Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
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Long Period Variables in Local Group dwarf Irregular Galaxies

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Abstract. The long-term SAAO survey of Local Group galaxies in the near-infrared (JHK_s) has included five dwarf irregulars (dIrr), namely, NGC 6822, IC 1613, WLM, Sgr dIG and NGC 3109. We have found long-period (Mira) variables in all of them. Most of the Miras, which follow a linear LMC period-luminosity (PL) relation well, are carbon-rich. A small group of oxygen-rich Miras are brighter than the linear PL relation predicts, presumably because they are undergoing hot-bottom burning (HBB).

Keywords. galaxies: Local Group, stars: AGB, stars: variables: Mira

1. Introduction

A survey of Local Group galaxies has been conducted at SAAO using the IRSF 1.4-m telescope and the SIRIUS camera that produces simultaneous JHK_s images. Five dwarf irregular galaxies have been observed, for three of which results have been published (NGC 6822: Whitelock *et al.* 2013; IC 1613: Menzies *et al.* 2015; Sgr dIG: Whitelock *et al.* 2018). Data for the other two (WLM and NGC 3109) are being prepared for publication. Because of the relatively small size of the telescope, the limiting magnitude is typically 18.5 mag at Ks. This limits the population of stars that we can observe in a given galaxy. Thus in NGC 6822 we reach well below the tip of the RGB (TRGB), while in NGC 3109 the limit is about 1 mag brighter than the TRGB. There are repercussions for very red stars, which might be well above the Ks limit but are too faint for J; this effect should be borne in mind when interpreting relative numbers of variables in different galaxies.

2. WLM and NGC 3109

WLM is an isolated galaxy in the Local Group, with a moderately low metallicity, [Fe/H] = −1.28, in which about 30% of the stars were formed by 10 Gyr ago, while there was a recent burst of star formation starting about 3 Gyr ago. Six Mira variables with periods in the range 184 to 520 days have been found. This is likely to be an underestimate of the full complement of Miras in the galaxy. Five of these are known or suspected C stars, while the other is O-rich. The colour magnitude diagram is shown in Fig. 1.

NGC 3109 is part of a small group of galaxies just outside the Local Group. The bulk of the stars are very metal poor, [Fe/H] = −1.84, though the young blue supergiants have [Fe/H] = −0.67. About 80% of the stars were formed before 10 Gyr ago, and there has been more recent star formation starting about 2 Gyr ago. A probably incomplete census of Mira variables reveals eight O-rich and one probably C-rich Miras. One of the O-rich stars has a period of about 1480 days while the probable C-rich variable has a period of about 1100 days; these are unusually long periods for such variables.

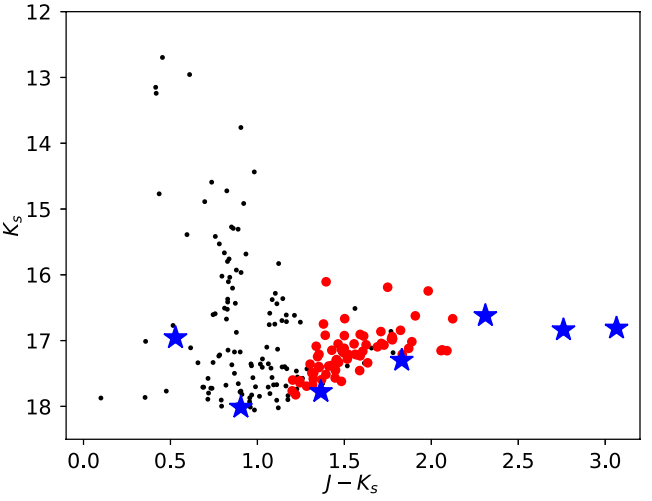

Figure 1. Colour-magnitude diagram of WLM. Large star symbols (blue) show 6 Mira variables and one Cepheid, large filled circles (red) show the known carbon stars, and small dots show field stars and WLM AGB stars.

3. Discussion

All the five galaxies have a complement of Miras, ranging from over 50 in NGC 6822 to at least three in Sgr dIG. These counts are almost certain to be underestimates in the case of the three most distant of the galaxies (Sgr dIG, WLM and NGC 3109). Most of these are C stars, which follow the LMC linear PL relation (Whitelock *et al.* 2008), particularly once bolometric corrections are applied, in the same way as for the dwarf spheroidals. However, unlike in the dwarf spheroidals, all except WLM have O-rich Miras with periods greater than about 400 days. These stars are brighter than expected from the linear PL relation, presumably because they are undergoing hot-bottom burning. The dwarf spheroidals generally comprise an old to intermediate age metal-poor population with a moderate range of metal abundances. The situation in dwarf Irregulars is more complex. In these galaxies there tends to be a wide range of ages and metallicities and in the case of NGC 3109, at least some of the AGB stars, including Miras, are quite young.

References

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