X-ray monitoring of the Wolf-Rayet binary WR140 with Suzaku

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Abstract

We report on preliminary results of the Suzaku observations of the W-R binary WR 140 (WC7+O5I), with the aim of understanding the W-R stellar wind as well as the wind-wind collision shocks. Our observations with exposures of 210 ksec in total were made at four different epochs around periastron passage in Jan. 2009. We detected hard X-ray excess in the HXD band. This is the first time that the hard X-ray excess above 10 keV was detected from a W-R binary. Moreover, we found a part of the soft component is not absorbed even by the dense wind. The spectra can be fitted by three different components, with a stationary soft component at kT$\sim$0.1 keV, a high temperature component at kT$\sim$3 keV and a harder power-low component. The column density at periastron is a factor of 30 higher than that at pre-periastron, which can be explained as self-absorption of the W-R wind. It is found that the emission measure of high temperature component is not proportional to the inverse of the separation of the two stars.

Key words: stars: Wolf-Rayet – binaries:spectroscopic – stars: WR140

1. Introduction

The Wolf-Rayet WC7+O5I binary WR140 (HD 193,793) has a long-period (P=7.94 yrs), and extremely eccentric (e=0.88) orbit (Marchenko et al. 2003 ApJ., 596, 1295). The X-ray spectrum is the best measure of conditions in the hot postshock gas, and the crucial time for observations is around periastron passage when densities are changing most rapidly. X-ray monitoring observations in a single orbital cycle around periastron passage are key to understand the W-R stellar wind parameters as well as the wind-wind collision shocks.

2. Observation

We observed WR140 with Suzaku at four different epochs around periastron passage in Jan. 2009, for a total exposure time of $\sim$210 ksec. Figure 1 shows the geometry at four epochs.

3. Results

Figure 2 shows X-ray spectra obtained with each detector at four epochs. The high-quality XIS spectra show emission lines from highly ionized ions from various elements. The spectra can be fitted by three different component model.

First model is a stationary soft component at kT$\sim$0.1 keV. In epoch C and D, we found for the first time a part of the soft component is not absorbed even by the dense wind. Since no significant change in X-ray flux were detected, we suppose this component is stationary. A single temperature model yielded an acceptable fit with 0.1 keV in plasma temperature (kT) and $\sim 1 \times 10^{22}$ cm^{-2} in hydrogen column extinction($N_{\rm H}$). Some residuals, may be identified with the RRC structures of OVII, OVIII, NeIX and NeX, were left. The chi square value of the fit with the four recombination edge (redge) was improved.

Second model is a high temperature component at kT$\sim$3 keV. This component dominates with the X-ray

