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THE WIND PROPERTIES OF ETA CARINAE

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We perform X-ray spectral fits to a recently obtained *Chandra* grating spectrum of η Carinae, one of the most massive and powerful stars in the Galaxy, and which is strongly suspected to be a colliding wind binary system. The good fit that we obtain gives us further confidence in the binary hypothesis, and we find $\dot{M} \approx 2.5 \times 10^{-4}\,M_{\odot}\,\mathrm{yr}^{-1}$ for the mass-loss rate of η Car.

In recent years, there has been growing evidence that the superluminous star η Carinae (HD 93308, HR 4210) may be a binary (Damineli 1996; Duncan et al. 1995; Lamers et al. 1998; Corcoran et al. 2000). The presence of an early-type companion means that a powerful wind-wind collision will contribute to the observed emission, and is consistent with observed X-ray and radio variability. In addition, the X-ray emission from η Car is unlike any of the other single stars observed so far at high energies and dispersion and shares some common features with other colliding wind binaries. A binary interpretation remains somewhat controversial, however, not least because recent STIS spectra did not confirm the predicted variations in the radial velocity of the emission lines (Davidson et al. 2000). To test the binary hypothesis, and to obtain accurate estimates of the wind parameters of each star, we have recently fitted a *Chandra* grating spectrum against a grid of synthetic spectra calculated from a range of hydrodynamical models of the wind-wind collision (see Pittard & Corcoran 2002 for further details).

As η Carinae has a relatively slow wind, the majority of the hard X-ray emission arises from the shocked wind of the companion. In our calculations we fix the wind speed of η Car to $500\,\mathrm{km\,s^{-1}}$ and the wind momentum ratio, $\eta = (\dot{M}_2 v_{\infty,2})/(\dot{M}_1 v_{\infty,1})$, to 0.2, as suggested from models of the X-ray eclipse. Our best-fit to the data (Figure 1) yields the following wind parameters for the companion: $\dot{M}_2 \approx 10^{-5}\,M_{\odot}\,\mathrm{yr}^{-1}$, $v_{\infty,2} \approx 3000\,\mathrm{km\,s^{-1}}$. With our previous assumptions this implies that the mass-loss rate of η Carinae is $\dot{M}_1 \approx 2.5 \times 10^{-4}\,M_{\odot}\,\mathrm{yr}^{-1}$. This is smaller than typically inferred (e.g., Hillier et al. 2001) but closer to estimates for the mass-loss rate of the Pistol star.

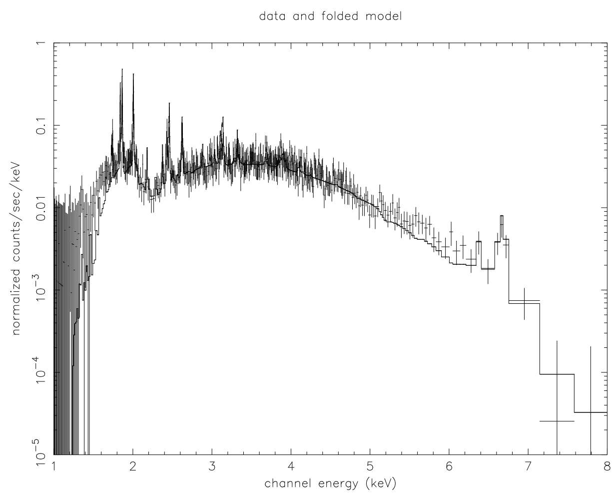

Fig. 1. The best fit to the *Chandra* grating spectrum. The continuum level is matched very well.

While our analysis does not prove that η Carinae is a binary, we find that the colliding wind emission model naturally provides for the range of ionization seen in the emission lines in the X-ray grating spectrum. The parameters for the companion are rather extreme, however, such that it should be clearly visible in the optical and UV spectra, yet there is no He II 4686 Å emission line, and the UV wind spectrum is that of a peculiar B supergiant and not an early Of. In addition, most of the binary models attribute a rather lower mass to the secondary than an early Of star would imply.

We will apply similar modeling to data from future X-ray observations scheduled around periastron passage to test these results.

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