Probing the properties of the interstellar medium of nearby galaxies with Herschel

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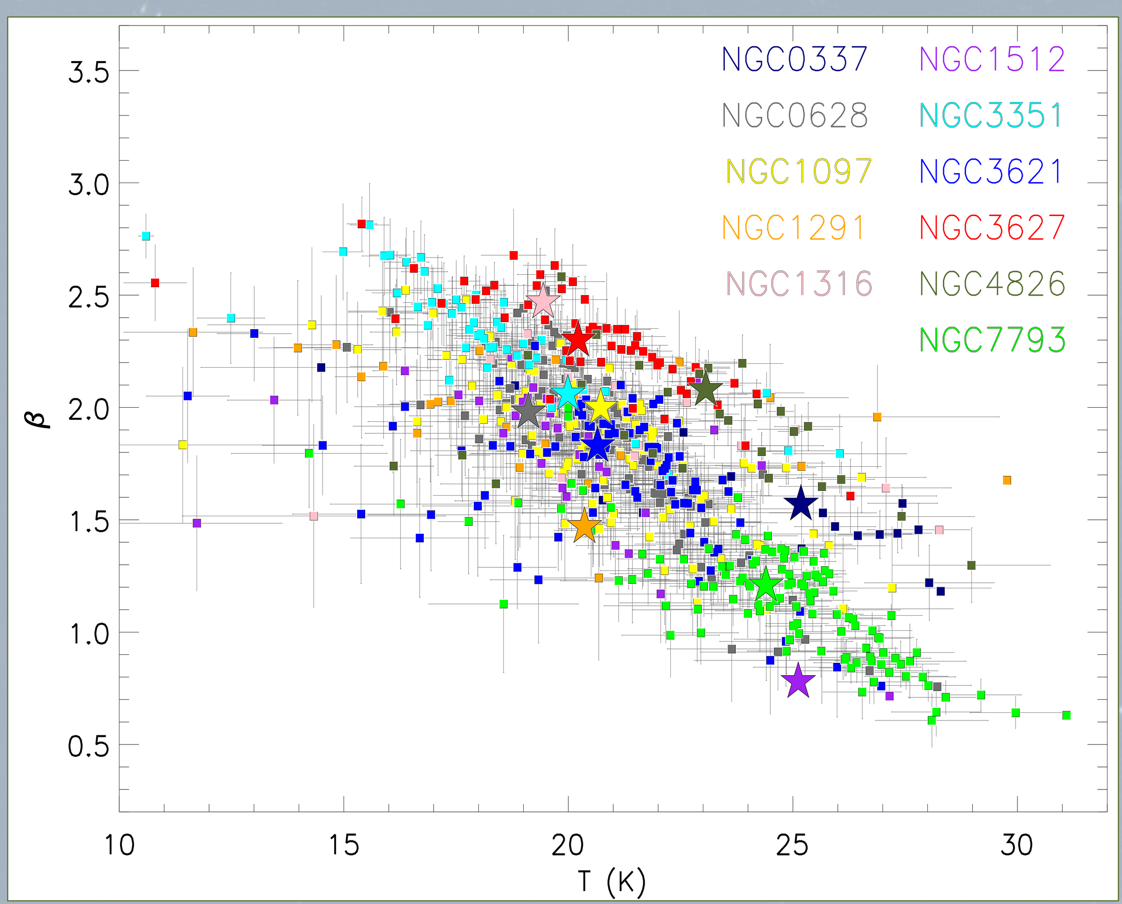
The interstellar medium (ISM) plays a key role in galaxy evolution. Dust emission in particular is a powerful tool to get a handle on star formation in galaxies. The Herschel Observatory now provides us with maps of the thermal dust emission of nearby galaxies from 70 µm up to 500 µm and enables us to draw a full inventory of the dust grain population in a wide range of environments. In the present poster, we describe how the Herschel observations of nearby galaxies enable us to build resolved maps of dust properties such as dust temperatures, dust mass surface densities or emissivity indices. We also compare observations at 870 µm (APEX/LABOCA) with predictions from Herschel to study potential submm excess and how it varies with the physical conditions of the ISM. We finally derive relations to calibrate the total infrared luminosity in galaxies from monochromatic or combined Spitzer and Herschel bands.

