X-ray emitting B stars in the Carina Nebula: magnetism or active low-mass companions?

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Abstract

The Chandra Carina Complex Project (CCCP) has detected an important number of X-ray emitting late-B stars in the Trumpler 14 and Trumpler 16 clusters. This result was surprising given the relatively low incidence of magnetic fields in such stars. Multi-object spectroscopy was obtained on GMOS for over 60 of these objects. The goal of this study is to determine whether the X rays are due to intrinsic processes, or whether they origin from young, active low-mass binary companions. By acquiring multiple epochs for each of these 60+ stars, we search for radial velocity shifts indicative of such companions, and flag potential candidates for follow-up observations.

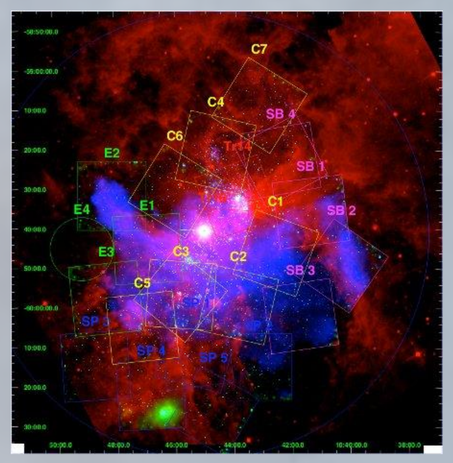

Figure 1: Smoothed Chandra ACIS-I mosaic of Carina: blue = 0.5-2 keV, green = 2-7 keV. The intense, extended region in the south is a cluster of galaxies.

Observations

16 hours of observing time were awarded at the Gemini South telescope, on the GMOS instrument (in multi-object spectroscopy mode). Each cluster (Tr 16 and Tr 14) was divided into two fields of view, requiring 4 masks. Here are the specifications for each mask:

Field of view	Early-type candidates	Late-type candidates
Tr 16 field A	3 (2 + 1 + 0)	15 (11 + 4)
Tr 16 field B	6 (3 + 2 + 1)	10 (5 + 5)
Tr 14 field A	6 (2 + 3 + 1)	12 (8 + 4)
Tr 14 field B	2 (0 + 0 + 2)	14 (9 + 5)

Table 1: Number of candidate B stars on each mask; the numbers between parentheses represent respectively: candidates with no X-ray detection, soft X-ray emitting candidates and hard X-ray emitting candidates (for the early-type candidates), and candidates with no X-ray detection and hard X-ray emitting candidates (for the late-type candidates).

In order to detect binaries with short to intermediate periods, a total of 5 or 6 observations for each field was acquired, spread over a period of a few weeks. Short exposures (80s) and long exposures (800s) were necessary as the range of magnitudes was quite important between the targets (V = 10-15).

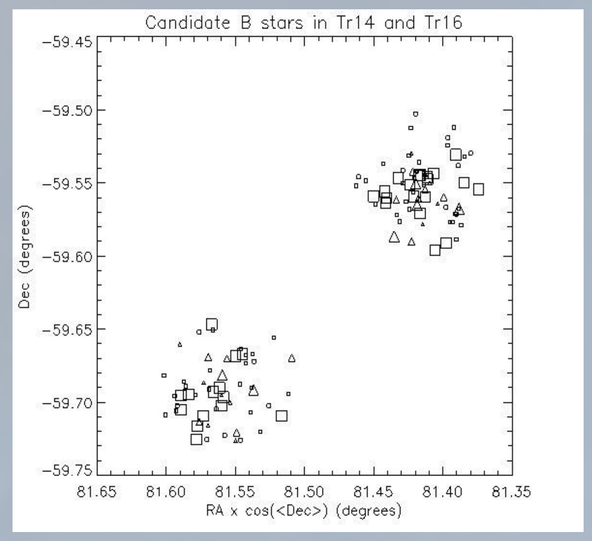

Figure 2: Candidate B stars in Tr14 (upper right) and Tr16 (lower left); triangles mark early-B stars (29) and squares mark mid/late-B stars (95). Largest symbols mark hard X-ray detections (6+33=39), while middle-sized symbols mark soft X-ray detections (12+0=12). Small symbols indicate no X-ray detection (11+62=73).

Preliminary results and current status

- Data reduced; preliminary analysis using the fitting of select spectral lines shows radial velocity variations in a number of stars (e.g. the star shown in Fig. 3)
- For better results, cross-correlation routine will be used, masking problematic regions (nebular emission, CCD gaps)

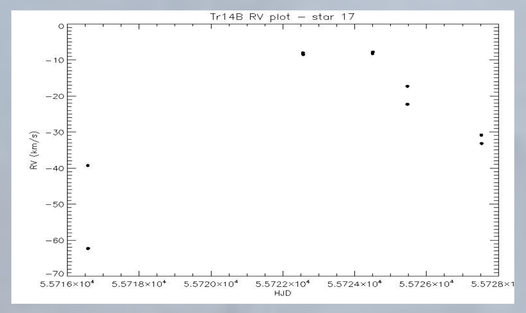

Figure 3: Radial velocity variations for one of the stars from the Tr 14B field. The dispersion between the long and short exposures is indicative of the error bars.

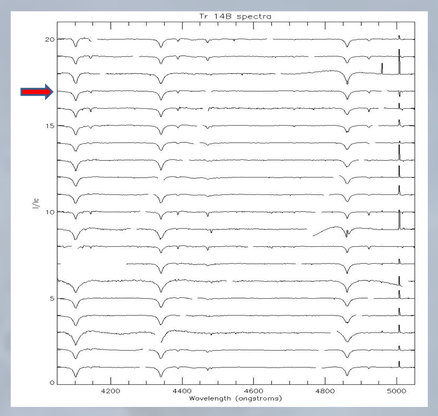

Figure 4: Stacked plot of the spectra obtained in the Tr 14B field. The star from Fig. 3 is highlighted. CCD gaps can be seen, as well as a few normalization issues at the edges of the CCD panels. There is also nebular emission present. A few “filler” stars are also present, which are not part of our targeted sample.

GEMINI OBSERVATORY

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