

Visualization

- Visualization is useful for:
 - 1) Data entry (initial conditions)
 - 2) Code debugging and performance analysis
 - 3) Interpretation and display of results
- Our focus will be #3. The computational astrophysicist can either:
 - 1) Develop new visualization software tailored to problem under study
 - 2) Use an existing software package

Plotting 1-D Data

- Function of one variable only: $f(x)$ vs. x
- Examples: sm, gnuplot, xgobi, IDL, etc.
- Minimum requirements:
 - Read data from file
 - Perform arithmetic manipulation of data
 - Multiple data sets on plot
 - Multiple plots on page
 - Add text to plots

Plotting 2-D Data

- Function of 2 variables, i.e. $f(x,y)$
- If f is a scalar quantity, can:
 - 1) **Make image**
 - Represent each x,y data point by one or more pixels on screen. Use integer value to represent data value at x,y point (8 bit: 0-255; 24-bit: 0-16.8 million).
 - 2) **Make contour plot**
 - Contours are isosurfaces of data.
 - 3) **Make 3-D surface plot**
 - Use x,y as 2 coordinates, f as 3rd coordinate, plot surface.

Plotting 2-D Data, Cont'd

- If f is a vector quantity, can:
 - 1) Plot vectors directly
 - Can be hard to see
 - 2) Plot streamlines
 - Contours of ϕ where $\mathbf{f} = \nabla\phi$
- 2-D plotting packages include:
 - sm, gnuplot, xgobi, IDL, ximage, NCAR graphics, etc.

Plotting 3-D Data

- Function of 3 variables, i.e. $f(x,y,z)$
- If f is a scalar quantity, can:
 - 1) Plot 2-D slices
 - e.g. Faces of cube
 - 2) Plot isosurfaces
 - These are now 3-D surfaces. Can use wireframe or polygons. Can shade with second variable $g(x,y,z)$.
 - 3) Plot volumetric rendering
 - Solve transfer equation ("ray tracing") using emissivity proportional to data value.

Plotting 3-D Data, Cont'd

- Standard algorithms exist for 3-D rendering, including shadowing, hidden surface removal, etc. Often implemented in hardware. Also have "dynamic/interactive" visualization: rotation, etc.
- If f is a vector quantity, can:
 - 1) Plot 3-D vectors on 2-D slice
 - 2) Plot streamlines in 3D
- 3-D plotting packages include:
 - tipsy, xgobi, IDL, NCAR graphics, xdataslice, etc.

Animation

- If any one of the coordinates of data in a plot is time, it makes sense to render images as a time sequence, e.g. make animation.
- The eye is very sensitive to motion, can discover much detail using animations.
- Animation formats include MPEG, FLI, QT, AVI, GIF, plus many custom formats.
- Animation players include mpeg_play, xanim, quicktime, etc.