

Searching for Luminous Blue Variables in nearby galaxies

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Abstract. We have identified five new candidate LBVs in the NE half of M 31 and provide age limits for these objects through the color-magnitude diagrams of their potential parent OB associations. We note that three of the five candidates are not in OB associations nor are they in prominent H II regions.

1. Introduction

The post-main sequence evolution of massive stars is a crucial, but still poorly understood progression (Bohannon & Walborn 1989). In this regime LBVs play an important role as the descendants of massive main sequence O stars, and the probable progenitors of Wolf-Rayet stars. The details of transit into and out of the LBV stage and the duration are only tentatively known as few LBVs have been identified in nearby galaxies (Humphreys & Davidson 1994). We are addressing this problem in two ways. We have developed an effective search technique to find massive stars with extreme mass loss rates in nearby galaxies, and we are studying the environments of known LBVs and new candidates to constrain their ages.

2. Observations

We have obtained spectroscopy of five new candidate LBVs and 15 remaining targets in the NE half of M 31 with the ARC 3.5-m telescope (King, Walterbos & Braun 1998; King, Walterbos & Gallagher 1999). With the WIYN 3.5-m and ARC 3.5-m telescopes we have obtained high-resolution *UBR*, H α and *JHK* images of the environments of the five candidates, and two of the M 31 LBVs (King, Gallagher & Walterbos 1999).

3. Discussion

We have limited the ages of the candidate LBVs, and the LBVs V 15 and Var A-1 with color-magnitude diagrams (CMDs) of the potential parent OB associations and by noting the proximity of prominent H II regions (a sign of youth). Red-

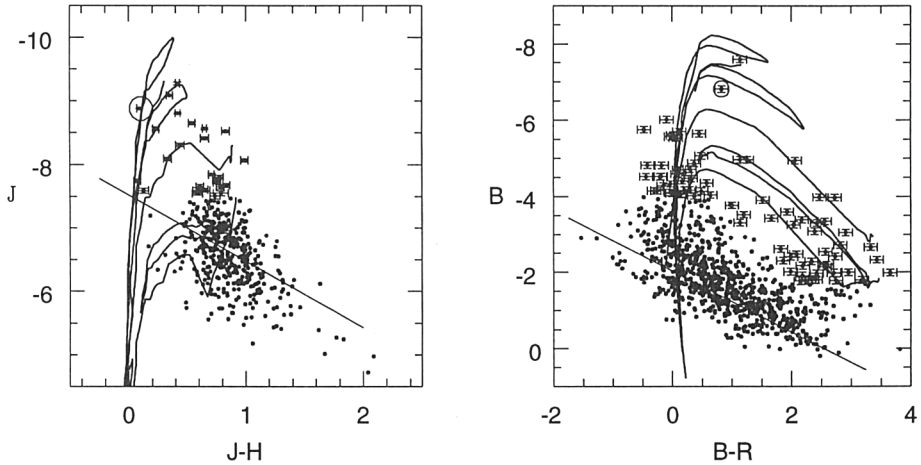


Figure 1. IR and optical CMDs of stars in OB 38 within 280 pc of LBV V 15 (circled). Isochrones are $t = 5, 7, 10,$ and 20 Myr. The completeness limits are the diagonal lines. Error bars are shown for some stars.

denings for the associations and age constraints were determined from the use of the isochrones of Meynet *et al.* (1994), where we have added red and infrared intrinsic colors for consistent interpretation of the CMDs. This is demonstrated for V 15 in Figure 1.

Points of interest follow:

- (1) most of the potential parent OB associations are 4–5 Myr old, with some showing a spread to 10 Myr;
- (2) the spectra for K 411 and K 895 show radial space motion of $\sim 40 \text{ km s}^{-1}$ with respect to the background H I;
- (3) three out of the five candidates, K 411, K 895, and K 114a are not in OB associations nor are they in prominent H II regions suggesting they are runaways or field stars formed *in situ*; and
- (4) we anticipate finding 20–25 candidate LBVs in all of M 31.

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