Astronomical Data Analysis Software and Systems IX
ASP Conference Series, Vol. 216, 2000
N. Manset, C. Veillet, and D. Crabtree, eds.

DIRT: The Dust InfraRed Toolbox

M. W. Pound, M. Wolfire, L. Mundy, P. J. Teuben

Astronomy Dept, University of Maryland, College Park

S. Lord

IPAC

Abstract. We present **DIRT**, a Java applet geared toward modeling a variety of processes in envelopes of young and evolved stars. 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. The computing cluster for the database is described in the accompanying paper by Teuben et al. (2000).

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.

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.

The URL for this project is `http://dustem.astro.umd.edu`.

1. The Model Server

1.1. The Database Interface

The database is kept on disk in a directory structure that uniquely specifies each model parameter. Thus a search through the database is extremely fast: simply `chdir` to the correct directory and file `glob` on subdirectories to return the models which match the user inputs. The model files (9 per model – primary and 8 auxiliary) are kept in a single file in TGZ (tar, gzipped) format (primarily due to inode limitations), and when requested are untarred in a temporary directory. (This untarring process is a little slow for $\sim$ 100 models and we are working on ways to speed it up by parallelizing it - suggestions welcome!). The ASCII contents of the primary files are then sent through a stream to the **DIRT** applet, where they are loaded into the 3-D plotter (Figure 1). Subsequent requests for auxiliary files for any model (e.g. in the Details Window) are handled the same way. The search, untar, and stream reply are done via Perl CGI scripts.

1.2. Example

Say the user specified an Envelope model, MRN Grains, Density Law = 0.0, Luminosity = 100, Effective Temperature = 40000, and Outer Radius = 5E14. The directory to `chdir` to is

```
envelope/MRN/D-0.0/L1.00E+02/T4.00E+04/O5.00E+14/
```

All subdirectories below this contain models which match the inputs, but have varying Visual Extinction (A) and Inner Radius (I):

```
A1.00E+00
          /I1.00E+13/models.tgz
          /I3.00E+13/models.tgz
A1.00E+01
          /I1.00E+13/models.tgz
          /I3.00E+13/models.tgz
.
.
.
A5.00E+02
          /I1.00E+13/models.tgz
          /I3.00E+13/models.tgz
```

Each `models.tgz` file is untarred into the temporary area on the server, from which the model data are transferred to the client applet. Note this directory structure allows for insertion of new models at any point in the tree. At runtime, the Java applet queries a short index to determine what models are currently available and can be presented as choices to the user. The index is kept up to date by a daily `crontab`.

The envelope models contained in **DIRT** are based on the transfer code of Wolfire & Cassinelli (1986). The code solves for the grain temperatures and the emitted spectral energy distribution of a spherical dust shell under the constraints of thermal and radiative equilibrium.

2. The Java User Interface

2.1. The Plot Controller

The primary window in **DIRT** is the Plot Controller (Figure 1). It displays the actual model values, as well as any observed data the user may have added, in 3-dimensional Cartesian coordinates. Initially, the axes are Frequency, Flux, and Visual Extinction, but any of the available model parameters may be selected as axes. An additional model parameter may be shown as symbol size (initially this is opacity, Tau). Points may also be color-coded with Visual Extinction or Inner Radius. The background may be set to a grid, opaque, or both, and any axis may be projected. The plot may be rotated with the mouse or with the wheels, and zoomed with the zoom slider. The user may also set filters (upper and lower bounds) for all model parameters to add points to or eliminate points from the display.

