

SIRTF Tools for DIRT

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Abstract. The Dust InfraRed ToolBox (DIRT – a part of the Web Infrared ToolShed, or WITS¹) is a Java applet for modeling astrophysical processes in circumstellar shells around young and evolved stars.² DIRT has been used by the astrophysics community for about 5 years. Users can automatically and efficiently search grids of pre-calculated models to fit their data. A large set of physical parameters and dust types are included in the model database, which contains over 500,000 models.

We are adding new functionality to DIRT to support new missions like SIRTF and SOFIA. A new Instrument module allows for plotting of the model points convolved with the spatial and spectral responses of the selected instrument. This lets users better fit data from specific instruments. Currently, we have implemented modules for the Infrared Array Camera (IRAC) and Multiband Imaging Photometer (MIPS) on SIRTF. The models are based on the dust radiation transfer code of Wolfire & Cassinelli (1986) which accounts for multiple grain sizes and compositions. The model outputs are averaged over the instrument bands using the same weighting ($\nu F_\nu = \text{constant}$) as the SIRTF data pipeline which allows the SIRTF data products to be compared directly with the model database.

1. Using DIRT

A typical user query will return about 50-100 models, which the user can then interactively filter as a function of 8 model parameters (e.g., extinction, size, flux, luminosity). A flexible, multi-dimensional plotter (Figure 1) allows users to view the models, rotate them, tag specific parameters with color or symbol size, and probe individual model points (Pound et al. 2000; Amarnath et al. 2003). For any given model, auxiliary plots such as dust grain properties, radial intensity profiles, and the flux as a function of wavelength and beamsize can be viewed. The user can fit observed data to several models simultaneously and see the results of the fit; the best fit is automatically selected for plotting.

¹<http://dustem.astro.umd.edu>

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2. The Instruments

The Infrared Array Camera (IRAC) and Multiband Imaging Photometer for SIRTF (MIPS) are two of SIRTF's three science instruments. IRAC is a four-channel camera that provides simultaneous $5.12' \times 5.12'$ images at 3.6, 4.5, 5.8, and 8 μm . MIPS provides imaging at 24, 70, 160 μm and limited spectroscopy from 50 to 100 μm . The MIPS field of view varies from about $5' \times 5'$ at the shortest wavelength to about $0.5' \times 5'$ at the longest wavelength.

3. "Cores To Disks" SIRTF Legacy Project

DIRT is specifically supporting the SIRTF Legacy project "Cores To Disks," or C2D. C2D is meant to investigate the life cycle of star formation, following evolution from starless cores to planet-forming disks. It will comprise a complete database for nearby (< 350 pc), low mass star formation. The C2D project will provide IRAC and MIPS maps of 5 large molecular clouds; photometry of 200 stars; and spectroscopy of disk material for about 200 targets. In support of C2D, we have substantially expanded our previous model database, computing nearly 218,000 models of very low-luminosity ($10^{-5} L_{\odot} < L < 10 L_{\odot}$) and low-mass protostars ($M < 1 M_{\odot}$). At the request of the C2D team (of which UMD is partner), we are now computing a grid of models using Ossenkopf & Henning (1994) ice mantle grains. Upon completion of the new dust grain grid, we will have doubled our database size to $\sim 10^6$ models.

4. DIRT and the Virtual Observatory

We are currently investigating how to "VO-enable" both DIRT and the model database itself. The model database provides a large uniform set of spectra which would be a good use-case for putting theory in the VO (Teuben et al. 2002). Other papers in this volume investigate both a general spectral format and instrument models for the VO. These developments could provide a useful interface for the "raw" and instrument-convolved models.

References

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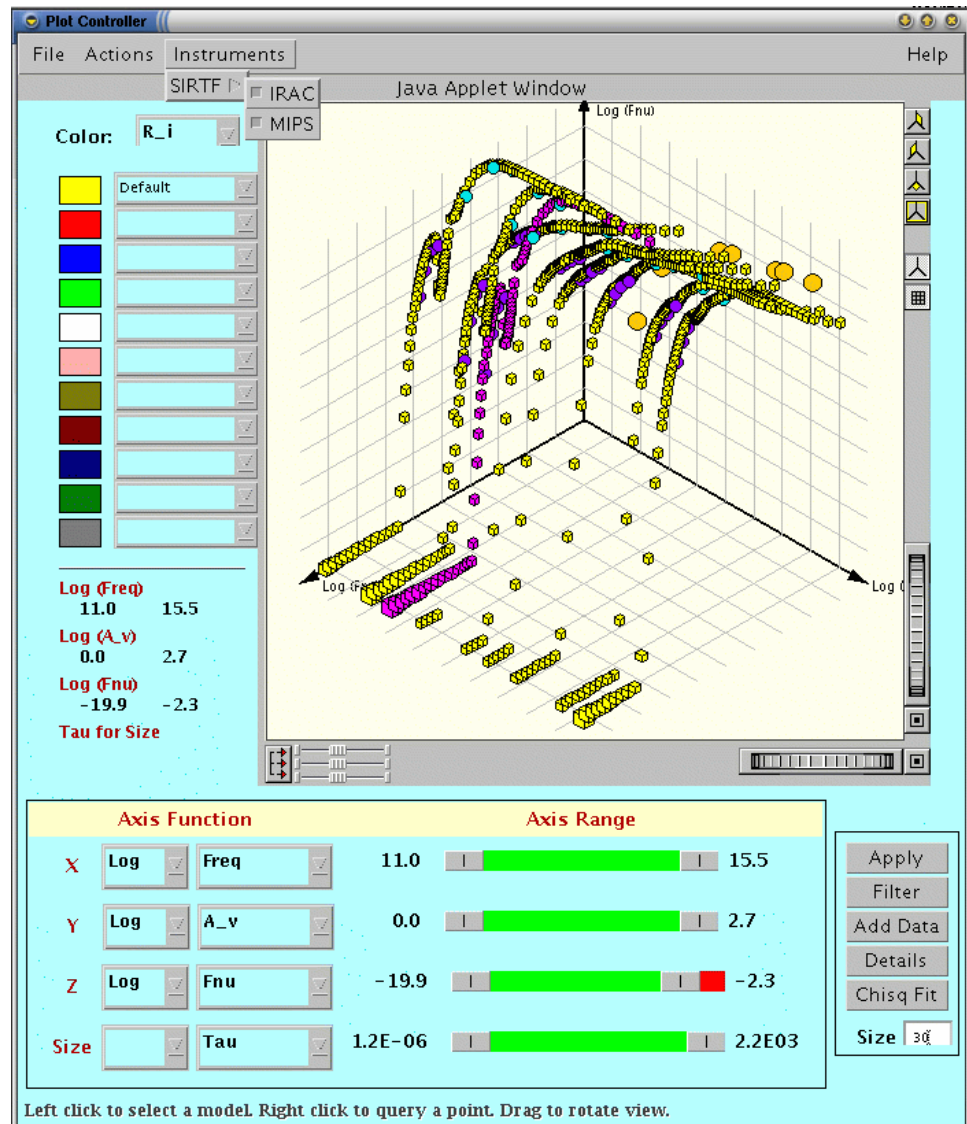


