The Magellanic System: Stars, Gas, and Galaxies
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Galactic C and S Stars as Guidelines for Magellanic Cloud AGB Stars

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Abstract. The study of the evolutionary properties of Asymptotic Giant Branch stars still presents unresolved topics. Progress in the theoretical understanding of their evolution is hampered by the difficulty to empirically explain key physical parameters like their luminosity, mass loss rate and chemical abundances. We are performing an analysis of Galactic AGB stars trying to find constraints for these parameters. Our aim is to extend this analysis to the AGB stars of the Magellanic Clouds and of the Dwarf Spheroidal Galaxies using also mid-infrared observations from the Antarctic telescope IRAIT. AGB sources from the Magellanic Clouds will be fundamental in our understanding of the AGB evolution because they are all at a well defined distance (differently from the Galactic AGBs). Moreover, these sources present different values of metallicity: this fact should permit us to examine in a better way their evolutionary properties, comparing their behaviour with the one from Galactic sources.

Keywords. stars: AGB and post-AGB, stars: evolution, infrared: stars

1. Introduction

The Asymptotic Giant Branch (hereafter AGB) phase lies at the end of the active life for low- and intermediate-Mass Stars (M $<$ 8 $M_\odot$); a detailed description can be found in Busso et al. (1999) and references herein. Stars in this phase lose mass very effectively; stellar winds deeply affect their evolution, and are fundamental for the C-enrichment of the Interstellar Medium. Moreover, AGB winds account for about 70% of all the matter returned after stellar evolution (Sedlmayr 1994) and provide the starting conditions for the formation of planetary nebulae. Radiation from cool dust particles in the infrared (IR) normally dominates the energy distribution of AGB stars: this fact is due to their strong stellar winds building up huge dusty circumstellar envelopes.

Our quantitative knowledge of crucial chemical and physical parameters of AGB sources is unfortunately still poor. Among the uncertain issues we emphasize in particular the mass loss rate and the distance, hence also the luminosity. These facts have hampered for decades our capability of satisfactorily describing the physics of these dust-enshrouded variable objects, despite their evolution is based on the two best known nucleosynthesis phases, namely H and He burning.

2. A Study of Galactic AGBs

We are performing an analysis of Galactic AGB stars looking for correlations between their basic parameters (bolometric luminosity, mass loss rate, etc) and observable quantities. Our main aim is that of establishing observationally-based criteria permitting a more quantitative determination of mass loss rates and of luminosities for the various types of AGB stars, thus providing general rules to be adopted in the improvement of

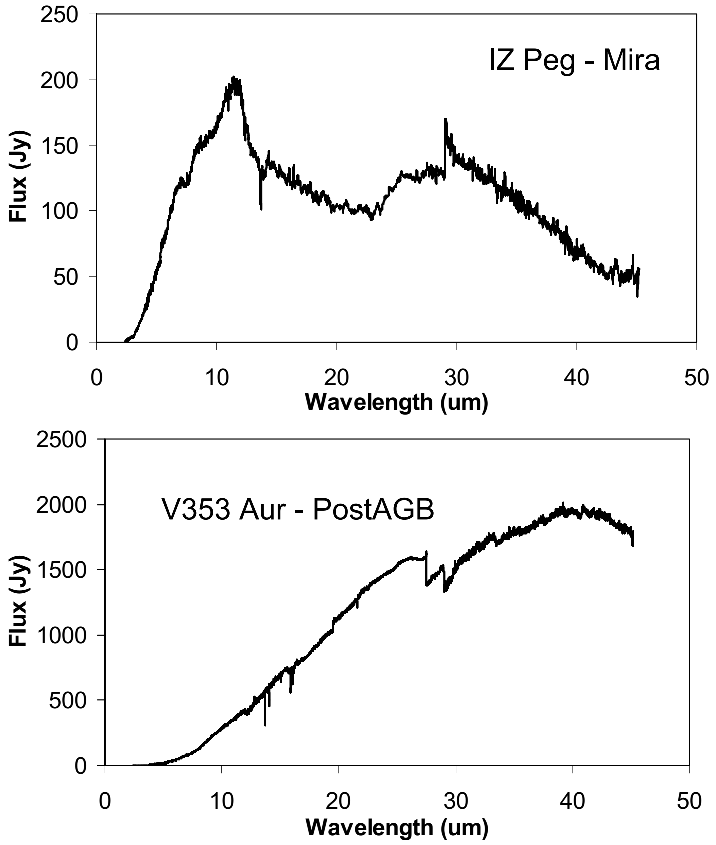

Figure 1. ISO-SWS1 spectra of 2 C-rich evolved AGB stars (Guandalini et al. 2006).

stellar codes. Extensive samples of well studied Galactic AGB stars (M-type, S-type, C-rich) have been collected. They are large enough (several hundreds of sources per type) that conclusions on them have a good statistical significance. They also have detailed and accurate Spectral Energy Distributions (SEDs) at near- and mid-IR wavelengths and, very often, reliable measurements of mass loss rates and distances. The first results of this ongoing research have been already published for carbon-rich and S-type stars (Guandalini et al. 2006, Busso et al. 2007, Guandalini & Busso 2008).

