

# K-Type Supergiants in the Large Magellanic Cloud

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**Abstract.** Two-dimensional spectral classifications, on a narrow-band photometric system that measures near-infrared bands of TiO and CN, are being obtained for several hundred previously unclassified “suspected late-type supergiants” in the Large Magellanic Cloud. The objective is to identify supergiants of spectral type K, which are known to be plentiful in the Small Magellanic Cloud but were thought to be rare in the LMC. In the fields examined to date, 35 % of the targets are found to be K-type supergiants, while 25 % are early-M supergiants and 40 % are foreground stars of lower luminosity.

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## 1. The Problem

The brightest stars of the Large Magellanic Cloud are supergiants with magnitudes in the range  $V = 11 - 14$  and colors that are either very blue (spectral types O, B, and A) or very red (type M). The apparent absence of supergiants of intermediate types (F, G, K) is particularly noteworthy because the Small Magellanic Cloud is known to contain large numbers of K-type supergiants.

Are K-type supergiants really absent from the LMC, or have they simply been missed by the survey techniques employed to date? Near-infrared objective-prism surveys of the LMC by [Westerlund \*et al.\* \(1981\)](#) and Blanco (unpublished) have identified several hundred M supergiants on the basis of their TiO absorption near 7100 Å. These TiO-based surveys, which had no way of identifying K stars, were subsequently used by [Humphreys \(1979\)](#) in her spectroscopic study of the red supergiants in the LMC. By contrast, when [Elias, Frogel, & Humphreys \(1985\)](#) studied the red supergiants of the SMC, no such infrared TiO-based survey of the SMC was available, and they selected their targets from a survey by [Prévoit \*et al.\* \(1983\)](#) in which the main criterion had been the slope of the spectrum on their blue/visual objective-prism plates.

In an attempt to avoid the selection effects that may have artificially removed K-type supergiants from the LMC sample, I have gone back to the blue objective-prism survey by [Sanduleak & Philip \(1977\)](#) who reported 609 stars suspected of being late-type supergiants on the basis of their spectral slope and a magnitude in the range  $V = 11.0 - 13.5$ . Interestingly, the great majority of these had not been picked up in Westerlund’s earlier TiO-based surveys. Are these the “missing” K-type supergiants? They must be of spectral types G, K, or early M, but are they LMC supergiants or foreground stars of lower luminosity?

## 2. Method

Sanduleak & Philip (1977) marked their suspected LMC late-type supergiants, as well as carbon stars, on charts of the Hodge-Wright Atlas (Hodge & Wright 1967). In the central  $5 \times 5$  array of Atlas fields, which includes nearly all of the visible Cloud and some outlying regions, they marked 589 suspected late-type supergiants, and these comprise my target list.

Stars are assigned two-dimensional (temperature/luminosity) classifications from photometric measurements in 5 narrow-band filters, which include bands of TiO and CN and continuum points in the region 7100–10400 Å. The great majority of stars in this sample can be given unambiguous two-dimensional spectral types by this method, although a few peculiar stars have also been encountered (including two very red, weak-banded stars which may be halo giants of extremely low metallicity).

All observations for this project have been obtained at the Cerro Tololo Inter-American Observatory. The work began in the 1990s with a photoelectric photometer at the 1.0-m telescope, but was discontinued when photoelectric photometry stopped being supported. After a hiatus, observations have resumed with a CCD photometer at the 0.9-m telescope, now operated by the SMARTS consortium. With the latter arrangement, observations of the LMC target stars consist of 60-second integrations at each of the first four filters centered at 7120, 7540, 7810, and 8120 Å, while a 600-second integration is required for the long-wavelength (10350 Å) continuum point.

## 3. Preliminary Results

Since the work is still in progress, useful statistics can be given only for the 6 fields which have complete observations (Hodge-Wright fields 37, 38, 46, 54, 62, and 63). Results for the 133 suspected late-type supergiants in these fields break down as follows:

Confirmed K-type supergiants :	46	(35 %)
Early-M supergiants :	34	(25 %)
Probable foreground stars :	53	(40 %)

In short, the majority (60 %) of the target stars in these fields are classified as supergiants of luminosity classes Ib, Iab, or Ia, and are thus spectroscopically confirmed as members of the LMC. Their spectral types are nearly all K4, K5, M0, and M1 – and their distribution is similar to that found by Elias *et al.* (1985) in the SMC.

Individual types will, of course, be published when the observations are complete.

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