Mapping the dust properties (Galametz et al. 2012)

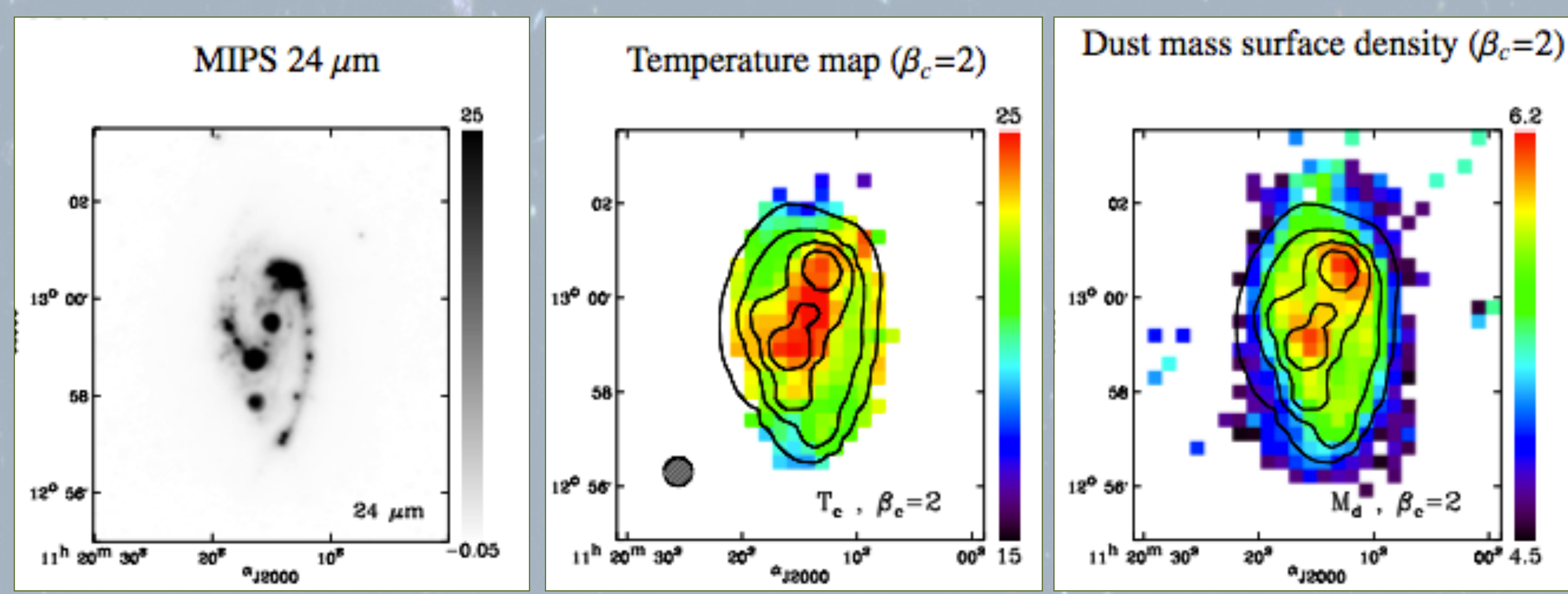
We model the thermal dust emission of 11 nearby galaxies using Spitzer and Herschel photometric data (from 24 to 500 µm) and a two-temperature (modified blackbodies or MBBs) fitting technique.

On global scales, we observe a wide range of values for the cold dust temperature Tc and the cold dust emissivity index βc (0.8 to 2.5).



Resolved temperature / emissivity anti-correlation

On local scales, we observe strong temperature gradients as a function of radius when βc is fixed. We also let βc vary. Gathering each resolution element in a Tc - βc diagram underlines an anti-correlation between the two parameters. It remains difficult to assess whether the dominant effect is the physics of dust grains, noise, or temperature mixing in the beam.



24µm emission, temperature and dust mass map of NGC 3627 when βc=2

The dust column density peaks in the centres and at bar ends (usually coinciding with molecular gas reservoirs).

We also quantify how the total dust mass varies with our assumptions (choice of βc, wavelength coverage). Modified blackbody fits using a shallow emissivity (βc < 2.0) lead to significantly lower dust masses compared to the βc = 2.0 case. Dust masses are lower by up to 50% if βc =1.5 for instance.

