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# LUMINOUS BLUE VARIABLES IN THE LOCAL UNIVERSE

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**Preliminary results of a candidate luminous blue variable (LBV) search made in a region of M33 are presented. The objects were found with narrow band filter images centered on characteristic emission lines of these objects. We show that the GTC, with the appropriate instrumentation, would generate important results through the analysis of high resolution optical spectral analysis of these kinds of objects in the Local Group.**

## 1. INTRODUCTION

Luminous blue variables (LBVs) are irregular variables characterized by their intrinsic high luminosities and blue colors, their photometric behavior, and their related spectroscopic changes. Members of this group have been identified in the Milky Way and in nearby galaxies. Recent reviews of LBVs can be found in Humphreys & Davidson 1994, and in Bohannan 1997.

Is believed that these objects represent one of the latest evolutionary stages of some of the most massive stars. It is expected that during the LBV phase at least 5 (or even 10) $M_\odot$ are lost, making a great contribution to the input of momentum and to the chemical enrichment of the interstellar medium. The importance of the LBV number in a particular galaxy is its direct relation with the lifetime of this evolutionary stage. Humphreys (1991) deduced that the LBV phase lifetime is $\sim$25 000 yr by comparing the number of known Wolf–Rayet (WR) stars with the number of LBVs in the Large Magellanic Cloud (LMC), but she also pointed out that the lifetimes of LBVs can be greater because not all the LBVs in the LMC are known. The spectra of LBVs and candidate LBVs (LBVcs) have in common that their H and He I lines are in emission. One of the He I lines (5015.6 Å) usually falls in the wavelength band of the filters used to isolate the [O III] 5007 Å line, and sometimes objects with emission in He I are confused with objects with [O III] emission. Spiller (1992) classified an object (H 108 = B 517, Humphreys & Sandage 1980) as a possible H II region because it appears in emission in the [O III] images of M33. The spectrum showed by Spiller (1992) and in Corral (1996) demonstrate that this object is an LBVc.

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## 2. LBV IN M33

In M33 there are at least six known LBVs. Four of them were first identified by their variability: Var B, Var C, Var 2 (Hubble & Sandage 1953), and Var 83, (van den Bergh et al. 1975) and two more LBVs have recently been identified : UIT 003 (Kurtev et al. 1999) and B 416 (Shemmer et al. 2000). B 324 has also been proposed as an LBV on the grounds of its spectral variability (Herrero et al. 1994; Monteverde et. al. 1996).

The present search for LBVs is based on images of an M33 region acquired with filters that isolate H$\alpha$, He III 5007 Å (or He I 5015.6 Å) and He I 5876 Å. Using continuum images in a band close to the emission lines, we isolate objects that present emission in these spectral lines. The observations were made using ALFOSC at the 2.5 m Nordic Optical Telescope telescope on La Palma in direct image operating mode. The images were reduced with IRAF in the standard way and the continuum images were subtracted from the in-line images, after scaling them, in order to isolate the emission object and areas. The region observed was chosen because it covers spiral arms and interarm areas, there are previous observations in the literature (Massey et al. 1995) and also two of the LBVs known in M33 (Var C and Var B) can be observed. We found that only 14 objects fulfill the condition that the emission in the He I line filter ($\lambda_c$ = 5876 Å) is larger than the emission in the He III filter ($\lambda_c$ 5010 Å), a characteristic also found in the case of the known LBVs. In Figure 1 we present a finding chart of two of the new LBVc found. It turns out that we also found objects that can be classified as planetary nebula candidates (PNcs). These objects were pinpointed by the fact that they do not show any counterpart in the continuum filter images. A list of the PNcs found in this study are presented elsewhere (Corral & Herrero 2001).



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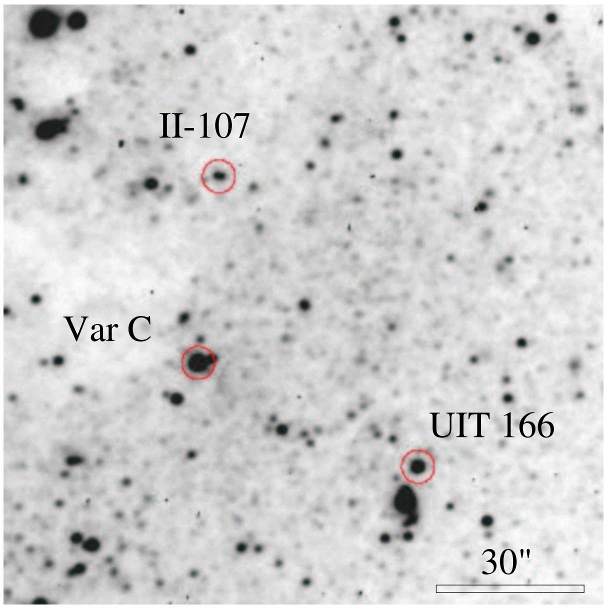


Fig. 1. Finding chart for two new LBVcs found near the M33 LBV Var C (north up and east to the left).

## 3. THE GTC AND THE LOCAL GROUP SUPERGIANTS

Spectroscopic analysis of extragalactic stars beyond the Milky Way are at the limit of 4 m telescope capabilities (see Monteverde et al. 2000; Smartt et al. 2001; Urbaneja et al. 2002) and can only be fully exploited with 10 m class telescopes (McCarthy et al. 1995; McCarthy et al. 1997; Venn et al. 2000). With the advent of the GTC we could contribute to the analysis of these objects, making possible the determination of their parameters and metallicities.

The S/N for a spectrum can be calculated as:

$$S/N \sim \sqrt{[N \times A \times \mathrm{QE_{CCD}} \times \tau \times d \times t_{\mathrm{int}}]},$$

where $N$ is the number of photons above the atmosphere, $A$ the collecting area of the telescope ($7.85 \times 10^5$ cm$^2$ for the GTC), $\tau$ the combined transmission of the atmosphere, telescope, and spectrograph, $d$ the dispersion of the spectrum, and $t_{\mathrm{int}}$ the integration time in seconds. Assuming a transmission of $\sim$12%, a dispersion of 0.1 Å/pixel, a CCD QE of $\sim$60%, and an integration time of 1 hr, we obtain a spectrum of a B supergiant in M33 ($\sim$17 mag) with $SN \sim 150$. Also an $R = 4000$ spectrum of an O supergiant at the distance of M81 (3.4 Mpc, $\sim$22 mag) will have $S/N \sim 60$ in an 8 hr integration.

The GTC, together with OSIRIS and its photometric and multiobject spectroscopic modes, will be crucial for the study of these objects.

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