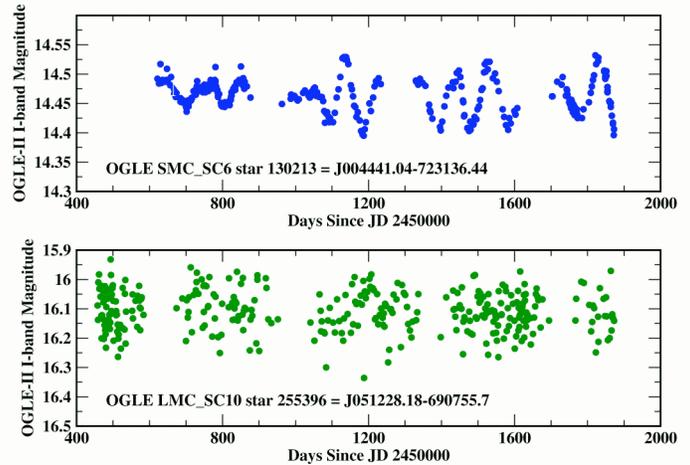
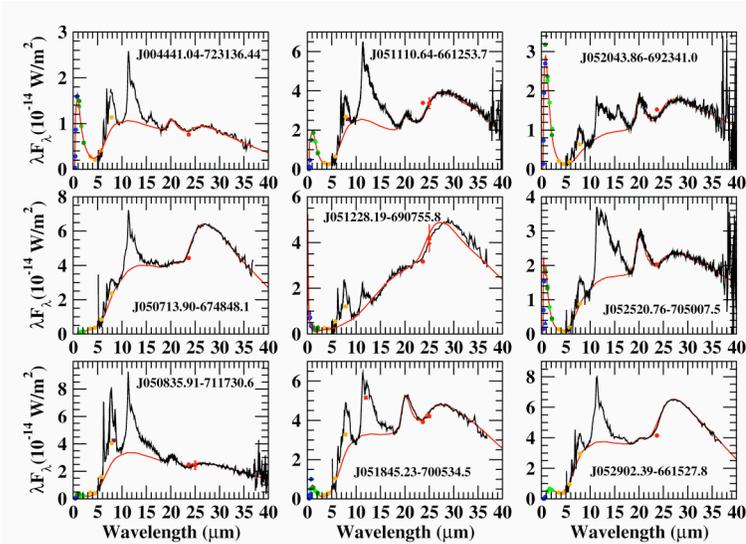


Discovery of 21 μm Sources in the Magellanic Clouds

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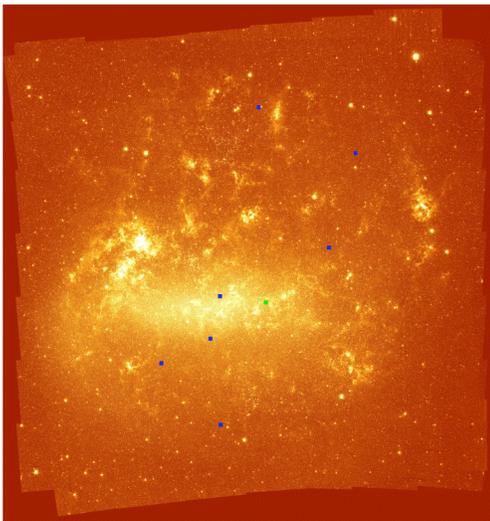
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Spitzer Space Telescope IRS spectroscopy has discovered 8 LMC and 1 SMC carbon-rich proto-planetary nebulae, 8 of which show the unidentified 21 μm feature. The 9th object may be a very young planetary nebula. Compared to the 14 previously known Galactic 21 μm feature objects, the “PAH” bands (6.2/7.7/8.6/11.2 μm) are very strong in these spectra (compare with Hrivnak, Volk, & Kwok, 2009, ApJ, **694**, 1147 and Hrivnak, Volk, & Kwok, 2000, ApJ, **535**, 275).



The spectra are shown above with IRAC, MIPS, 2MASS, DENIS, MSX, IRAS, and UVB photometry as available. The one SMC object J004441.0-723136.44 has relatively weak 21 and 30 μm features. The red curves show model fits excluding the non-equilibrium PAH features.

Optical photometry from the OGLE project shows that the objects have low amplitude variability with periods of ~40 to ~90 days. The amplitudes are smaller and the periods shorter than for the Galactic objects.



The LMC image (IRAC [3.6]) showing the positions of the eight 21 μm objects (blue) and the other object (green). They are found mostly in the outer regions of the LMC.

Object Name	Observed Flux (10^{-14} W/m ²)	Total Luminosity (L_{\odot})	Model T_{\ast} (K)	Model $T_{\text{dust}}(r_{\text{in}})$ [K]	Model V Optical Depth	21 μm feature strength	30 μm feature strength
J004441.04-723136.44	4.20	4750	6000	317	1.46	0.365	0.369
J050713.76-674848.1	8.25	6290	9500	242	13.78	0.039	0.979
J050835.91-711730.6	8.37	6550	5000	337	27.43	0.297	0.469
J051110.64-661253.7	8.55	6700	5700	253	5.63	0.5	1.55
J051228.19-690755.8	5.37	4200	30000	151	0.82	---	0.7
J051845.23-700534.5	8.49	6650	9000	306	3.77	0.583	0.233
J052043.86-692341.0	6.46	5060	5600	335	1.08	0.912	0.822
J052520.76-705007.5	6.43	5040	7000	261	1.52	0.735	0.281
J052902.39-661527.8	11.0	8630	6500	306	8.93	0.104	0.744

Some object properties are listed in the Table above. The luminosities are based on the observed fluxes plus distances of 50 and 60.1 kpc for the LMC and the SMC. Galactic 21 μm object luminosities are estimated to be 7000-10000 L_{\odot} , subject to large distance uncertainties. Therefore these LMC/SMC luminosities are smaller than expected. Values in the right part of the Table are from the dust model fits. The 21 and 30 μm feature strengths are given relative to the continuum. The model dust temperatures are ~100K larger than is found for Galactic objects.

A PDF version of this is available at <http://www.stsci.edu/~volk>.