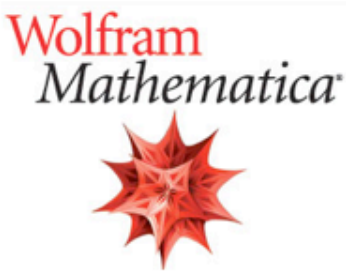
Using Python for fun and profit

~~Why you shouldn't be using IDL~~

Why python is Awesome.

Hard Code | Easier Code | Pure GUI | Game

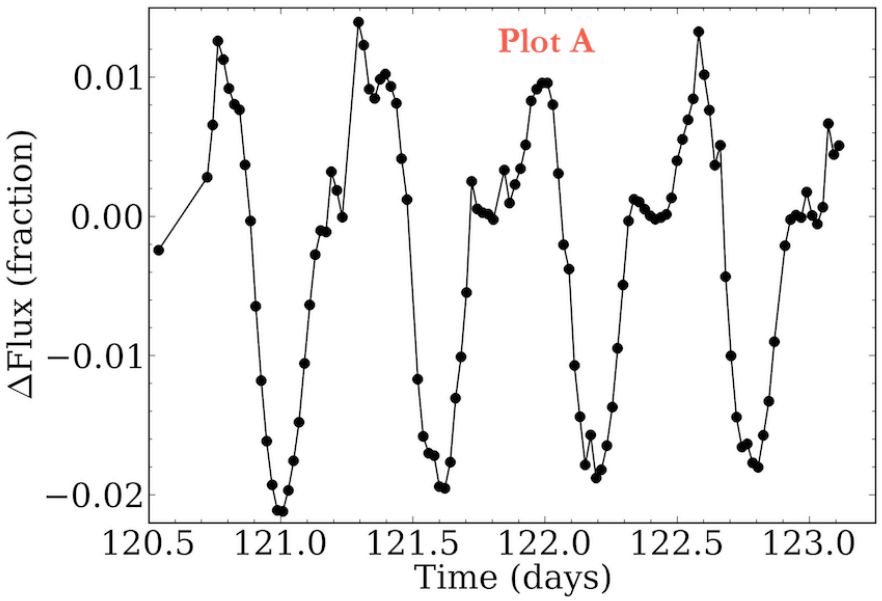
