Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
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AGB stars of the Magellanic Clouds as seen within the Δa photometric system

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Abstract. The a-index samples the flux of the 5200 Å region by comparing the flux at the center with the adjacent regions. The final intrinsic peculiarity index Δa was defined as the difference between the individual a-values and the a-values of normal stars of the same colour (spectral type). Here we present, for the first time, a case study to detect and analyse Asymptotic Giant Branch (AGB) stars in the Magellanic Clouds. For this, we use our photometric survey of the Magellanic Clouds within the a-index. We find that AGB stars can be easily detected on the basis of their Δa index in an efficient way.

Keywords. Magellanic Clouds, stars: AGB and post-AGB, techniques: photometric

1. Introduction

Asymptotic Giant Branch (AGB) stars trace the intermediate age population of galaxies (ages between one and several Gyr). In near-infrared (near-IR) light they are often the brightest isolated objects in a galaxy and can be studied at distances beyond 1 Mpc. There are two main kinds of AGB stars: oxygen-rich stars (spectral type M or K) and carbon-rich stars (spectral type N or C). When the number of O-atoms equals that of C-atoms, the AGB star is of type S. It is not straightforward to identify S stars either photometrically or spectroscopically, and this introduces as well intermediate classes of AGB stars (e.g. MS and SC). Single stars enter the AGB phase as oxygen-rich, but may be converted into carbon-rich stars after several short episodes in which matter that has been enriched in carbon nuclei by nuclear fusion is dredged-up to the stellar surface.

2. AGB stars in the Magellanic Clouds

Cioni & Habing (2003) showed that the ratio between C-rich and O-rich AGB stars (C/M ratio) varies within the Magellanic Clouds (MCs). Interpreting C/O changes as variations in the mean metallicity, they concluded that in the Large Magellanic Cloud (LMC) a metallicity gradient is present. Later, this result was revised (Cioni *et al.* 2006a) using new stellar models and taking into account different age distributions. It was suggested that a fit to the K_s-band magnitude distribution of both C- and O-rich AGB stars should be particularly useful to detect variations on the mean age and metallicity across the surface of nearby galaxies. For some well-defined LMC regions, both the mean age and metallicity were found to span the whole range of grid parameters. The Small Magellanic Cloud (SMC) stellar population was found to be on average 7 to 9 Gyr old, but older stars are present at its periphery and younger stars are present towards the

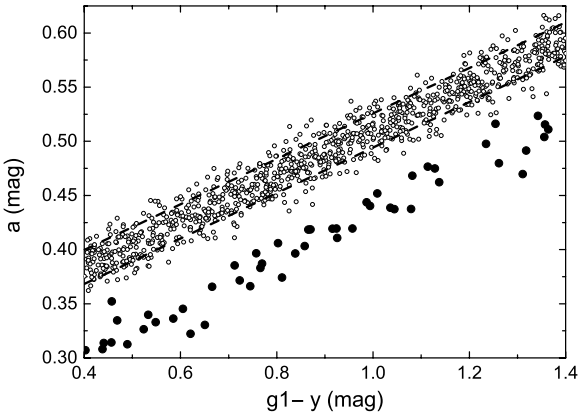

Figure 1. Δa photometry of a selected field in the LMC. The known AGB stars (filled circles) are clearly distinct from the normal MS stars (open circles). The dashed lines denote the 3σ level due to observational errors.

LMC (Cioni *et al.* 2006b). The metallicity distribution traces a ring-like structure that is more metal rich than the inner region of the LMC.

3. The Δa photometric system and results

Basically, the Δa photometric system consists of one filter which measures the 5200 Å region ($g2$) and an additional information about the continuum flux of the same object. This can be either achieved by measuring the flux at the adjacent spectral regions (using $g1$ and y) or by any other effective temperature sensitive colour.

During the last years, we have performed a survey of almost the complete MCs in the $g2$ filter. The CCD photometric measurements were obtained with the 1.54m Danish and 2.2m MPG telescope at the La Silla Observatory in Chile. The high accurate measurements yielded a mean error of a few mmags for the individual stars.

We have selected the stars published by Cioni & Habing (2003) and Cioni *et al.* 2006a,b) for our investigation. The stars on the main sequence are already quite faint in the $g2$ filter. From our analysis we conclude that

- 99% of all AGB stars in the MCs can be unambiguously detected (Figure 1).
- The C/M ratio can be directly deduced from the Δa value.
- This method works in the optical region without any pre-selection of targets.

In a forthcoming study, we publish all our observations in the MCs of AGB and post-AGB stars.

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