[U]LIRG dust luminosity properties with two different dust emission models

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We present a comparison between two dust emission models, used by the CIGALE tool fitting galaxy Spectral Energy Distributions (SEDs) for [Ultra] Luminous InfraRed Galaxies ([U]LIRGs). We focused on the dust luminosity comparison.

[U]LIRGs are a class of objects with significantly higher emission in the infrared part of the spectrum than other star forming galaxies. They are highly obscured by dust, which is heated by young stars which are a strong source of ultraviolet (UV) light. Heated gas re-emits this energy in infrared. [U]LIRGs are divided according to their IR luminosity into LIRGs ($10^{11} < L_{IR}[L_{\odot}] < 10^{12}$), ULIRGs ($10^{12} < L_{IR}[L_{\odot}] < 10^{13}$) and HLIRGs ($10^{13} < L_{IR}[L_{\odot}]$) where L_{IR} corresponds to the total IR luminosity between 8 and $1000\mu m$. In this work we present a comparison of the outcome of two dust emission models, using a galaxy sample put together by Małek et al. (2017) selected at 90μm in the AKARI Deep Field-South (ADF-S) survey.

For our research we performed the SED fitting, using the *Code Investigating Galaxy Emission* (CIGALE; Noll et al., 2009), version 0.9.0. We used two different dust emission models: the Dale et al. (2014) and the Casey (2012) model. Dale et al. (2014) developed as a semi-empirical model, which describes the progression of the far-infrared peak towards shorter wavelengths for increasing global heating intensities. A free parameter in the Dale et al. (2014) model is α, which is a slope representing IR emission from dust heating. This model was based upon Spitzer observations and consists of a series of templates varied in the parameter space accounting for the dust emission, influence of active galactic nuclei and polyaromatic hydrocarbon emission. The Casey (2012) model is a three-parameter function comprised of four grey-body emission functions approximated by one greybody function convolved with a power-law function. Parameters which can be set are: dust temperature, β – the emissivity index for grey-body emission, and α – the mid-infrared power slope.

We fitted our ADF-S sample using both dust emission models. We found that the Casey (2012) model fits with higher dust luminosities than the Dale et al. (2014) model as shown in Table 1. For $\sim 23\%$ of the sample, dust luminosities estimated by the Casey (2012) model exceed by more than 3σ the estimates obtained by the Dale et al. (2014) model, which results in $\sim 2\%$ more galaxies being identified as LIRGs. Figure 1 presents the relation between L_{dust} obtained using both models. Table 1 presents the difference between Dale et al. (2014) and Casey (2012) classification of ADF-S galaxies based on both models with calculated luminosities.

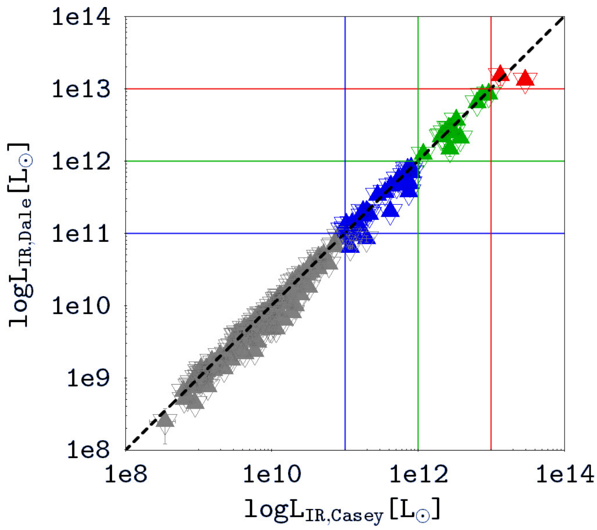

Fig. 1: Relation between L_{dust}, computed by two models. Black dashed line represents the $x = y$ relation. Filled and open triangles represent data fitted with the Casey (2012) model and Dale et al. (2014) model, respectively. Colors represent classification: grey – normal star-forming galaxies, blue – LIRGs, green – ULIRGs and red – HLIRGs.

galaxy type	Dale et al. (2014)		Casey (2012)	
	N	mean $L_{IR}[L_\odot]$	N	mean $L_{IR}[L_\odot]$
starburst	150 (78%)	$(1.31 \pm 0.08) \times 10^{10}$	145 (76%)	$(1.19 \pm 0.09) \times 10^{10}$
LIRGs	26 (14%)	$(3.58 \pm 0.25) \times 10^{11}$	31 (16%)	$(3.58 \pm 0.31) \times 10^{11}$
ULIRGs	14 (7%)	$(3.50 \pm 0.32) \times 10^{12}$	14 (7%)	$(3.74 \pm 0.35) \times 10^{12}$
HLIRGs	2 (1%)	$(1.41 \pm 0.24) \times 10^{13}$	2 (1%)	$(2\ 13 \pm 0.15) \times 10^{13}$

Table 1: Classification of ADF-S galaxies using two dust emission models along with mean luminosities derived by the CIGALE. N corresponds to number of galaxies.

References

Casey, C. M., *Far-infrared spectral energy distribution fitting for galaxies near and far*, MNRAS **425**, 3094 (2012), 1206.1595

Dale, D. A., et al., *A Two-parameter Model for the Infrared/Submillimeter/Radio Spectral Energy Distributions of Galaxies and Active Galactic Nuclei*, ApJ **784**, 83 (2014), 1402.1495

Małek, K., et al., *[Ultra] luminous infrared galaxies selected at 90 μm in the AKARI deep field: a study of AGN types contributing to their infrared emission*, A&A **598**, A1 (2017), 1611.07410

Noll, S., et al., *Analysis of galaxy spectral energy distributions from far-UV to far-IR with CIGALE: studying a SINGS test sample*, A&A **507**, 1793 (2009), 0909.5439