C++
FORTRAN

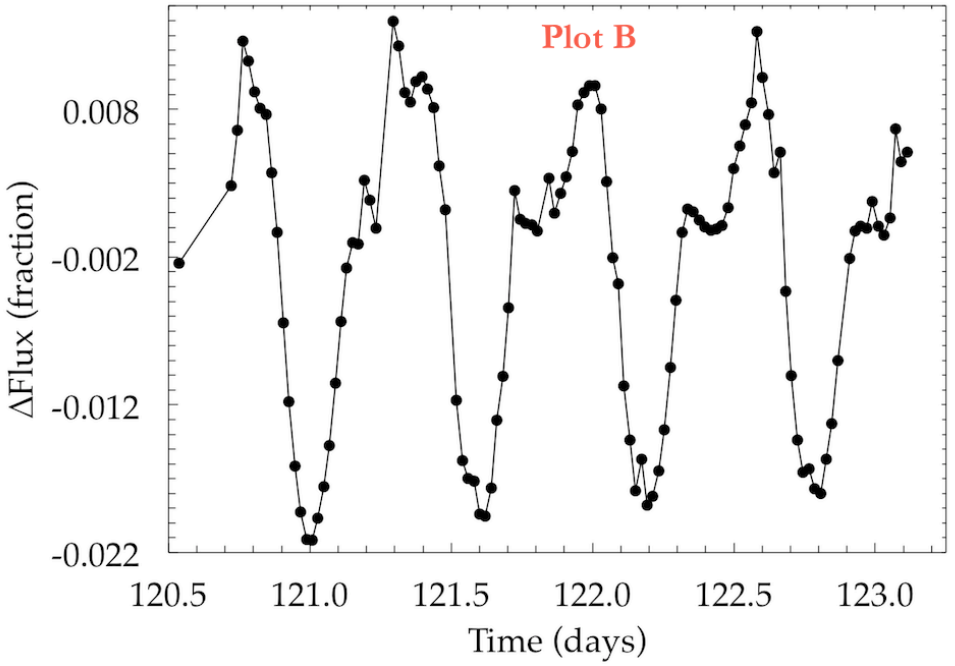


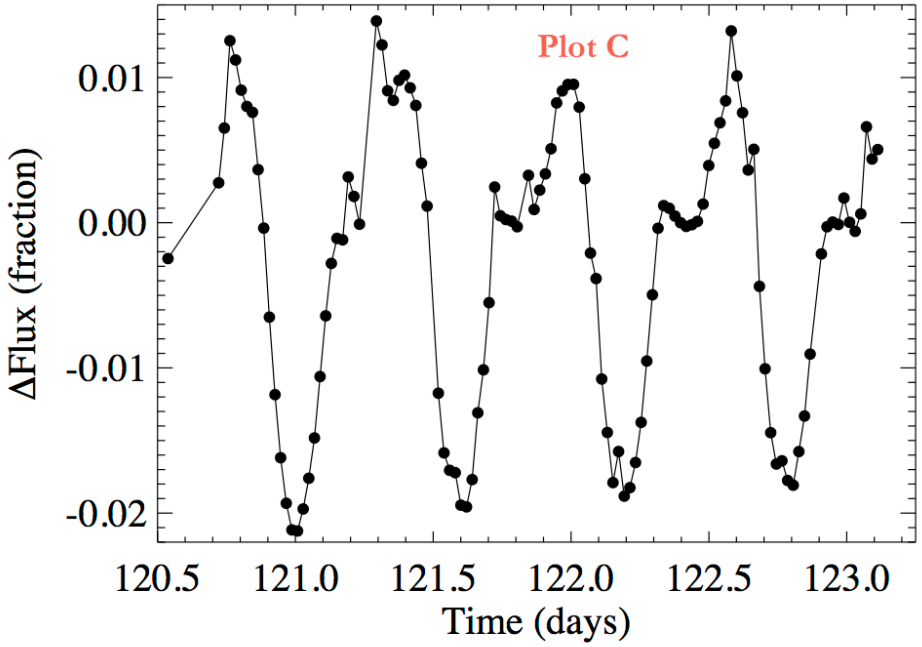
glue

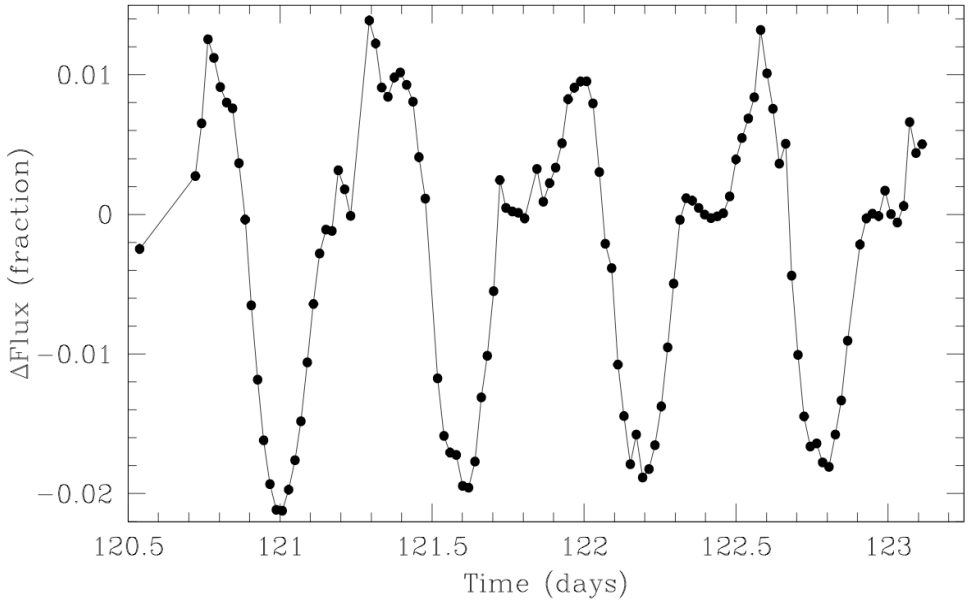
Where do *you* need to be
to do astrophysics research?

