Using the DEBRIS Survey to Constrain Disc Properties

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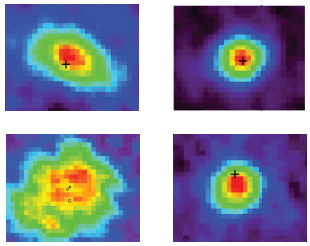
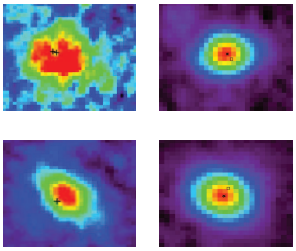
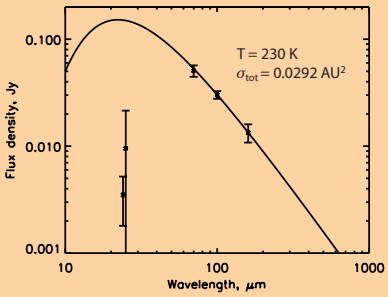


1. DEBRIS Survey

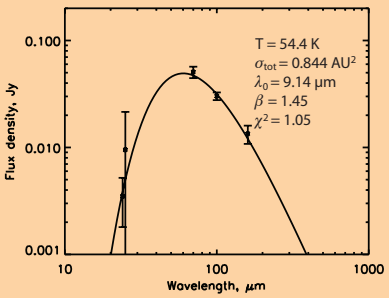
DEBRIS (Disc Emission via a Bias-free Reconnaissance in the Infrared/Sub-millimetre) is an open time key project (PI: Brenda Matthews) on the Herschel Space Observatory. The aim of the project is to conduct an unbiased, flux limited survey of the nearest stars for debris discs (Phillips et al. 2010). It is in the process of observing 446 systems (of spectral types A, F, G, K and M) at wavelengths of 100 and 160 μm with the PACS instrument and many of these systems will be followed up with SPIRE at 250, 350 and 500 μm (Matthews et al. 2010). Many of the targets are also shared with (and some observed by) the DUNES team (Eiroa et al. 2010).



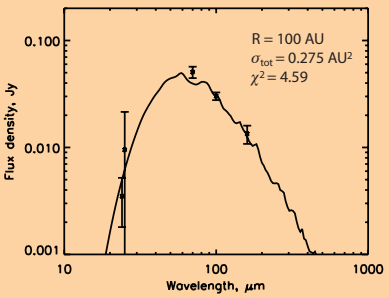
2. SED Modelling



These plots show the photosphere subtracted data from IRAS, MIPS and PACS for one of the stars in our sample. In the above plot a black-body curve has been fit to the two PACS fluxes. This fit gives a radius of 10.8 AU. This fit clearly gives a flux far too high for the 24 and 25 μm wavelengths.

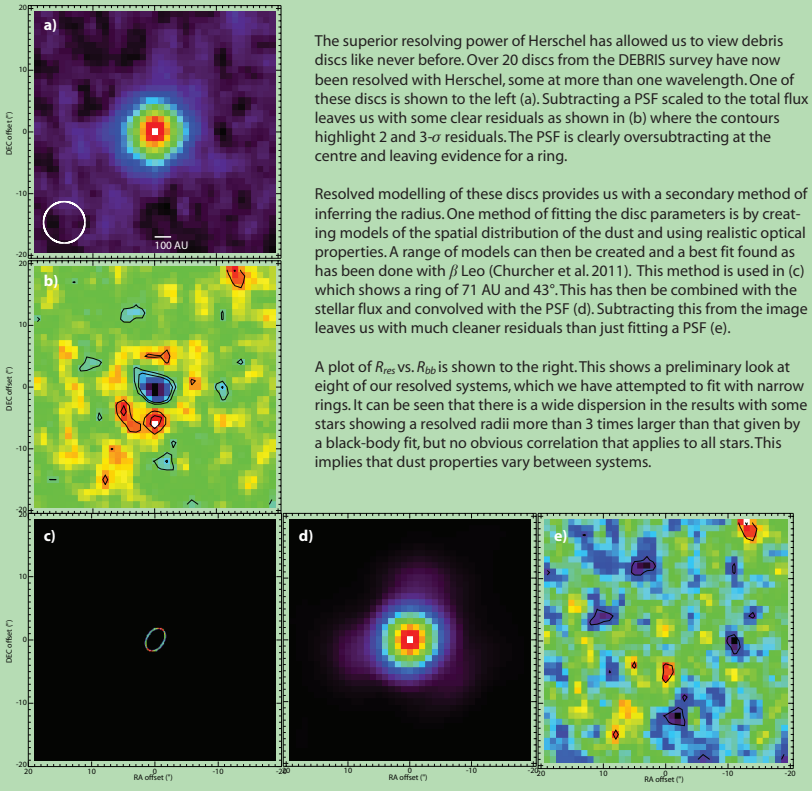


Here a modified black-body is used to fit to all the points. The black-body is modified by a factor $(\lambda_0/\lambda)^\beta$. For this star the λ_0 value is unusually low (values around 210 μm are more common e.g. Wyatt 2008) however, without any sub-mm data this parameter is poorly constrained by the fitting process.



In this plot realistic grain properties have been used. We use optical properties from the Li and Greenberg (1997) core mantle model. In this case amorphous silicate grains have been used with a silicate to organics ratio of 1:2. A Dohnanyi (1969) size distribution has been used with a minimum grain size equal to the blowout grain size (18 μm).

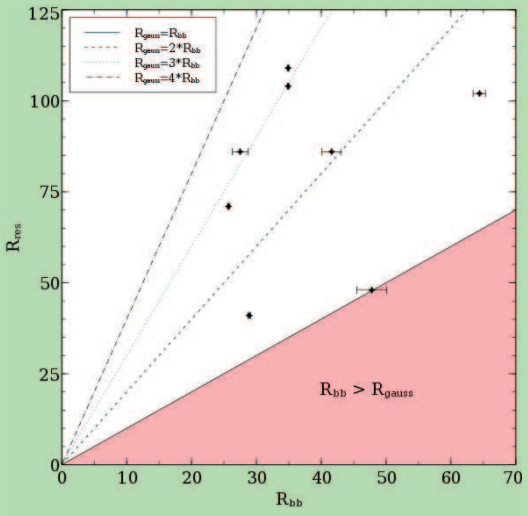
3. Resolved Modelling



The superior resolving power of Herschel has allowed us to view debris discs like never before. Over 20 discs from the DEBRIS survey have now been resolved with Herschel, some at more than one wavelength. One of these discs is shown to the left (a). Subtracting a PSF scaled to the total flux leaves us with some clear residuals as shown in (b) where the contours highlight 2 and 3-σ residuals. The PSF is clearly oversubtracting at the centre and leaving evidence for a ring.

Resolved modelling of these discs provides us with a secondary method of inferring the radius. One method of fitting the disc parameters is by creating models of the spatial distribution of the dust and using realistic optical properties. A range of models can then be created and a best fit found as has been done with β Leo (Churcher et al. 2011). This method is used in (c) which shows a ring of 71 AU and 43°. This has then be combined with the stellar flux and convolved with the PSF (d). Subtracting this from the image leaves us with much cleaner residuals than just fitting a PSF (e).

A plot of R_{res} vs. R_{bb} is shown to the right. This shows a preliminary look at eight of our resolved systems, which we have attempted to fit with narrow rings. It can be seen that there is a wide dispersion in the results with some stars showing a resolved radii more than 3 times larger than that given by a black-body fit, but no obvious correlation that applies to all stars. This implies that dust properties vary between systems.



References

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