FULL TITLE
ASP Conference Series, Vol. **VOLUME**, **YEAR OF PUBLICATION**
NAMES OF EDITORS

Spitzer's Observations of the Small Magellanic Cloud: Probing the PAH Distribution

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Abstract. The Spitzer program to image the Small Magellanic Cloud (SMC) with all IRAC and MIPS bands is well underway. IRAC observations in particularly will allow, for the first time, to quantify the distribution and properties of very small dust grains and PAHs across the entire SMC, as well as to study their environmental dependence and preferences. In this paper we describe project goals and give a flavor of the 24μm observations by examining briefly the structure in one of the most oxygen-rich supernova remnants, E0102-7219.

1. Motivation and Project Goals

The Small Magellanic Cloud (SMC), our gas-rich and low-metallicity neighbor, offers a unique opportunity to study the evolution of dust properties and their effects on the various phases of the interstellar gas, in a system that is significantly less evolved than our own Milky Way. Very small grains (VSGs) and PAHs play a crucial role in the heating and cooling balance in the interstellar medium (ISM), but very little is known about properties, distribution, life-cycle, and environmental dependence of these grains across the SMC. Furthermore, while IRAS observations suggested a low overall abundance of VSGs and PAHs, the only two direct observations of PAHs in the SMC by ISO showed that they existed with characteristics and abundances similar to that found in the Milky Way.

The Spitzer program to image the SMC with all IRAC and MIPS bands is well underway. The MIPS observations were obtained in December 2004, the IRAC observations are expected this spring. We will address the following scientific questions: (1) What are the abundances and distributions of VSGs and PAHs in the SMC, and how do they correlate with other tracers (neutral hydrogen, molecular gas)? (2) What constrains can we apply to theoretical dust models (Li & Draine 2002) through spectral energy distribution measurements for different regions in the SMC? (3) What is the composition of PAH molecules in the SMC and is it different from that in the Milky Way?

In addition, these data sets will provide significant serendipitous discoveries. As an example we briefly present the case of E0102-7219, a young, oxygen-rich supernova remnant revealed in the 24 μm image.

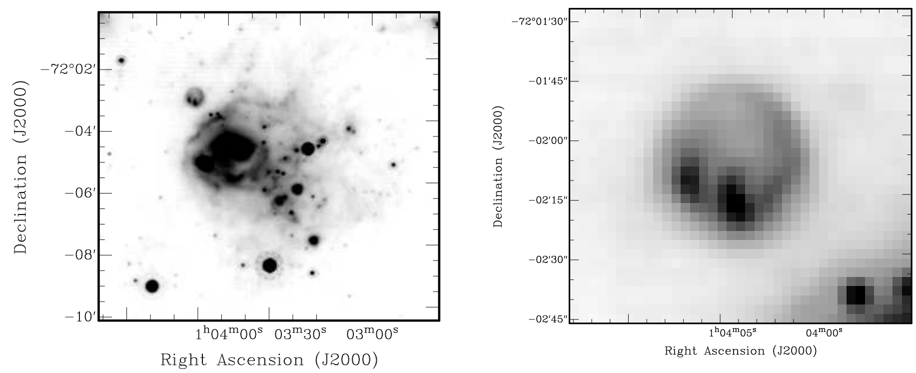

Figure 1. (Left) MIPS 24 μm image of N76 and E0102-7219. (Right) A zoomed in view of E0102-7219 emphasizing its ring-like morphology and two filamentary features.

2. E0102-7219 – a young, oxygen-rich supernova remnant

One of the prominent features revealed in the Spitzer's 24 μm image is E0102-7219, the brightest X-ray emitting supernova remnant (SNR) in the SMC. This is one of the youngest SNRs known ($\sim$ 1000 years) and also one of less than a dozen O-rich SNRs, a class of SNRs whose typical representative is Cassiopeia A. Young, especially O-rich, SNRs are remnants of massive stars, Blair et al. (2000) suggested that the progenitor of E0102-7219 was most likely in the range 25–35 $M_\odot$. Dynamically, E0102-7219 is very similar to Cassiopeia A (Morse 2003). Recent Chandra observations of this SNR (Vink 2003) show a limb brighten ring, about $50''$ in diameter, with several knots and filaments.

Fig. 1 shows the Spitzer's 24 μm image of E0102-7219. The image on the left shows the HII region N76, E0102-7219 is located just to the northeast of N76. The image on the right is a zoom in on the remnant itself. The remnant is detected only in the 24 μm image, contrary to Cassiopeia A which has a very similar morphology at both 24 and 70 μm. This suggests that the source of infrared emission is primarily an emission line of OIV, instead of thermal dust emission. The remnant has a ring-like morphology with two prominent filaments. The morphology and size of the remnant are similar to those of the X-ray shell seen by Chandra. Two north-east filaments run almost parallel to each other, and may correspond to filaments seen in the Chandra's image. The filaments represent material ejected from the core of the precursor star during the supernova event.

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