Stellar Populations as Building Blocks of Galaxies
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A SAGE View of the Mass Losing Sources in the Large Magellanic Cloud

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Abstract. We present the deepest, widest color-magnitude diagrams at mid infrared wavelengths ever produced for the Large Magellanic Cloud (LMC). The SAGE (Surveying the Agents of a Galaxy's Evolution) survey of the LMC comprises a seven by seven degree mapping of the entire LMC in each of the Spitzer IRAC and MIPS bands. The present work includes mid and near infrared photometry between 1.25 and 24 microns. These data are used to identify 100's of thousands of red giants and 10's of thousands of asymptotic giant branch stars and supergiants which are classified as oxygen rich, carbon rich, or "extreme" mass losing stars, among others. SAGE will revolutionize the study of evolved stars and mass input into the ISM in the LMC because its deep photometry is sensitive to all significant mass losing sources in the galaxy and provides the context of the overall stellar populations which give rise to the mass losing AGB stars. The SAGE data can be used to help synthesize and assess models of star forming galaxies at high redshift for a range of ages and chemical compositions.

1. Surveying the Agents of a Galaxy's Evolution (SAGE)

SAGE is an all Large Magellanic Cloud (LMC) survey utilizing the full IRAC and MIPS imaging capability of the *Spitzer* Space telescope. Combined with the 2MASS survey, the present SAGE point source catalog covers 1.2 to 160 microns for seven by seven square degrees centered on the LMC. Details of the survey and initial results are presented by Meixner *et al.* (2006); see also Meixner *et al.* in these proceedings.

The survey has resulted in unprecedented depth and coverage at near and mid-infrared wavelengths yielding color-magnitude diagrams for evolved stars of similar quality to those produced at optical wavelengths. The J − [8.0] vs [8.0] color–magnitude diagram (CMD) and the [8.0]–[24] vs. [24] CMD are represented in the grayscale representations of their respective Hess diagrams shown in Figure 1.

There are nearly one million IRAC sources with 2MASS counterparts in the high quality SAGE catalog, and of these some 32000 evolved stars are detected above the tip of the red giant branch.

2. Mass Loss and Aggregate Properties

One of the key goals of the SAGE project is to quantify the mass loss from the individual sources and thus assess the mass loss budget for the different populations which contribute to the total.

We plan to use the wealth of information which can be derived from the existing star formation history work in the LMC in conjunction with the observed properties at near

Table 1. Integral mass Loss (Msun/yr)

Source	Number
Carbon Rich AGB stars	1.70E-03
Oxygen Rich AGB stars	1.70E-03
Super giants	1.00E-03
Extreme AGB	2.60E-03
Total	7.00E-03

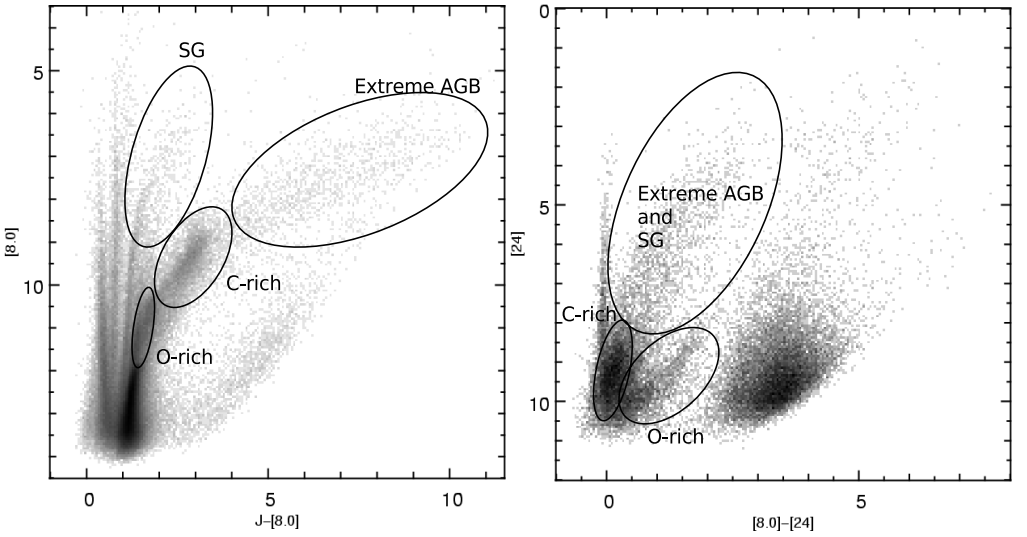

Figure 1. Grayscale Hess diagrams of the $J-[8.0]$ vs. [8.0] (*left*) and $[8.0]-[24]$ vs. [24] (*right*) color–magnitude diagrams. Different classes of evolved stars are indicated in the figure and discussed in detail in Blum *et al.* (2006).

infrared and mid infrared wavelengths from the SAGE project to quantify the mass loss history from evolved stars and determine its impact on the ISM and the enrichment of material forming successive generations of stars.

The current mass loss budget (integral mass loss rate) can be estimated crudely from the SAGE data themselves. The van Loon *et al.* (1999) mass loss rates for about 50 stars with $[24] \leqslant 11$ have been fitted to the SAGE [24] data. Adopting a linear fit, the resulting integral mass loss for the evolved stars in Figure 1 is given in Table 1 for C-rich, O-rich, supergiant, and extreme AGB stars (as defined in Blum *et al.* 2006). This is a lower limit to the contribution from evolved stars since the [24] source counts are not complete at the faint end (though this corresponds to mdot of appoximately 10^{-8} for individual stars). The total shown in Table 2 is comparable to the enrichment due to LMC supernovae (0.1–0.5 per 100 yr); see Pavlidou & Fields, 2001.

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