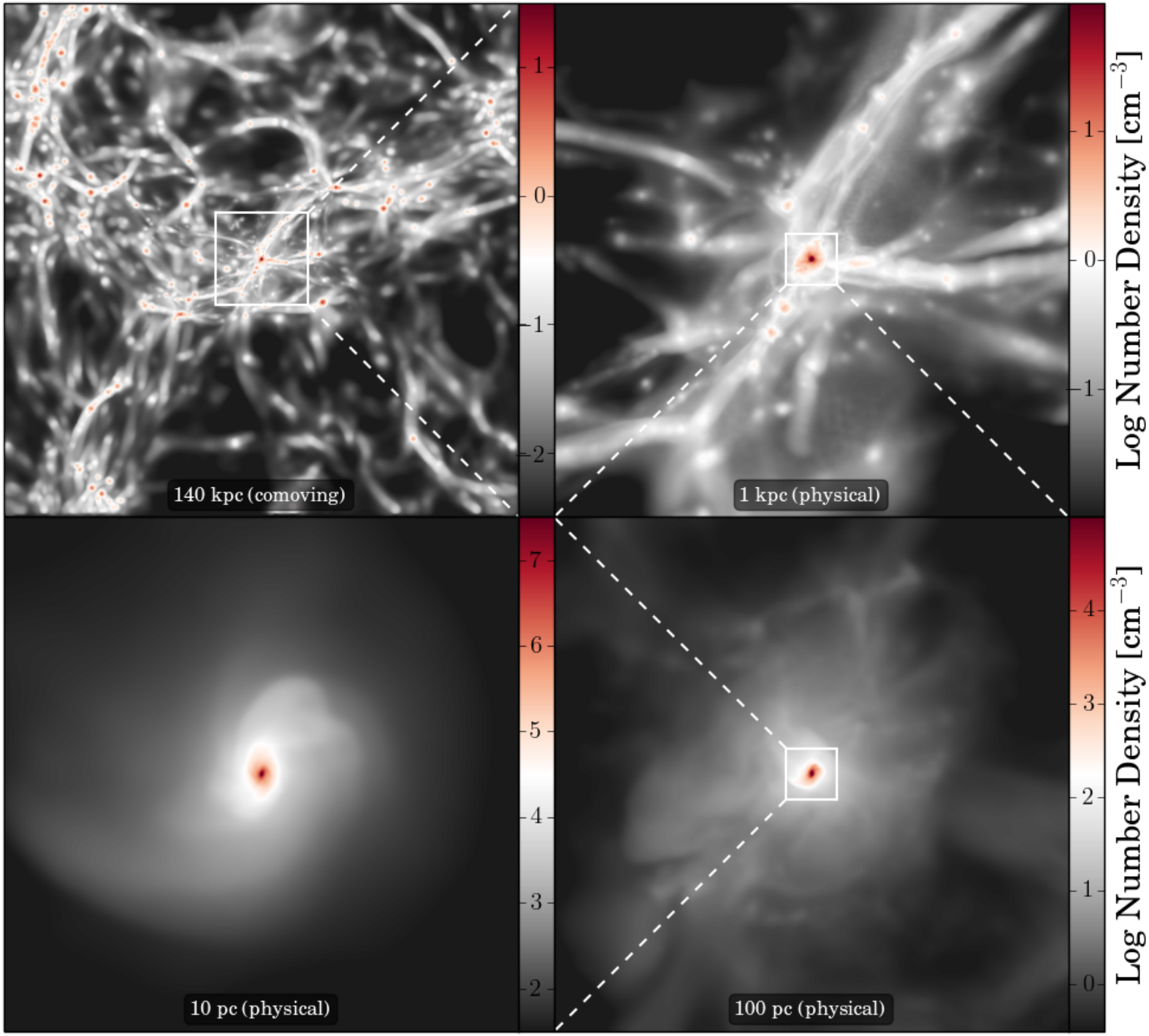
Slide Shamelessly stolen from J. Davenport


Plot A
0.01
0.00
−0.01
−0.02
ΔFlux (fraction)
120.5
121.0
121.5
122.0
122.5
123.0
Time (days)


Plot B
0.008
-0.002
-0.012
-0.022
ΔFlux (fraction)
120.5
121.0
121.5
122.0
122.5
123.0
Time (days)


Plot C
0.01
0.00
-0.01
-0.02
ΔFlux (fraction)
120.5
121.0
121.5
122.0
122.5
123.0
Time (days)


0.01
0
−0.01
−0.02
ΔFlux (fraction)
120.5
121
121.5
122
122.5
123
Time (days)