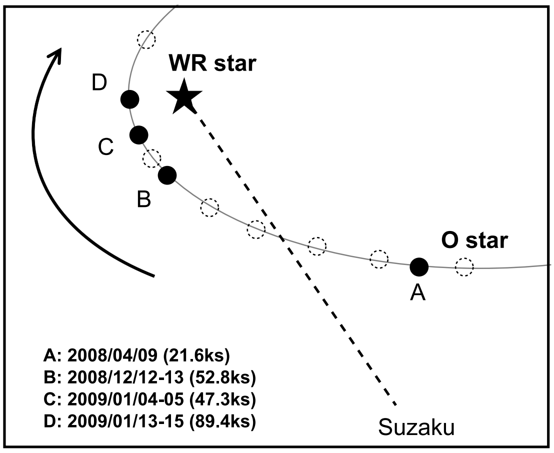

Fig.1. The geometry in four epochs

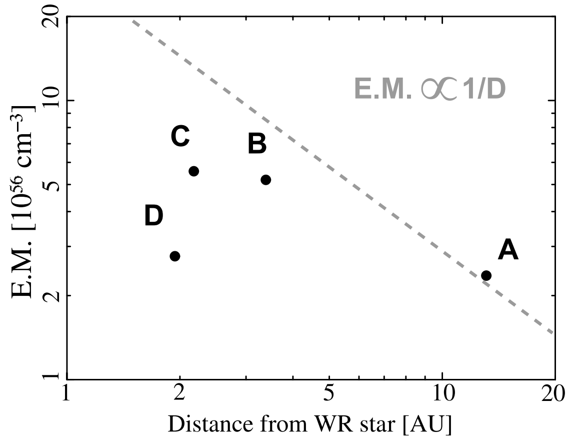

Fig.3. The binary separation vs. emission measure

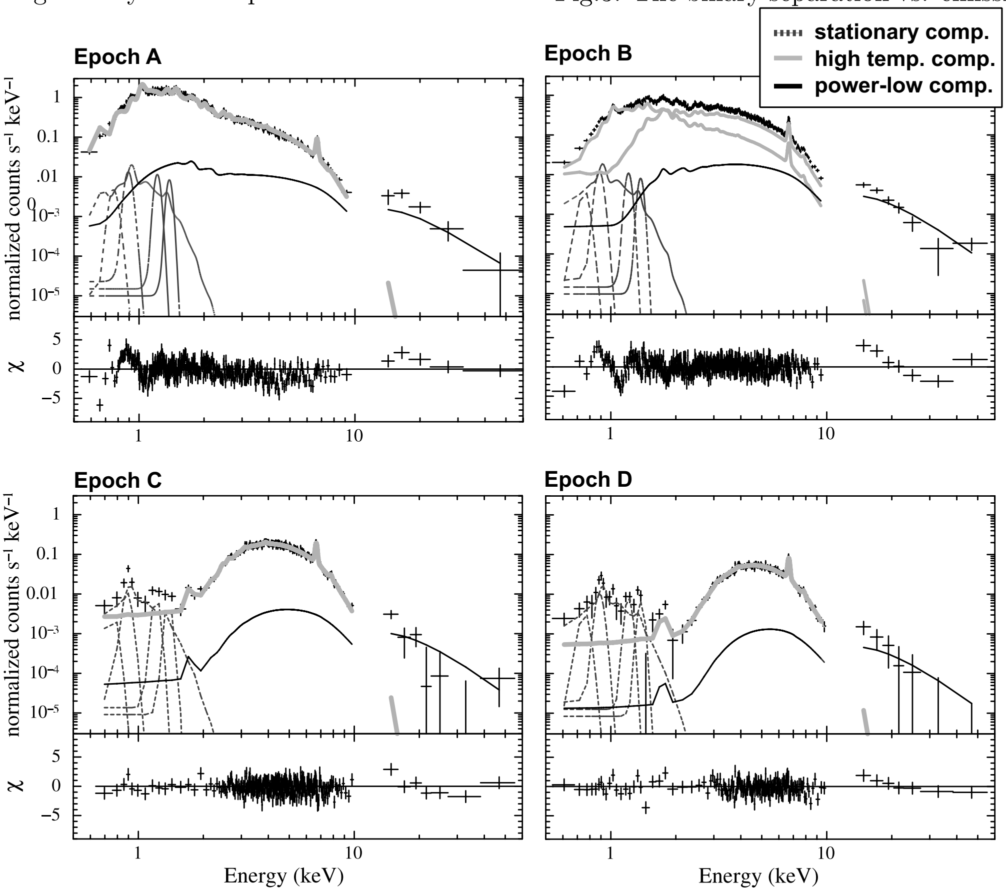

Fig.2. The XIS and HXD-PIN spectra of WR140 in each epoch. Grouped and background subtracted data with uncertainties are plotted. The upper panels shows best-fit model. The lower panel shows the residuals of the fit.

emitting gas. The column density at periastron is a factor of 30 higher than that at pre-periastron, which can be explained as self-absorption of the W-R wind. Figure 3 shows the variation of emission measure. The variation of a high temperature component between epoch A to B is consistent with the theoretically prediction (Usov 1992 ApJ., 389, 635), but the variation between epoch B to D is not obviously. Since the higher plasma temperature is not varied rapidly among the epochs, the variation between epoch B to D would be attribute to emission measure of shocked region.

Third model is a harder power-low component ($\Gamma = 1.1^{+0.4}_{-0.2}$ in epoch B). We detected hard X-ray excess in the HXD band. This is the first time that the hard X-ray excess above 10 keV was detected from a W-R binary. The hard excess emission may be attributable to inverse Compton interactions between relativistic electron and stellar UV photons or to the thermal bremsstrahlung of higher temperature shock plasma.