Why Galaxies Care About AGB Stars: A Continuing Challenge through Cosmic Time
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The star formation history of the M31 galaxy derived from Long-Period-Variable star counts

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Abstract. The determination of the star formation history is a key goal for understanding galaxies. In this regard, nearby galaxies in the Local Group offer us a complete suite of galactic environment that is perfect for studying the connection between stellar populations and galaxy evolution. In this paper, we present the star formation history of M31 using long period variable stars that are prime targets for studying the galaxy formation and evolution because of their evolutionary phase. In this method, at first, we convert the near-infrared K-band magnitude of evolved stars to mass and age and from this we reconstruct the star formation and evolution of the galaxy.

Keywords. stars: AGB and post-AGB - stars: luminosity function, mass function - galaxies: evolution - galaxies: formation - galaxies: individual: M31 - galaxies: stellar content - galaxies: structure

1. Star Formation History in the Andromeda Galaxy M31

M31 is the nearest spiral galaxy to the Milky Way and this is a great chance for us to study the formation and evolution of this galaxy. Our approach to investigate the star formation history (SFH) is based on employing long period variable stars (LPVs) which we have successfully applied in other galaxies in the Local Group such as M33 (Javadi *et al.* 2011a; Javadi *et al.* 2011b; Javadi *et al.* 2017), Magellanic Clouds (Rezaeikh *et al.* 2014), NGC147 and NGC185 (Golshan *et al.* 2017). For this research, we use the catalogue of LPVs in M31 from Mould *et al.* (2004). LPVs are mostly Asymptotic Giant Branch (AGB) stars as well as red supergiants (RSGs) in the final stage of evolution and this point of evolution is characterised by strong radial pulsations. AGB stars are luminous ($\sim 10^4$ L$_\odot$) and cool (< 4000 K) and hence stand out at near-infrared wavelengths. AGB stars will lose up to 85 percent of their initial mass at a rate of up to 10^{-4} M$_\odot$ yr^{-1} (Javadi *et al.* 2013), so they have great influence on the chemical mixture and the rate of star formation in the universe. Actually, the SFH of a galaxy is a measure of the rate at which the gas mass was converted into stars over a time interval in the past. The star formation rate (SFR), ξ (in M$_\odot$ yr^{-1}) as a function of time is estimated by:

$$\xi(t) = \frac{\int_{\rm min}^{\rm max} f_{\rm IMF}(m) m \, dm}{\int_{m(t)}^{m(t+dt)} f_{\rm IMF}(m) \, dm} \, \frac{dn'(t)}{\delta t}, \tag{1.1}$$

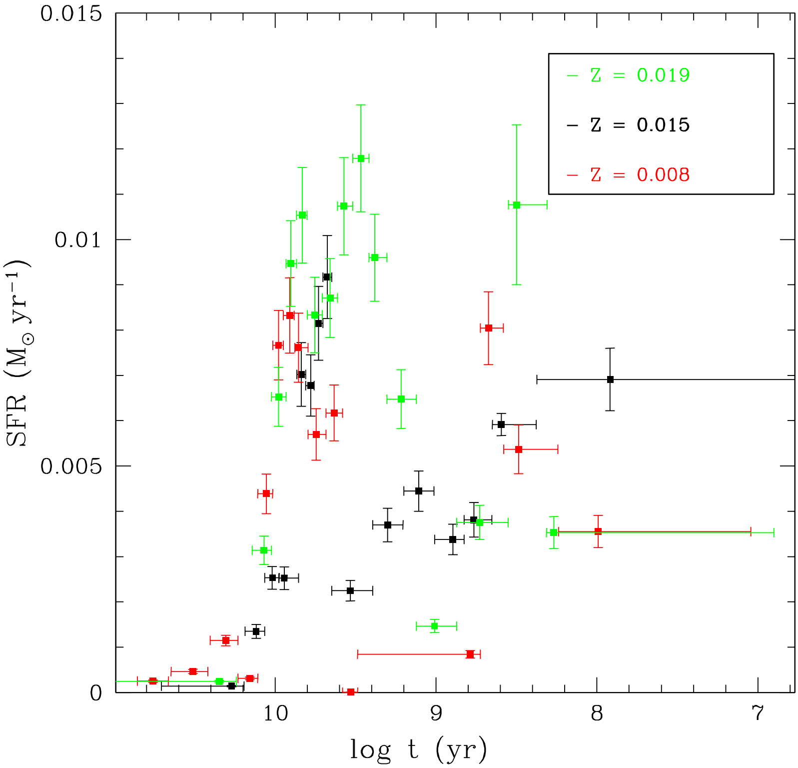

Figure 1. The SFH in M31 for a region displayed in Mould *et al.* (2004) for three choices of metallicity: Z = 0.019 (green), Z = 0.015 (black), Z = 0.008 (red).

where n' is the number of variables that we have identified, $f_{\rm IMF}$ is the initial mass function describing the relative contribution to star formation by stars of different mass and δt is the duration of variability of these stars displaying strong radial pulsation. The SFH in M31 is shown in Figure 1 for different metallicities. The horizontal errorbars represent the age bins and vertical lines demonstrate statistical errorbars.

2. Conclusions

We have applied the novel method of Javadi *et al.* (2011) using long period variable stars to derive the SFH in M31. With this method, we estimated the SFR in M31 during the broad time interval from 30 Myr to 10 Gyr ago.

References

Golshan, R. H., Javadi, A., van Loon, J. Th., *et al.*, 2017, MNRAS, 466, 1764
Javadi, A., van Loon, J. Th., and Mirtorabi, M. T., 2011a, ASPC, 445, 497
Javadi, A., van Loon, J. Th., and Mirtorabi, M. T., 2011b, MNRAS, 414, 3394
Javadi, A., van Loon, J. Th., Khosroshahi, H. G., and Mirtorabi, M. T. 2013, MNRAS, 432, 2824
Javadi, A., van Loon, J. Th., Khosroshahi, H. G., *et al.*, 2017, MNRAS, 464, 2103
Mould, J., Saha, A., Hughes, S., 2004, ApJ, 154, 623
Rezaeikh, S., Javadi, A., Khosroshahi, H. G., and van Loon, J. Th., 2014, MNRAS, 445, 2214

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