140 kpc (comoving)
1 kpc (physical)
10 pc (physical)
100 pc (physical)
Log Number Density [cm^{-3}]
Log Number Density [cm^{-3}]

In [ ]:

```
from mpl_toolkits.axes_grid1 import ImageGrid

scales = ['140 kpc (comoving)', '1 kpc (physical)', '10 pc (physical)', '100 pc (physical)']
ratio = [.1788, .1, None, .1]
zoom = ['right', 'down', None, 'left']
clims = [(-2.5,1.5), (-2.,2.), (1.5,7.5), (-0.5,5.)]
ticks = [(-2,-1,0,1), (-1,0,1), (2,3,4,5,6,7), (0,1,2,3,4)]
cpad = [-17, -17, -15, -16]
clabel = [False, True, False, True]
bbox_props = dict(boxstyle="round", fc="k", ec="k", alpha=0.5)
zc = 'w'
zls = '--'
zlw = 1.5

fig = plt.figure(1, (12., 12.), dpi=600)
grid = ImageGrid(fig, 111, # similar to subplot(111)
                 nrows_ncols = (2, 2), # creates 2x2 grid of axes
                 axes_pad=0.0, # pad between axes in inch.
                 cbar_mode = 'each', cbar_size='7%', cbar_pad=0.
                 )

for i in range(4):
    x = imzoom[i][0]
    y = imzoom[i][1]
    im = imzoom[i][2]
    ax = grid[i]
    img = ax.imshow(im, cmap=plt.cm.RdGy_r, origin='lower')
    ax.xaxis.set_visible(False)
    ax.yaxis.set_visible(False)
    img.set_clim(clims[i])

    cb = plt.colorbar(img, cax=grid.cbar_axes[i])
    cb.set_ticks(ticks[i])
    cb.ax.tick_params(left='on', pad=cpad[i],
                      labelsize=15, labelcolor='k', labelleft='on', labelright='off')
    if clabel[i]: cb.set_label('Log Number Density [cm$^{-3}$]')

    ax.text(0.5, 0.025, scales[i], color='w', ha='center', va='bottom', size=12,
            transform=grid[i].transAxes, bbox=bbox_props)

    if ratio[i]:
        axmin, axmax = ax.get_xlim()
        axlength = axmax - axmin
        mid = axlength/2
        s = ratio[i] * axlength
        s00 = [mid - s/2, mid - s/2]
        s01 = [mid - s/2, mid + s/2]
        s11 = [mid + s/2, mid + s/2]
        ax.add_line(plt.Line2D(s00, s01, c=zc, lw=zlw))
        ax.add_line(plt.Line2D(s11, s01, c=zc, lw=zlw))
        ax.add_line(plt.Line2D(s01, s00, c=zc, lw=zlw))
        ax.add_line(plt.Line2D(s01, s11, c=zc, lw=zlw))
        if zoom[i] == 'right':
            ax.add_line(plt.Line2D([mid+s/2, axmax], [mid+s/2, axmax], c=zc, lw=zlw, ls=zls))
            ax.add_line(plt.Line2D([mid+s/2, axmax], [mid-s/2, axmin], c=zc, lw=zlw, ls=zls))
        elif zoom[i] == 'down':
            ax.add_line(plt.Line2D([mid-s/2, axmin], [mid-s/2, axmin], c=zc, lw=zlw, ls=zls))
            ax.add_line(plt.Line2D([mid+s/2, axmax], [mid-s/2, axmin], c=zc, lw=zlw, ls=zls))
        elif zoom[i] == 'left':
            ax.add_line(plt.Line2D([mid-s/2, axmin], [mid+s/2, axmax], c=zc, lw=zlw, ls=zls))
            ax.add_line(plt.Line2D([mid-s/2, axmin], [mid-s/2, axmin], c=zc, lw=zlw, ls=zls))
plt.show()
fig.savefig('figures/structure.png', bbox_inches='tight', dpi=100)
```

Reasons NOT to use Python

- I already know how to do this in IDL/SM/Excel/etc
- Legacy Code
- Legacy Professors
- Better resources for getting help with other languages
- Better code libraries

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2008

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You want it – Python has it (probably)