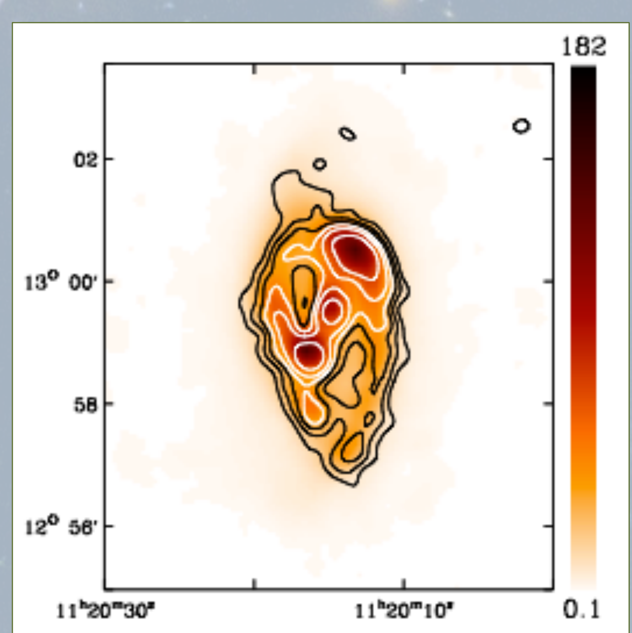
The working resolution also affects our total dust mass estimates, with a dust mass increase from global fits to spatially-resolved fits.

Probing the submm beyond Herschel

(Galametz et al. in prep)

We compare the LABOCA 870 µm emission of nearby galaxies with estimates predicted from Herschel bands and various SED models.

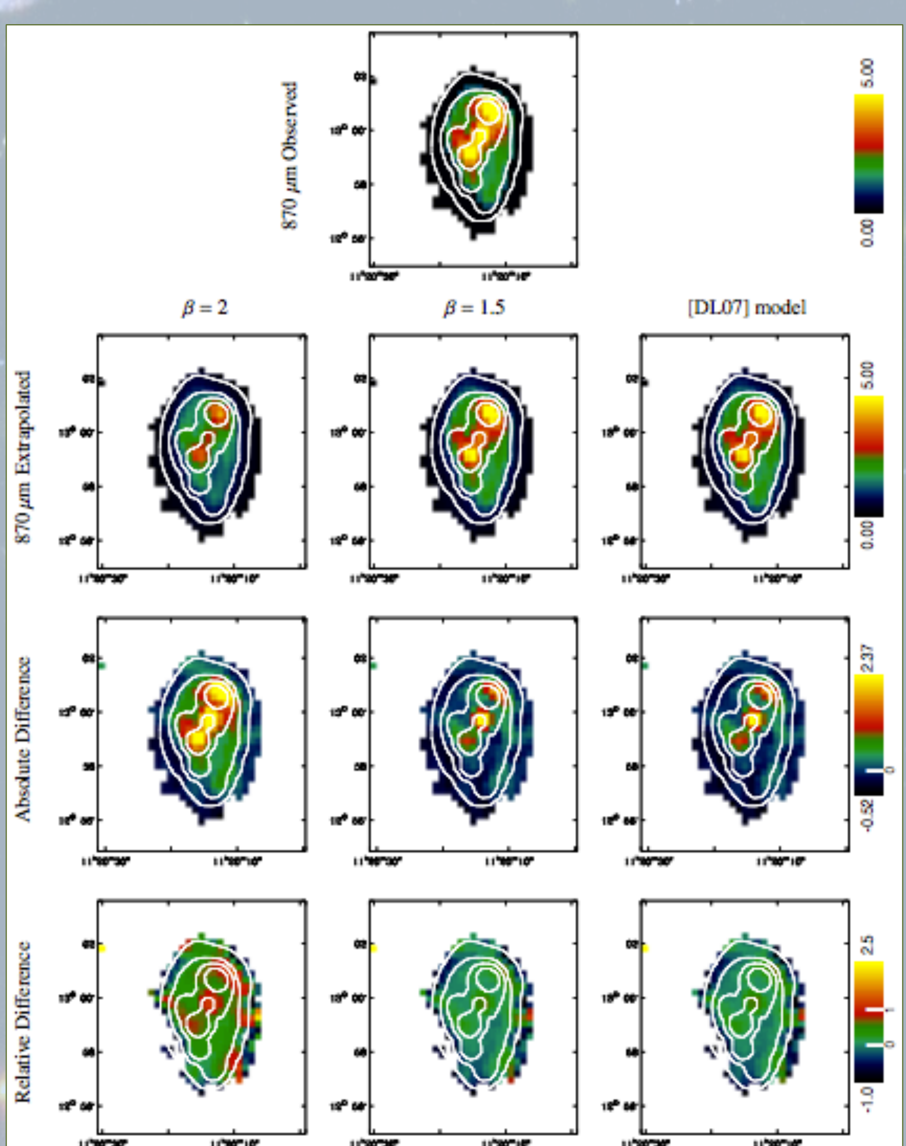
On global scales, using a MBB model with βc=2 or 1.5 or the Draine & Li (2007) models can reproduce the observed 870 µm emission, except in the galaxies NGC 337 and NGC 7793.



