# reading_data

October 18, 2016

In [2]:
```
%matplotlib inline
print('-- ')
print('-- Read data files in different formats (and save them) in python')
print('-- ')
```

```
--
-- Read data files in different formats (and save them) in python
--
```

In [3]:
```
print('\n ---- Ascii files! ----\n')
```

```
---- Ascii files! ----
```

In [4]:
```
# In test_data/ there is a text file called spectrum2.dat with
# data that we want to import into python.
# (spectrum2.dat is a model stellar spectrum from starburst99 for
# a group of stars with 0.7 x solar metallicity,
# 1e4 solar masses population, Kroupa IMF and a starburst 1e6 years ago)
```

In [5]:
```
print('Read data into numpy array!')
import numpy as np
# http://docs.scipy.org/doc/numpy/reference/generated/numpy.loadtxt.html
spec_nparray    =   np.loadtxt('test_data/spectrum2.dat',skiprows=6)
print(type(spec_nparray))
```

```
Read data into numpy array!
<type 'numpy.ndarray'>
```

In [6]:
```
# Shape of this numpy array will be determined by number of columns and rows in your data:
print(spec_nparray.shape)
```

```
(1221, 5)
```

In [7]:
```
# And if you want to extract e.g. time, you need to remember the column index, in this case 0:
t_yr = spec_nparray[:,0]
print(t_yr)
```

```
[ 10010000.  10010000.  10010000. ...,  10010000.  10010000.  10010000.]
```

In [9]:
```
# By default, numbers are loaded with float 64bit precision:
t_yr.dtype
```

Out[9]:
```
dtype('float64')
```

In [10]:
```
# The genfromtxt function from numpy is a bit more flexible
# http://docs.scipy.org/doc/numpy/reference/generated/numpy.genfromtxt.html
```

In [14]:
```
spec_nparray2    =   np.genfromtxt('test_data/spectrum2.dat',skip_header=6,\
                    names=['time','wavelength','L_tot','L_stellar','L_nebular'])
print(type(spec_nparray2))
print(spec_nparray[0,0])
print(spec_nparray2['time'][0])
```

```
<type 'numpy.ndarray'>
10010000.0
10010000.0
```

In [18]:
```
# Try to change one of the times to something that is not a number (like %%%) and you will see
# can handle this with the keywords missing_values='%%%',filling_values=-1:
spec_nparray2    =   np.genfromtxt('test_data/spectrum2.dat',skip_header=6,\
                    names=['time','wavelength','L_tot','L_stellar','L_nebular'],\
                    missing_values='%%%',filling_values=-1)
print(spec_nparray2['time'][0])
```

```
10010000.0
```

In [19]:
```
# But loadtxt will crash:
spec_nparray    =   np.loadtxt('test_data/spectrum2.dat',skiprows=6)
print(type(spec_nparray2))
```

```
<type 'numpy.ndarray'>
```

In [20]:
```
# Typically, a smarter way is to load the data directly into a pandas dataframe
# http://pandas.pydata.org/pandas-docs/stable/dsintro.html
```

In [21]:
```
print('Read data into pandas dataframe!')
import pandas as pd
names=['time','wavelength','L_tot','L_stellar','L_nebular']
spec_dataframe    =   pd.read_table('test_data/spectrum2.dat',\
                names=names,\
                skiprows=6,sep=r"\s*",engine='python')
print(type(spec_dataframe))
```