NumPy
Base N-dimensional array package

SciPy library
Fundamental library for scientific computing

Matplotlib
Comprehensive 2D Plotting

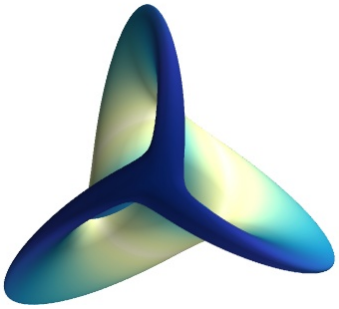
IP[y]: IPython

IPython
Enhanced Interactive Console

Sympy
Symbolic mathematics

pandas
Data structures & analysis

scikits learn
machine learning in Python



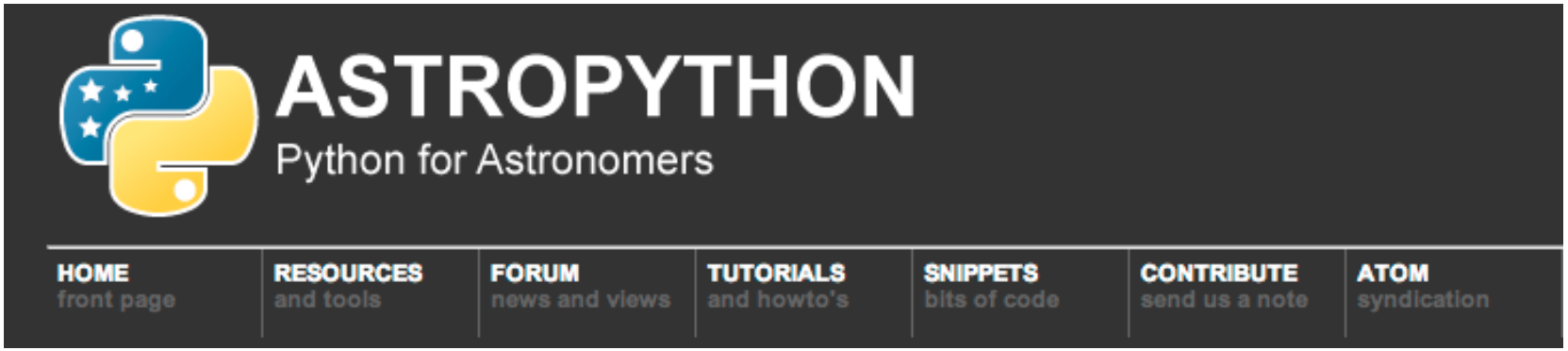
Mayavi – 3D visualization

PyTables

H5py and PyTables:
hdf5 made easy

But what about Astronomy?

- An entire ecosystem of python tools specifically for python exists.

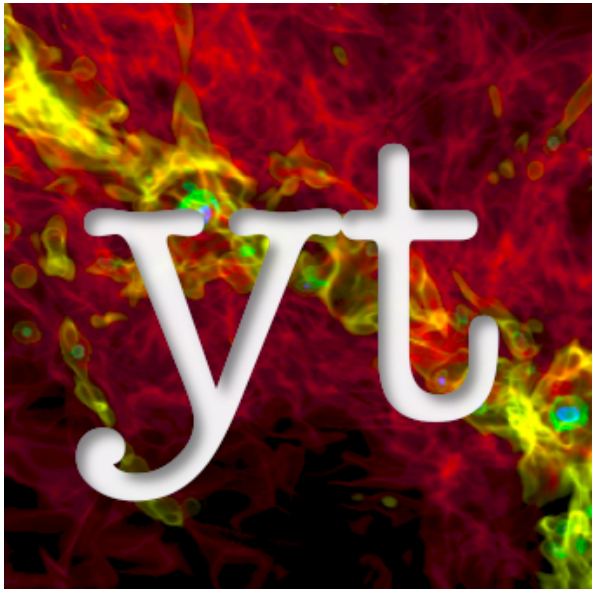


http://www.astropython.org/

But what about Astronomy?

PyRaf – a python wrapper for IRAF

PyFITS – interface for FITS formatted images



Still can't find what you need?

- Perhaps Python's greatest strength is how easy it is to extend
- Works great as 'glue' to piece together your analysis pipeline
- Use Cython; scipy.weave; f2py to speed up computationally intensive parts of your code

- Parallel processing is possible

IPython Notebooks

- interactive, repeatable analysis
- Use as a living research journal
- quickly and easily share your analysis with others