350 µm map of NGC 3627 with 870 µm contours overlaid.

On local scales, the remaining “excesses” at 870 µm generally occur towards the centres of galaxies and can in many cases be explained by radio or CO line contributions.

In three non-barred galaxies, the remaining excesses rather occur in the outskirts of the disks, which could be a sign of a flattening of the submm slope with radius.



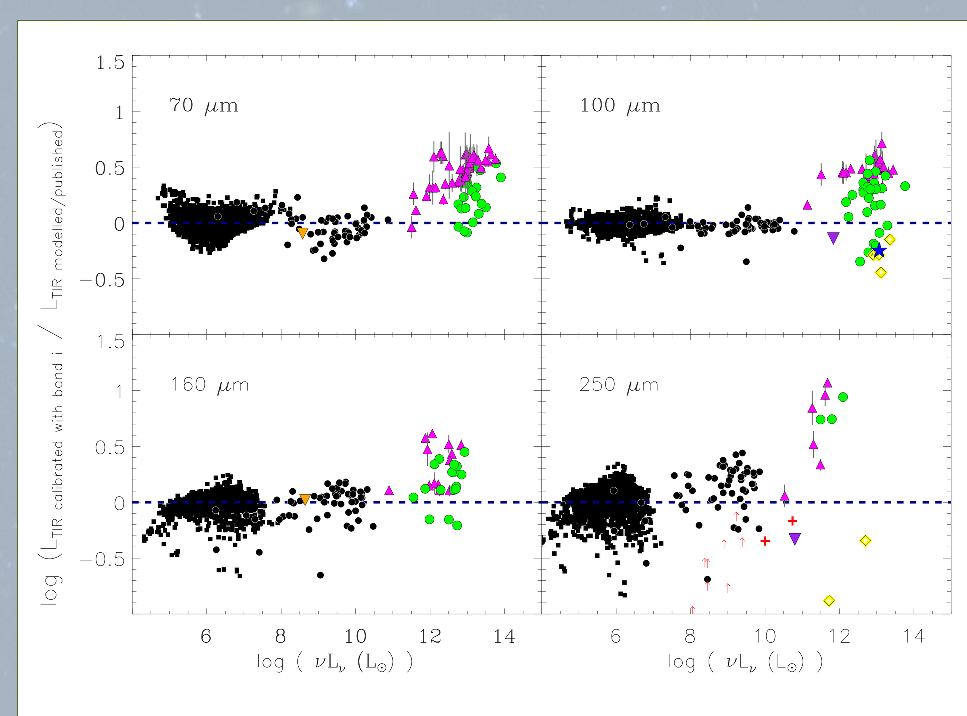
Top line: 870 µm map of NGC 3627. ***Second line:*** Extrapolated 870 µm maps using various models. ***Third line:*** Absolute difference between the observed and the extrapolated 870 µm maps. ***Bottom line:*** Relative difference (obs – extrap) / (extrap)

Calibration of the TIR luminosity

(Galametz et al. 2013b)

We study the correlation between the total infrared luminosities (L_{TIR}) of ISM elements of the KINGFISH galaxies with their monochromatic or combined luminosities in Spitzer and Herschel bands.

We base our calibrations on resolved elements of nearby galaxies (3 to 30Mpc) observed with *Herschel*.



Comparison between L_{TIR} predicted with our monochromatic calibrations and those estimated from a full SED model for a wide range of sources. (KINGFISH elements are in black)

The L_{TIR} are estimated from a resolved SED fitting using a Draine & Li dust model. We conclude that PACS bands can be used as reliable estimators of the L_{TIR}, particularly the 100µm band. Our monochromatic relations are able to reproduce the integrated L_{TIR} of nearby objects as well as those of z~1-3 sources.

References

Draine B. T., Li A., 2007, ApJ, 657, 810
Galametz M. et al., 2012, MNRAS, 425, 763
Galametz M. et al., 2013, MNRAS, 431, 1956