3. The Importance of Infrared Observations

An extended wavelength coverage is fundamental in the study of the evolutionary phases of AGB stars. In order to show this, Fig. 1 displays the SEDs of evolved AGBs (usually Miras), which emit a large part of their flux at mid-IR wavelengths. As a consequence, both near and mid-IR observations sources are necessary to obtain good estimates of the apparent bolometric magnitudes, either by physically integrating the SEDs, or by applying pre-calibrated, reliable bolometric corrections (BC). Examples of such corrections are presented in Fig. 2 as a function of infrared colours (see Guandalini et al. 2006, Guandalini & Busso 2008). Once mid-IR wavelengths and bolometric corrections have been properly included, an example of the (absolute) HR diagrams that can be obtained is shown in Fig. 3. The straight dashed line illustrates how, at least for Mira variables,

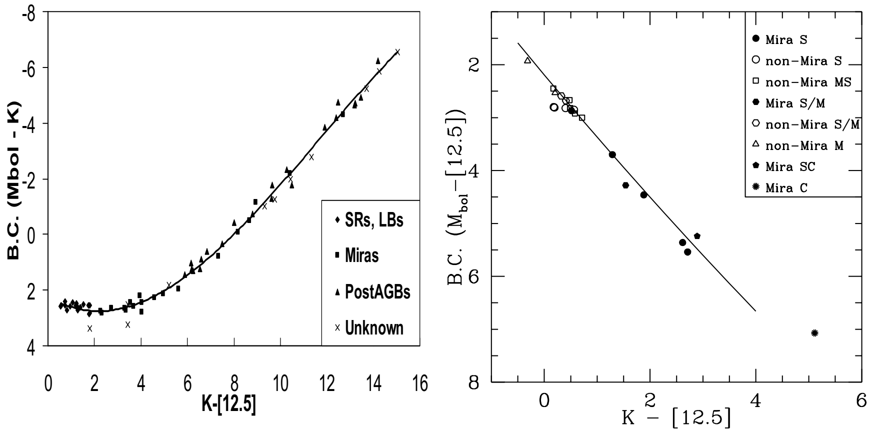

Figure 2. Bolometric Corrections for samples of C-rich (left) and S-type (right) AGB stars.

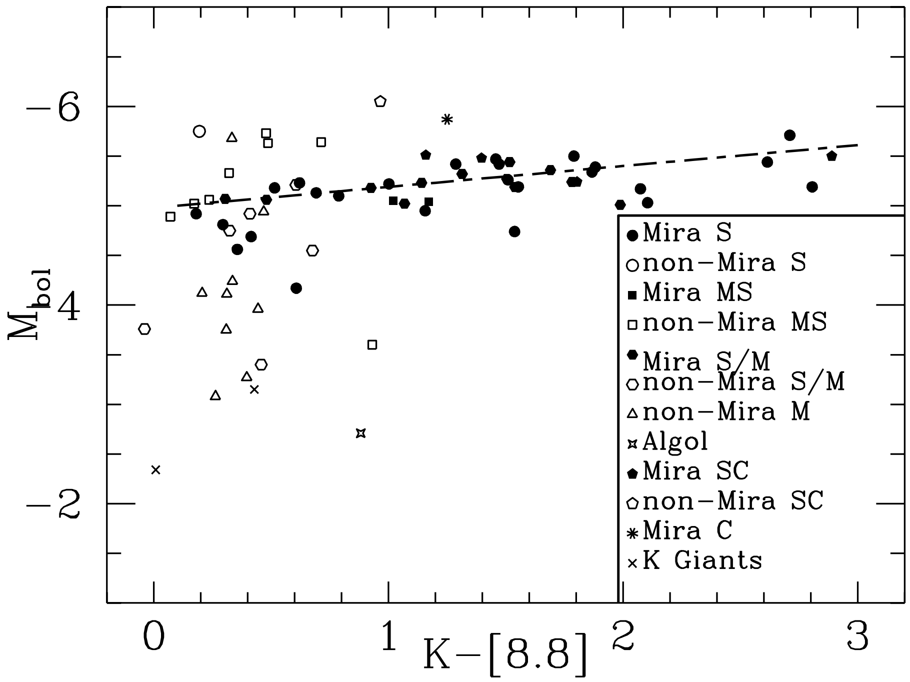

Figure 3. HR diagram of a sample of S-type stars (Guandalini & Busso 2008).

a rather well defined relation emerges between the absolute bolometric magnitude and a near-to-mid infrared color (this last also directly linked to the extension and temperature of the circumstellar envelope).

4. AGB Stars and Magellanic Clouds

The study of the AGB phase through the analysis of Galactic sources presents many problems. As an example we can remember the large difficulties in estimating their distances. AGB sources from the Magellanic Clouds will therefore be fundamental in our understanding of the AGB evolution, because for them the problem of obtaining reliable distances is avoided by the good knowledge of the distance modulus. The above fact allows a good estimate for the luminosity in each photometric band, so that our bolometric corrections would provide the bolometric magnitudes directly. Moreover, AGB sources of the two Magellanic Clouds have different values of the metallicity, both with respect to each other and with respect to the Galaxy. This will allow us to study global properties (luminosity, mass loss rate, ratio of the number of C stars to M giants) also as a function of the chemical composition. Our aim is therefore to extend the analysis, which has been almost completed for Galactic AGB stars, to the Magellanic Clouds and to close-by Dwarf Spheroidal Galaxies. For doing this, important tools will be offered by the exploitation of Antarctic Infrared Astronomy, as offered by the Italo- Spanish robotic telescope IRAIT (Tosti et al. 2006).

References

Busso, M., Gallino, R., & Wasserburg, G.J. 1999, *ARAA*, 37, 239
Busso, M., Guandalini, R., Persi, P., Corcione, L., & Ferrari-Toniolo, M. 2007, *AJ*, 133, 2310
Guandalini, R., Busso, M., Ciprini, S., Silvestro, G., & Persi, P. 2006, *A&A*, 445, 1069
Guandalini, R., & Busso, M. 2008, *A&A*, 488, 675
Sedlmayr, E. 1994, *Lecture Notes in Physics*, 428, 163
Tosti, G., Busso, M., Nucciarelli, G., et al. 2006, *SPIE*, 6267, 47