The source of anomalously hard x-rays in M17’s central O4-O4 binary

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**Background**

- Name: CEN 1 or Kleinmann’s Anonymous Star
- Location: O4+O4 binary at the center of M17
- Separation: 1.8\(^\circ\) (2900 AU at 1.6 kpc)
- Extinction: \(A_v \approx 10\) (component A), 13 (component B)

**Motivation**

CEN 1A and 1B have extremely hard x-ray spectra and high luminosities. Component A is time variable (see time variability section). We want to know:

- What mechanism produces the extreme x-ray emission?
- How are strong x-rays from O-stars produced by colliding wind binaries (CWB), or magnetically channeled wind shock (MCWS) systems?

**Hard x-ray emission**

Strong x-rays from O-stars come from colliding wind binaries (CWB), or magnetically channeled wind shock (MCWS) systems.

**Line diagnostics**

- **CEN 1B**
  - \(L_x \approx 2 \times 10^{33}\)
  - \(T_\text{eff} \approx 10 \text{ keV}\)

- **CEN 1A**
  - \(L_x \approx 1 \times 10^{33}\)
  - \(T_\text{eff} \approx 3 \text{ keV}\)

**f/i ratio theory**

Helium-like emission complexes (S XV, Si XIII, etc) are subject to alterations of their forbidden-to-intercombination line ratios due to UV photoexcitation of electrons out of the metastable upper level of the forbidden line. Low f/i ratios are thus diagnostic of close proximity to the UV-bright photospheres of O stars.

**New Chandra grating data**

The two sources are separated by only 3.5 pixels, which necessitates custom spectral extraction regions (on right). Spectra were successfully extracted for both components, shown below.

**Results**

CEN 1 completely dominates x-ray emission in M-17, though component B \((L_x \approx 2 \times 10^{33}\), \(T_\text{eff} \approx 10 \text{ keV}\)) is slightly harder and more luminous than A \((L_x \approx 10^{33}\), \(T_\text{eff} \approx 3 \text{ keV}\), during its low state). Component A is found to increase in luminosity by a factor of three. The Si XIII f/i ratio is unaltered for B \((>2)\) but reduced for A. Line widths are very large - larger than those seen in single O stars, and comparable to the wind terminal velocities.

**Discussion**

The very broad lines in CEN 1A and 1B are consistent with the CWB hypothesis; this system contains at least four stars. This interpretation is consistent with recent detection of Paschen line splitting in both components A (on right) and B, indicating that they are both spectroscopic binaries. The high f/i ratio for component B indicates emission far from the star, again consistent with the CWB hypothesis. Component A’s low f/i ratio needs more detailed modeling, though it indicates emission only a few R\(_*\) out. This could suggest an asymmetry in wind momenta or a small binary separation during the observation.

**Time variability**

In this most recent Chandra observation, we see no significant time variability (right, 0\(^\text{th}\) order light curves). However, in 2006 CEN 1A brightened by a factor of 3 [below] in a manner indicative of a CWB periastron approach.

**Acknowledgments**

We thank the Provost’s Office at Swarthmore College and acknowledge support from Chandra grant GO9-0019 to West Chester University and Swarthmore College.

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