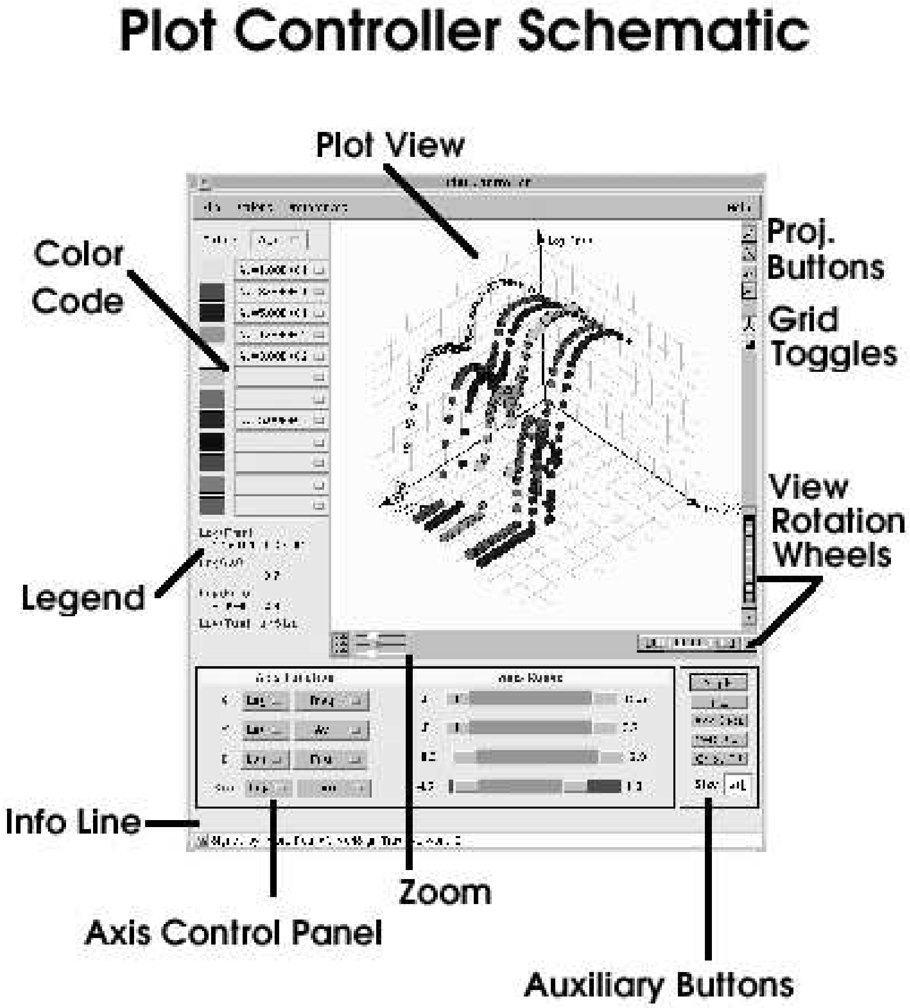

Figure 1. The **DIRT** Plot Controller, with its interactive components indicated.

2.2. Details and Chi-Squared Window

The Details Window displays auxiliary data associated with a chosen model (selected by a mouse-click in the Plot Controller). These are model outputs that have been calculated along with the spectral energy distribution, such as grain temperatures, gas density, and flux as a function of both frequency and beamsize.

The user finds the best-fit model to her data using the Chi-Squared Fit Window. Either total flux as a function of frequency or flux as a function of both frequency and beamsize can be fit and the best-fit model (based on a chi-squared statistic) is displayed along with the data.

Both of these windows make use of the Java two-dimensional plotting package PtPlot developed at U.C. Berkeley. PtPlot has a few annoying idiosyncrasies (e.g., plot symbol colors are declared `static`), but is generally a pretty good package.

3. Applet Security

The applet is digitally signed using a VeriSign certificate and Netscape Object Signing. The user accepts the digital certificate to grant the applet permission to print, save files, etc. Unfortunately, while Java is cross-platform, the certificate is not, and only works for the Netscape browser. The new security model in Java 2 remedies this by implementing certificates into the API, obviating the need for 3rd party certificates. When **DIRT** is upgraded to Java 2, the new certificate methods will be implemented.

Acknowledgments. Development of **DIRT** was supported in part by NASA ADP grant NAG5-6750.

References

Teuben, P. J., et al. 2000, this volume, 646

Wolfire, M. & Cassinelli 1986, ApJ, 310, 207