From Interstellar Clouds to Star-Forming Galaxies: Universal Processes?, E52, 1 of 2
Proceedings IAU Symposium No. 315, 2016
P. Jablonka, Ph. André, & F. van der Tak, eds.

doi:10.1017/S1743921316008140

The HerMES Local Luminosity Function

Lucia Marchetti[1,2], **Mattia Vaccari**[3,4,2], **Alberto Franceschini**[2]

[1]Department of Physical Sciences, The Open University, UK
[2]Dipartimento di Fisica e Astronomia, Università di Padova, Italy
[3]Astrophysics Group, Physics Department, University of the Western Cape, South Africa
[4]INAF - Istituto di Radioastronomia, Italy
email: lucia.marchetti@open.ac.uk

Abstract. We exploit the Herschel Extragalactic Multi-Tiered Survey (HerMES) dataset along with ancillary multi-wavelength photometry and spectroscopy from the Spitzer Data Fusion to provide the most accurate determination to date of the local ($0.02 < z < 0.5$) Far-Infrared Luminosity and Star Formation Rate Function. We present and compare our results with model predictions as well as other multi-wavelength estimates of the local star formation rate density.

Keywords. galaxies: luminosity function, mass function, galaxies: evolution, infrared: galaxies, submillimeter, astronomical data bases: miscellaneous

---

1. The HerMES Project & the Spitzer Data Fusion

The Herschel Space Observatory (Pilbratt *et al.*2010), and particularly its SPIRE imager (Griffin *et al.*2010), have brought along a dramatic increase in survey speed at far-infrared and sub-millimeter wavelengths. During Herschel's 3.5 yr science mission (2009-2013) this has allowed us to observe a substantial chunk of the extragalactic sky, e.g. as part of the HerMES project (Oliver *et al.*2012). Herschel maps, however, are severely affected by source confusion due to the large telescope beam, and great care must therefore be taken to determine the short-wavelength counterparts of Herschel sources (Roseboom *et al.*2010). In order to make the most of the HerMES dataset, we thus undertook a preparatory programme to bring together medium-deep wide-area Spitzer IRAC+MIPS Extragalactic Surveys over the HerMES fields. The resulting dataset, known as Spitzer Data Fusion (Vaccari *et al.*2010) and now available at `http://www.mattiavaccari.net/df/`, can be used to effectively identify and characterize Herschel sources over an area of ~ 65 deg^2.

2. The HerMES Local Luminosity Function

The far-infrared and sub-millimeter portion of the electromagnetic spectrum probed by Herschel contains a wealth of information about the cosmic star formation history. This is because a substantial portion of the ultraviolet light emitted by young stars and which can thus be used to trace star formation is absorbed by dust and re-emitted at IR wavelengths (Franceschini *et al.*2010). The rest-frame luminosity integrated between 8 and 1000 μm, also known as IR Bolometric Luminosity, is therefore an accurate estimator of a galaxy's star formation rate, and infrared surveys can thus be used to study the evolution not only of the IR Luminosity Function but also of the Star Formation Rate Function (Rodighiero *et al.*2010). In this work (Marchetti *et al.*2015), we used the Spitzer Data Fusion to identify, estimate the redshift and characterize the Optical-to-Sub-Millimeter Spectral Energy Distribution (SED) of HerMES DR3 sources spanning several wide fields totaling 39 deg^2. We selected a flux-limited ($S_{250\,\mu\text{m}} > 30$ mJy) sample of $0.02 < z < 0.5$ sources and carried out a phenomenological SED fitting using templates by Polletta *et al.*2007 to determine K-corrections and thus the effective volume corresponding to each source, and estimated the luminosity function using the $1/V_{max}$ method. We then fitted a modified Schecter function to our luminosity function estimates and integrated the resulting fits, deriving local luminosity density estimates and converting them into local star

