculated for a distance $d_{\mathrm{WR140}} = 1.3$ kpc. The Skinner *et al.* model of their June

TABLE I

Comparision of model fits to October 1993 WR140 *ASCA* X-ray data

circumstellar abundances	model 1 emission = absorption	model 2 Skinner *et al.*	
	H = 0.0	$N_{\mathrm{H}} = 4.2\times 10^{21}$	(cm^{-2})
	$N_{\mathrm{He}} = 4\times 10^{20}$	He/H = solar	(cm^{-2})
	C = 3.3	absorption C = 31	
	Ne = 2.0	emission Ne = 99	
	Fe = 0.2	emission Fe = 0.8	
interstellar	3.5×10^{21}	3.5×10^{21}	(cm^{-2})
temperature	3.1	2.1	(keV)
$L_X(1-10)$ keV	5.2×10^{33}	4.8×10^{33}	(ergs s^{-1})
χ^2/n	344/255	451/255	

10-11, 1993, observation gives a poor fit to our data of four months later. By this time, the low energies have recovered to a shape inconsistent with the abundance scheme they propose. We are able to get a reasonable fit with less extreme abundances, less extreme even than our earlier Williams *et al.* (1990) *EXOSAT* CNO value, that was calculated on the clearly erroneous assumption that the X-ray emission was a smooth, featureless power-law continuum as opposed to a thermal spectrum full of (unresolved) line features. We are in the process of reassessing these matters.

References

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