X-ray Spectral Variation of Eta Carinae through the 2003 X-ray Minimum

Kenji Hamaguchi(1,2), Michael F. Corcoran(1,2), Theodore Gull(3), Kazunori Ishibashi(4), Julian M. Pittard(5), D. John Hillier(6), Augusto Damineli(7), Kris Davidson(8), Krister E. Nielsen(3,9), Gladys Vieira Kober(3,9)

(1) CRESST and X-ray Astrophysics Laboratory NASA/GSFC , Greenbelt, MD 20771, (2) Universities Space Research Association, 10211 Wincopin Circle, Suite 500, Columbia, MD 21044, (3) Astrophysics Science Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771, (4) Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, 77 Massachusetts Ave. NE80-6035, Cambridge, MA 02139, (5) School of Physics & Astronomy, The University of Leeds, Woodhouse Lane, Leeds, LS2 9JT, UK, (6) Department of Physics and Astronomy, University of Pittsburgh, 3941 O'Hara Street, Pittsburgh, PA 15260, (7) Departamento de Astronomia do IAGUSP, R. do Matao 1226, 05508-900, Sao Paulo, Brazil, (8) Astronomy Department, University of Minnesota, 116 Church Street SE, Minneapolis, MN 55455, (9) Catholic University of America, Washington DC20064

We report the results of an X-ray observing campaign on the massive, evolved star Eta Carinae, concentrating on the 2003 X-ray minimum as seen by the XMM-Newton observatory. These are the first spatially-resolved X-ray monitoring observations of the stellar X-ray spectrum during the minimum. The hard X-ray emission, believed to be associated with the collision of Eta Carinae's wind with the wind from a massive companion star, varied strongly in flux on timescales of days, but not significantly on timescales of hours. The lowest X-ray flux in the 2-10 keV band seen by XMM-Newton was only 0.7% of the maximum seen by RXTE just before the X-ray minimum. In the latter half of the minimum, the flux increased by a factor of 5 from the lowest observed value, indicating that the X-ray minimum has two states. The slope of the X-ray continuum above 5 keV did not vary in any observation, which suggests that the electron temperature of the hottest plasma associated with the stellar source did not vary significantly at any phase. Through the minimum, the absorption to the stellar source increased by a factor of 5-10 to NH ~3-4E23 cm-2. The thermal Fe XXV emission line showed significant excesses on both the red and blue sides of the line outside the minimum and exhibited an extreme red excess during the minimum. The Fe fluorescence line at 6.4 keV increased in equivalent width from 100 eV outside the minimum to 200 eV during the minimum. The small equivalent widths of the Fe fluorescence line suggests small fluorescence yield in the companion's low-density wind. The lack of variation in the plasma temperature is consistent with the eclipse of the X-ray plasma during the minimum, perhaps by a clumpy wind from the primary star, although the deformation of the Fe XXV profile and the relatively weak fluorescence Fe line intensity during the minimum may suggest an intrinsic fading of the X-ray emissivity. The drop in the colliding wind X-ray emission revealed the presence of an additional X-ray component which exhibited no variation on timescales of weeks to years. This new component has relatively cool temperature (kT ~1 keV), moderate NH (~5E22 cm-2), large intrinsic luminosity (Lx ~1E34 ergs s-1) and a size <~1" (2300 AU at 2.3 kpc). This component may be produced by the collision of high speed outflows at v ~1000-2000 km s-1 from Eta Carinae with ambient gas within a few thousand AU from the star.

Reference: ApJ in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/astro-ph/0702409

Comments:

Email: kenji@milkyway.gsfc.nasa.gov