Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
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Infrared Studies of the Variability and Mass Loss of Some of the Dustiest Asymptotic Giant Branch Stars in the Magellanic Clouds

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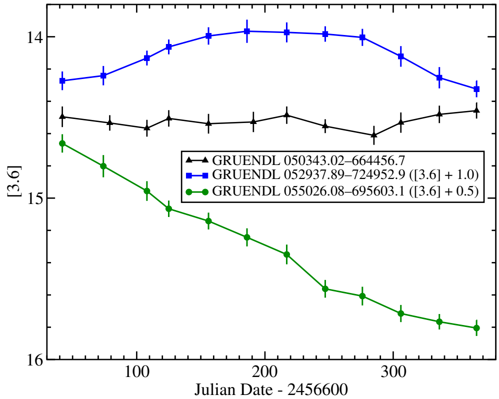
Abstract. The asymptotic giant branch (AGB) stars with the reddest colors have the largest amounts of circumstellar dust. AGB stars vary in their brightness, and studies show that the reddest AGB stars tend to have longer periods than other AGB stars and are more likely to be fundamental mode pulsators than other AGB stars. Such stars are difficult to study, as they are often not detected at optical wavelengths. Therefore, they must be observed at infrared wavelengths. Using the *Spitzer Space Telescope*, we have observed a sample of very dusty AGB stars in the Large Magellanic Cloud (LMC) and Small Magellanic Cloud (SMC) over Cycles 9 through 12 during the Warm Spitzer mission. For each cycle's program, we typically observed a set of AGB stars at both 3.6 and 4.5 μm wavelength approximately monthly for most of a year. We present results from our analysis of the data from these programs.

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

The asymptotic giant branch (AGB) phase is the phase of a star's life when the star expels its own material, and dust forms in the outflow (Sloan *et al.* 2016). The Large Magellanic Cloud (LMC; 50 kpc; Schaefer *et al.* 2008) and Small Magellanic Cloud (SMC; 60 kpc; Szewczyk *et al.* 2009) are nearby galaxies with many AGB stars and low foreground extinction. Their mean metallicities are 0.5×solar (Dufour *et al.* 1982) and 0.2×solar (Asplund *et al.* 2004), respectively. Thus, they are ideal laboratories to study AGB stars.

Spitzer-IRAC measurements were obtained about once per month in Cycles 9-12. Cycle 9 (pid 90219) targets were from Gruendl *et al.* (2008) and Vijh *et al.* (2009), and Cycle 10 (pid 10154) targets were Gruendl *et al.* (2008) and SMC follow-up targets. Cycle 11 (pid 11163) targets were Far-infrared (FIR) bright SMC AGB stars from Polsdofer *et al.* (2015), 1 SMC globular cluster AGB star (Tanabé *et al.* 1997; Nishida *et al.* 2000), and



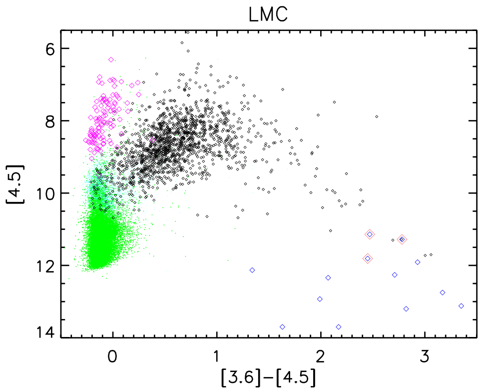


Figure 1. **Left**, light curves for 3 sources from the Gruendl *et al.* (2008) sample. **Right**, a CMD similar to a plot shown by Sloan *et al.* (2016). Green, cyan, black, and magenta points are oxygen-rich (O-rich), carbon-rich (C-rich), and extreme AGB candidate stars (Srinivasan *et al.* 2009), and red supergiants (Bonanos *et al.* 2009). The 3 red and blue points are the Gruendl *et al.* (2008) sources showing variability, while the 10 blue points are Gruendl *et al.* (2008) sources showing little to no significant variability.

20 SMC AGB stars from Ita (2005). Cycle 12 (pid 12097) targets included AGB and RSG stars detected by Herschel (Jones *et al.* 2015), an SMC OH/IR candidate (Polsdofer *et al.* 2015), optically-obscured AGB stars missing from optical surveys (Gruendl *et al.* 2008; Riebel *et al.* 2010; Srinivasan *et al.* 2016) and others from Vijh *et al.* (2009).

We expected most of our sample would show significant variability - high amplitudes of variation and longer periods. For the most part, this was true, except for the Gruendl *et al.* (2008) extremely red object (ERO) sample, constituting the reddest and dustiest AGB stars in the LMC. This sample was hardly variable at all (though see Figure 1). This, and their positions on the color-magnitude diagram (CMD; Figure 1), suggest they may be near or at the end of the AGB phase of their lives (see also Sloan *et al.* 2016). Future plans include monitoring a larger sample of the reddest extreme AGB candidate population, to look for additional non-variable extremely dusty stars. This work is based in part on observations made with the *Spitzer Space Telescope*, which is operated by the Jet Propulsion Laboratory, California Institute of Technology under NASA contract 1407. B.A.S. acknowledges funding from Spitzer-JPL contract RSA #1561703.

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