A {it Spitzer Space Telescope} far-infrared spectral atlas of compact sources in the Magellanic Clouds. I. The Large Magellanic Cloud

Jacco Th. van Loon^1
Joana M. Oliveira^1
Karl D. Gordon^2
Margaret Meixner^2
Bernie Shiao^2
Martha L. Boyer^2
F. Kemper^3
Paul M. Woods^3
A. G. G. M. Tielens^4
Massimo Marengo^{5,6}
Remy Indebetouw^{7,8}
G. C. Sloan^9
C.-H. Rosie Chen^7

1 - Astrophysics Group, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG, UK
2 - Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
3 - Jodrell Bank Centre for Astrophysics, Alan Turing Building, School of Physics and Astronomy, The University of Manchester, Oxford Road, Manchester M13 9PL, UK
4 - Leiden Observatory, P.O. Box 9513, NL-2300 RA Leiden, The Netherlands
5 - Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
6 - Department of Physics and Astronomy, Iowa State University, Ames IA, USA
7 - Department of Astronomy, University of Virginia, P.O. Box 400325, Charlottesville, VA 22904, USA
8 - National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, VA 22903, USA
9 - Department of Astronomy, Cornell University, Ithaca, NY 14853, USA

We present far-infrared spectra, $lambda$=52--93 mum, obtained with the {it Spitzer Space Telescope} in the Spectral Energy Distribution mode of its MIPS instrument, of a representative sample of the most luminous compact far-infrared sources in the Large Magellanic Cloud. These include carbon stars, OH/IR Asymptotic Giant Branch (AGB) stars, post-AGB objects and Planetary Nebulae, the R,CrB-type star HV,2671, the OH/IR red supergiants WOH,G064 and IRAS,05280$-$6910, the three B[e] stars IRAS,04530$-$6916, R,66 and R,126, the Wolf-Rayet star Brey,3a, the Luminous Blue Variable (LBV) R,71, the supernova remnant N,49, a large number of young stellar objects (YSOs), compact H,{sc ii} regions and molecular cores, and a background galaxy at a redshift $zsimeq0.175$. We use the spectra to constrain the presence and temperature of cold dust and the excitation conditions and shocks within the neutral and ionized gas, in the circumstellar environments and interfaces with the surrounding interstellar medium (ISM). First, we introduce a spectral classification scheme. Then, we measure line strengths, dust temperatures, and IR luminosities. Objects associated with star formation are readily distinguished from evolved stars by their cold dust and/or fine-structure lines. Evolved stars, including the LBV R,71, lack cold dust except in some cases where we argue that this is swept-up ISM. This leads to an estimate of the duration of the prolific dust-producing phase (``superwind'') of several thousand years for both RSGs and massive AGB stars, with a similar fractional mass loss experienced despite the different masses. We tentatively detect line emission from neutral oxygen in the extreme RSG WOH,G064, which suggests a large dust-free cavity with implications for the wind driving. In N,49, the shock between the supernova ejecta and ISM is revealed in spectacular fashion by its strong [O,{sc i}] $lambda$63-mum emission and possibly water vapour; we estimate that 0.2 M$_odot$ of ISM dust was swept up. On the other hand, some of the compact H,{sc ii} regions display pronounced [O,{sc iii}] $lambda$88-mum emission. The efficiency of photo-electric heating in the interfaces of ionized gas and molecular clouds is estimated at 0.1--0.3%. We confirm earlier indications of a low nitrogen content in the LMC. Evidence for solid state emission features is found in both young and evolved objects, but the carriers of these features remain elusive; some of the YSOs are found to contain crystalline water ice. The spectra constitute a valuable resource for the planning and interpretation of observations with the {it Herschel Space Observatory} and the {it Stratospheric Observatory For Infrared Astronomy} (SOFIA).

Reference: The Astronomical Journal
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/0910.3339

Comments:

Email: jacco@astro.keele.ac.uk