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A Photometric Survey of Field Stars in the Large Magellanic Cloud: Probing its Star-Formation History[1]

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1. Introduction

The Large Magellanic Cloud (LMC) is unique among galaxies in the Local Group in that it is the most massive non-spiral, is relatively gas-rich, and is actively forming stars. Determining its star-formation rate (SFR) as a function of time will be a cornerstone in our understanding of galaxy evolution. The best method of deriving a galaxy's past SFR is to compare the densities of stars in a color-magnitude diagram (CMD), a Hess diagram, with model Hess diagrams. The LMC has a complex stellar population with ages ranging from 0 to $\sim$ 14 Gyr and metallicities from $-2 \lesssim$ [Fe/H] $\lesssim -0.4$, and deriving its SFR and simultaneously constraining model input parameters (distance, age-metallicity relation, reddening, and stellar models) requires well-populated CMDs that span the magnitude range $15 \leq V \leq 24$. Although existing CMDs of field stars in the LMC show tantalizing evidence for a significant burst of star formation that occurred $\sim$ 3 Gyr ago (for examples, see Westerlund et al. 1995; Vallenari et al. 1996; Elson, et al. 1997; Gallagher et al. 1999, and references therein), estimates of the enhancement in the SFR vary from factors of 3 to 50. This uncertainty is caused by the relatively large photometric errors that plague crowded ground-based images, and the small number statistics that plague CMDs created from single Wide Field Planetary Camera 2 (WFPC2) images.

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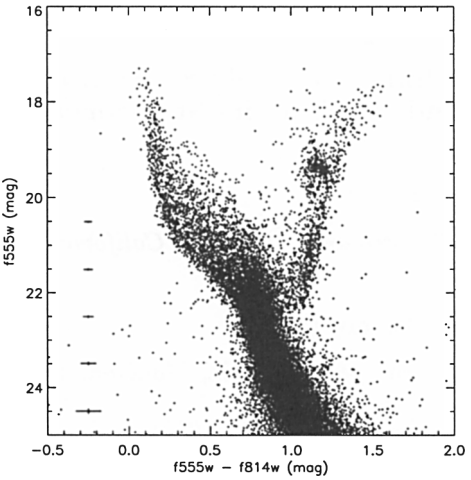

Figure 1. A CMD containing $\sim$ 28,000 stars from one WFPC2 pointing in the LMC bar. (Zero-points have been added to the instrumental magnitudes to approximate V and V-I magnitudes.) Notice the structure in the main-sequence turnoff region at $f555w = 21.5$ and 22 mag, signs of discontinuities in the SFR and/or age-metallicity relation.

2. Our Photometric Survey of LMC Areas

We are combining multicolor imaging of six areas of the LMC obtained with the Cerro-Tololo Inter-American Observatory 1.5-meter telescope with deeper, higher-spatial resolution, WFPC2 imaging in two of these fields. One area lies at the center of the bar (see Figure 1) and one lies in the disk approximately 2° from the center. Crucial ground-based observations provide data on stars with V $\lesssim$ 18.5 that are saturated in our WFPC2 images, an accurate calibration of WFPC2 photometry, and help quantify problems such as WFPC2's charge-transfer effect. Our goal is to create CMDs for numerous areas that each will contain $\sim 10^4$ stars in the critical magnitude range $20 \leq V \leq 23$. By modeling Hess diagrams with such a large sample, we can measure a 20% change in the star-formation rate averaged over 1 Gyr intervals at approximately the 2-sigma level. By comparing numerous fields in the bar and disk, we can begin to disentangle the histories of the LMC's three distinct components: the bar, the disk, and the thick disk/halo.

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