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The AGB Stellar Population in the Magellanic System: First Results from the VMC Survey

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Abstract. Mass loss is one of the fundamental properties of Asymptotic Giant Branch (AGB) stars, and through the enrichment of the interstellar medium, AGB stars are key players in the life cycle of dust and gas in the Universe. However, a quantitative understanding of the mass-loss process is still largely lacking, in particular its dependence on metallicity. Direct measures of mass-loss rates in AGB stars of the Magellanic Clouds (MCs) are limited to samples of ~ 100 stars (e.g. Groenewegen et al. 2009). Estimates on larger samples of stars are, to date, based on empirical relations between mass-loss rates and colors in the mid-IR (e.g. Matsuura et al. 2009). Our project aims at a direct measure of mass-loss rate in all AGB stars in the MC system.

1. The VMC Survey

The Vista Magellanic Cloud Survey (VMC) is one of six ESO public survey projects that will be carried out with the new ESO telescope VISTA (Cioni et al., submitted). It will image about 180 square degrees in the Magellanic system (LMC, SMC, the Bridge and the Stream) in the YJK_s wavebands, reaching a depth of $K_s \sim 20.5$ mag. Observations started in November 2009 and will be completed in 5 years. Images and catalogs will be delivered to the astronomical community at regular intervals following the ESO policy for public surveys. The VMC data will provide a detailed history of star formation across the Magellanic system and a measurement of its 3-D geometry.

2. Data Analysis

To date, VISTA has observed 6 VMC fields located in the LMC, which were processed by the v1.0 VISTA pipeline. For our project it is fundamental to combine near-IR data with optical photometry and mid-IR data from *Spitzer*. Hence, we started analysing the data obtained for one of the fields in common with the SAGE survey (Meixner et al. 2006) and the Magellanic Clouds Photometric Survey (Zaritsky et al. 2004) in the optical $UBVI$ bands. Figure 1 shows the VMC color-magnitude diagram for this field. Stars brighter than $K_s \sim 12$ are in the non-linear regime of VISTA detectors, but the correction applied by the pipeline extends the dynamic range by 2 or 3 magnitudes. We started the analysis considering only the 97 stars with J–$K_S > 1.5$ (2MASS magnitudes). This is a preliminary selection criterion, adopted to select only stars with mass-loss rates above $\sim 10^{-7}$ $M_\odot$/yr. In the future we will extend the analysis to bluer AGB stars.

The spectral energy distribution (SED) for all selected stars, extending from the optical to the mid-IR, was fitted using the DUSTY code (Ivezic et al. 1999), Aringer

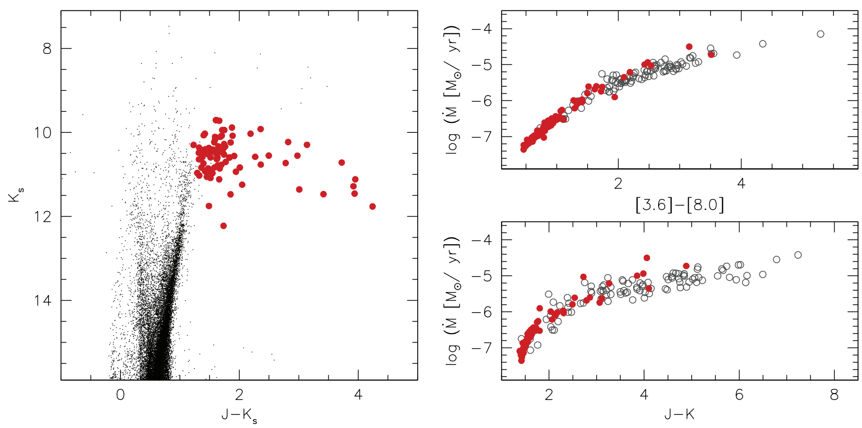

Figure 1. *Left*: VMC near-IR color-magnitude diagram. *Large red circles* show AGB stars used for the SED analysis. Note that non-linearity corrections are not reliable stars brighter than $K_s \sim 10$. Red objects brighter than $K_s \sim 10$ are saturated stars, with unreliable VMC photometry. *Right*: Mass-loss rates as a function of color. *Large red circles* show results from VMC data, while *open grey circles* are results from Groenewegen et al. (2009).

et al. (2009) models for carbon stars, and assuming that the dust around carbon stars is a combination of amorphous carbon and silicon carbide, as in Groenewegen et al. (2009). Since a few O-rich stars are expected among the selected stars (see Matsuura et al. 2009), we tried to fit the SEDs using also MARCS models for O-rich stars. For all 97 stars the fit was sensibly better using C-rich models. There are two possible explanations: (1) the observed field does not contain any O-rich stars, or (2) it is impossible with the available data to disentangle the O- and C-rich AGB populations. To give a reliable explanation to this issue we need to wait for future observations of other VMC fields, containing spectroscopically classified O-rich AGB stars.

Preliminary results of our analysis are shown in Figure 1. The reliability of our measures is indicated by their perfect agreement with the results of Groenewegen et al. (2009), obtained for 101 spectroscopically confirmed C stars in the LMC and SMC. Our sample extends the mass-loss measures to all AGB stars and will be the most complete database of measured mass-loss rates, representing a fundamental tool to understand dust properties, mass-loss processes, and hence the evolution of AGB stars.

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