Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
Proceedings IAU Symposium No. 343, 2019
F. Kerschbaum, M. Groenewegen & H. Olofsson, eds.

doi:10.1017/S1743921318007342

Near-Infrared Stellar Populations in the metal-poor, Dwarf irregular Galaxies Sextans A and Leo A

Olivia C. Jones[1], Matthew T. Maclay[2], Martha L. Boyer[2], Margaret Meixner[2] and Iain McDonald[3]

[1]UK Astronomy Technology Centre, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ
email: olivia.jones@stfc.ac.uk

[2]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

[3]Jodrell Bank Centre for Astrophysics, Alan Turing Building, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK

Abstract. We present JHK observations of the metal-poor ([Fe/H] < -1.40) dwarf-irregular galaxies, Leo A and Sextans A, obtained with the WIYN High-resolution Infrared Camera. Their near-IR stellar populations are characterized by using a combination of color-magnitude diagrams and by identifying long-period variable (LPV) stars. We detected red giant and asymptotic giant branch (AGB) stars, consistent with membership of the galaxy's intermediate-age populations (2-8 Gyr old). We identify 32 dusty evolved stars in Leo A and 101 dusty stars in Sextans A, confirming that metal-poor stars can form substantial amounts of dust. We also find tentative evidence for oxygen-rich dust formation at low metallicity, contradicting previous models that suggest oxygen-rich dust production is inhibited in metal-poor environments. The majority of this dust is produced by a few very dusty evolved stars.

Keywords. stars: late-type – infrared: stars – circumstellar matter – stars: mass-loss

1. Introduction

Metal-poor ($-2.1 \lesssim$ [Fe/H] $\lesssim -1.1$) dwarf galaxies offer a fantastic opportunity to investigate evolved stellar populations over a wide range of environments, star-formation histories (SFH) and metallicity.

Ground-based observations of Sextans A and Leo A were obtained through the broadband JHK_s filters using the WIYN High-Resolution Infrared Camera (WHIRC; Meixner *et al.* 2015) mounted on the 3.5m WIYN telescope at the Kitt Peak National Observatory. For a source to be included in the full catalogue we require it to be detected in at least two bands or at two epochs with high-confidence. Over 750 sources are included in the final point-source catalogue for both of the galaxies (Jones *et al.* 2018).

2. Dusty Variable Stars

AGB stars pulsate, and are variable on timescales of hundreds of days. These pulsations levitate atmospheric material, leading to the formation of dust grains. Thus, stars with long period variations can show a significant IR excess. Our data examines source variability for three epochs, separated by 82, 267 and 363 days for Sextans A, and two epochs separated by 463 days for Leo A. Using the variability index defined by Vijh *et al.* (2009), we identify 30 large-amplitude variables in Sextans A and 50 variables in Leo A. We classify these variables using near-IR colours; sources are identified as AGB stars

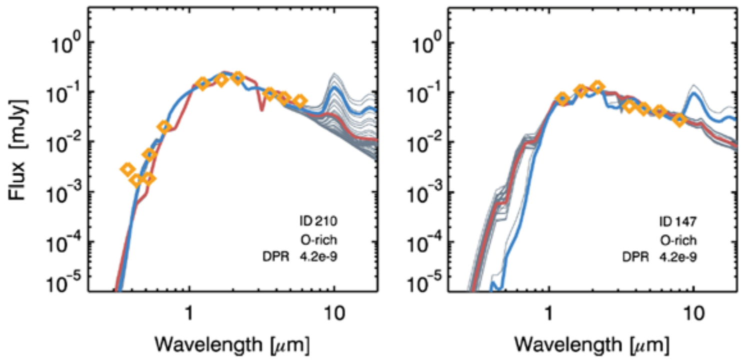

Figure 1. Spectral Energy Distributions (orange) of two dusty stars in Sextans A shown with the best-fitting O-rich model (blue) and carbon-rich model (red). The range of models which produce an acceptable fit are plotted in grey (Jones *et al.* 2018).

or RSGs candidates if they are brighter than the RGB tip and redder than foreground objects.

3. Dust Production in metal-poor galaxies

Dust-production rates (DPR) for every evolved star in Leo A and Sextans A can be computed by fitting their broadband spectral energy distributions (SEDs) with the GRAMS radiative transfer models (Sargent *et al.* 2011; Srinivasan *et al.* 2011), using the method described in Jones *et al.* (2014). This allows us to characterize the cumulative dust production in these galaxies, and constrain the evolutionary status and chemical type of the individual stars (see Fig. 1).

We identify 32 stars in Leo A and 101 stars in Sextans A with a dust production rate $> 10^{-11}$ $M_\odot$ yr^{-1} confirming that metal-poor stars can form substantial amounts of dust. In both galaxies, the total dust input into the ISM is dominated by one or two stars. Intriguingly, the star with the highest dust-production rate, SextansA-17, with a DPR of $(5.5 \pm 0.1) \times 10^{-7}$ $M_\odot$ yr^{-1}, is best fit with an oxygen-rich dust chemistry. Furthermore, it has been identified as variable x-AGB candidate by DUSTiNGS (Boyer *et al.* 2015). If this star is forming silicate dust then it may be more metal-rich, and hence younger and of higher mass, than the rest of the AGB population. Alternatively, this dust might be nucleating in a circumbinary disc, or that silicate dust may form via an alternate reaction mechanism to metal-rich stars. To verify these results, observations with *JWST* in the mid-IR would place significant constraints on both the dust chemistry and the stellar type (Jones *et al.* 2017a).

References

Boyer, M. L., McQuinn, K. B. W., Barmby, P., *et al.*, 2015, *ApJ*, 800, 51
Jones, O. C., Kemper, F., Srinivasan, S., *et al.* 2014, *MNRAS*, 440, 631
Jones, O. C., Meixner, M., Justtanont, K., & Glasse, A. 2017, *ApJ*, 841, 15
Jones, O. C., Maclay, M. T., Boyer, M. L., Meixner, M., McDonald, I., Meskhidze, H., 2018, *ApJ*, 854, 117
Meixner, M., Smee, S., Doering, R L., *et al.*, 2015, *PASP*, 122, 451
Sargent, B. A., Srinivasan, S., & Meixner, M. 2011, *ApJ*, 728, 93
Srinivasan, S., Sargent, B. A., & Meixner, M. 2011, *A&A*, 532, A54
Vijh, U. P., Meixner, M., Babler, B., *et al.*, 2009, *AJ*, 137, 3139