Figure 1. DIRT's main Model Viewer showing computed models (light cubes), IRAC band averages of the models (dark circles), MIPS band averages of the models (light circle), the user's input data (large circles). The model the user has selected is highlighted (dark cubes). Once a model is selected, the user can click on **Details** to further investigate that model (e.g., Figure 2).

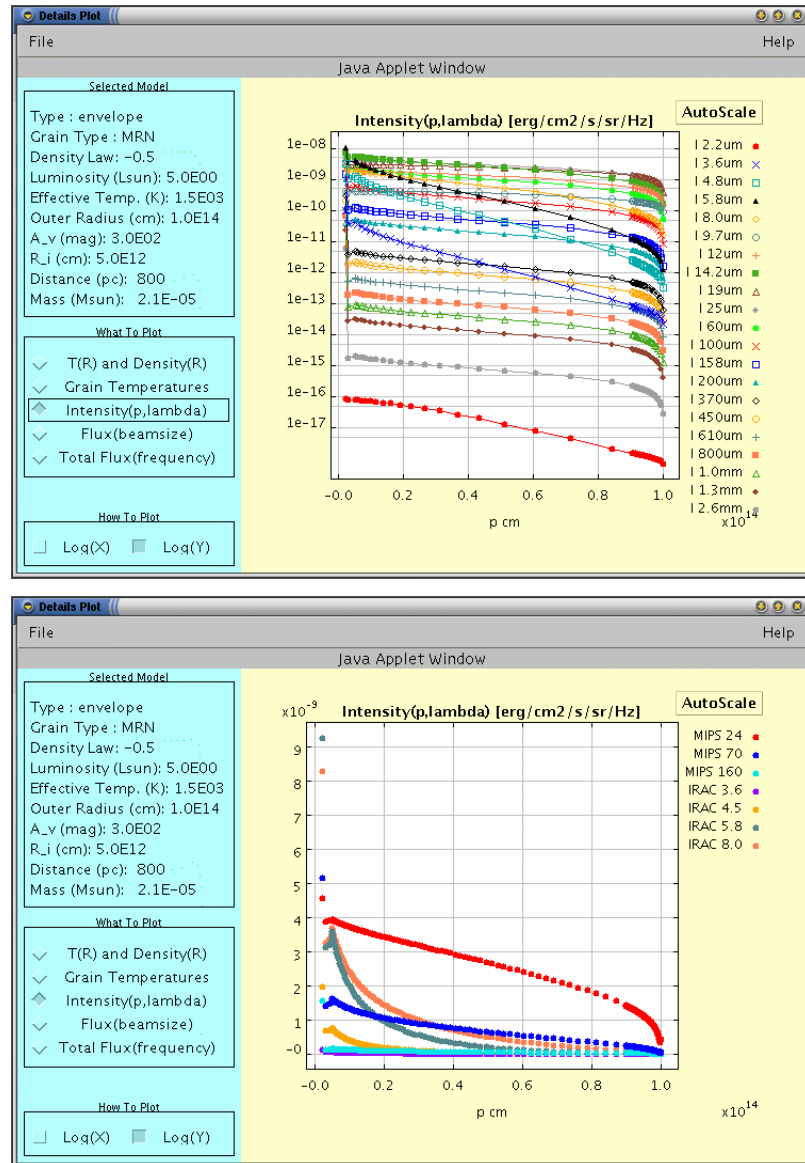


Figure 2. Source model Intensity as a function of impact parameter p and wavelength for the model selected in Figure 1. If no Instrument is selected in the main Model Viewer, the plot will show the computed model only (top). If an Instrument has been selected, the Instrument responses for that source model are shown (bottom).