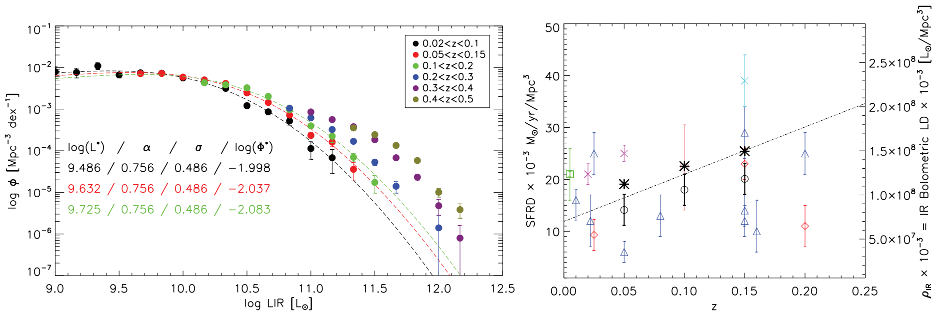

Figure 1. The evolution of the IR Bolometric (8-1000 μm) Luminosity Function and of the Star Formation Rate Density in the Local Universe. **Left**: The IR bolometric luminosity function within $0.02 < z < 0.5$, integrated in the first three redshift bins reported in the legend by using a modified Schechter functions; **Right**: The derived SFRD in the local Universe. Black open circles are our data as result of the integrations of the LFs on the left converted to SFRD by using the Kennicutt 1998 relation (assuming a Salpeter IMF) and black asterisks are our best estimate of the total SFRD in the Local Universe after correction for the contribution of the ultraviolet SFRD. Other data points are previous SFRD estimates from the literature.

formation rate density estimates following Kennicutt 1998. Figure 1 illustrates our main results, namely the evolution of the IR Bolometric Luminosity Function and of the Star Formation Rate Density of Herschel-Selected sources. The luminosity functions show significant and rapid luminosity evolution already at low redshifts, $0.02 < z < 0.2$, with $L^*_{IR} \propto (1+z)^{6.0\pm0.4}$ and $\Phi^*_{IR} \propto (1+z)^{-2.1\pm0.4}$, $L^*_{250} \propto (1+z)^{5.3\pm0.2}$ and $\Phi^*_{250} \propto (1+z)^{-0.6\pm0.4}$ estimated using the IR bolometric LF and the 250 μm LF respectively. Converting our IR LD estimate into an SFRD assuming a standard Salpeter IMF and including the unobscured contribution based on the UV dust-uncorrected emission from local galaxies, we estimate a SFRD scaling of $\mathrm{SFRD}_0 + 0.08z$, where $\mathrm{SFRD}_0 \simeq (1.9 \pm 0.03) \times 10^{-2}\,[\mathrm{M}_\odot\,\mathrm{Mpc}^{-3}]$ is our total SFRD estimate at $z \sim 0.02$. Future work within the scope of the Herschel Extragalactic Legacy Project (Vaccari *et al.*2015) will extend such studies to the more than 1,000 deg^2 of the extragalactic sky probed by Herschel surveys. The HerMES and HELP Data Products are available through `http://hedam.lam.fr`.

References

Franceschini, A., Rodighiero, G., Vaccari, M., *et al.* 2010, *A&A*, 517, 74
Griffin M. J., et al., 2010, *A&A*, 518, L3
Kennicutt, R. C., Jr. 1998, *ApJ*, 498, 541
Marchetti, L., Vaccari, M., Franceschini, A., *et al.* 2015, *MNRAS*, in press
Oliver S. J., et al., 2012, *MNRAS*, 424, 1614
Pilbratt, G. L., Riedinger, J. R., Passvogel, T., *et al.*2010, *A&A*, 518, L1
Polletta M., et al., 2007, *ApJ*, 663, 81
Rodighiero G., Vaccari, M., Franceschini, A., et al., 2010, *A&A*, 515, 8
Roseboom, I. G., Oliver, S. J., Kunz, M., *et al.*2010, *MNRAS*, 409, 48
Vaccari, M., Marchetti, L., Franceschini, A., *et al.* 2010, *MNRAS*, 518, L20
Vaccari, M. 2015, *Proceedings of "The Universe of Digital Sky Surveys"*, `arXiv:1508.06444`

https://doi.org/10.1017/S1743921316008140 Published online by Cambridge University Press