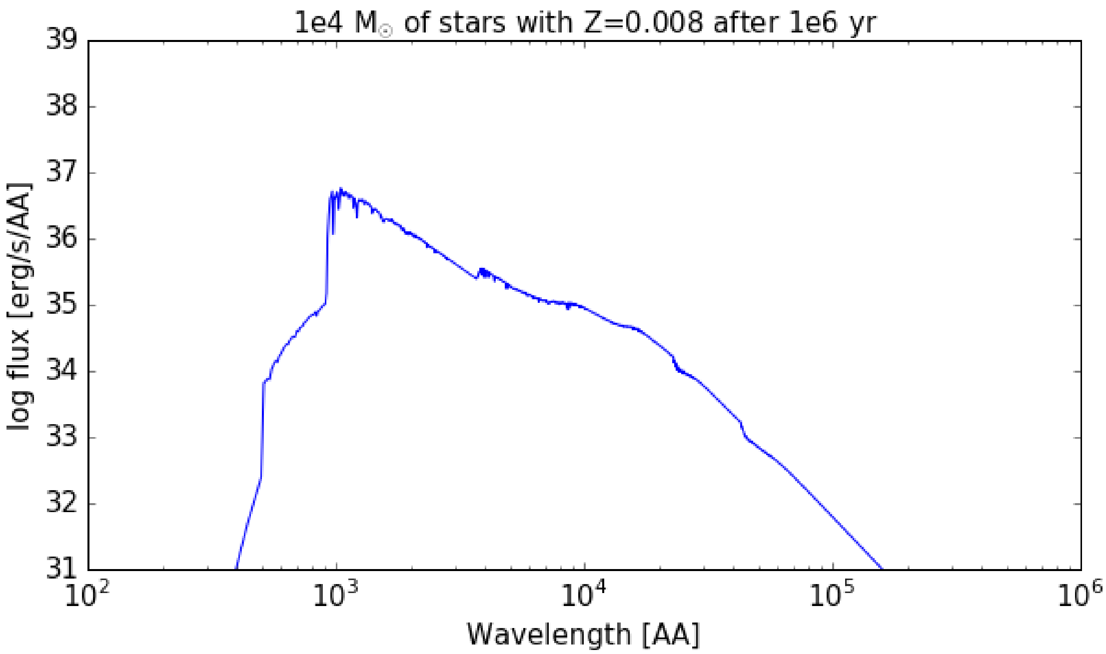
```
Read data into pandas dataframe!
<class 'pandas.core.frame.DataFrame'>
```

In [22]:
```
spec_dataframe['time'][1]
```

Out[22]:
```
10010000.0
```

In [23]:
```
# Plot spectrum
import matplotlib.pyplot as plt
import matplotlib as mpl
mpl.rcParams['xtick.labelsize'] = 15
mpl.rcParams['ytick.labelsize'] = 15
fig          =   plt.figure(0,figsize=(10,5))
ax1          =   fig.add_axes([0.15,0.1,0.75,0.8])
ax1.set_ylim(31,39)
ax1.set_xlim(1e2,1e6)
ax1.set_xscale('log')
ax1.set_xlabel('Wavelength [AA]',fontsize=15)
ax1.set_ylabel('log flux [erg/s/AA]',fontsize=15)
ax1.set_title('1e4 M$_{\odot}$ of stars with Z=0.008 after 1e6 yr',fontsize=15)#+str(t1)+' yr'
```

```
#ax1.plot(spec_nparray[:,1],spec_nparray[:,2],'b')
#ax1.plot(spec_nparray2['wavelength'],spec_nparray2['L_tot'],'b')
ax1.plot(spec_dataframe['wavelength'],spec_dataframe['L_tot'],'b')
plt.show()
```




```
In [24]: print('\n ---- Fits files! ----\n')
```

```
---- Fits files! ----
```

```
In [25]: # In test_data/ there is a file called cloud.fits with data that we
         # want to import into python.
         # (cloud.fits is a simulated HCO+ data cube of a cloud, calculated
         # with RT code LIME)
```

```
In [26]: # Read fits file into list-like Python opject with the fits function from the astropy module
         from astropy.io import fits
         fits_file = fits.open('test_data/cloud.fits')
         print(type(fits_file))
         fits_file.info() # get basic info, like number of header cards and dimensions of data
```

```
<class 'astropy.io.fits.hdu.hdulist.HDUList'>
Filename: test_data/cloud.fits
No.    Name         Type      Cards   Dimensions   Format
0    PRIMARY     PrimaryHDU      34   (100, 100, 61)   float32
```

```
In [27]: print(fits_file[0].header) # display all header cards
```

```
SIMPLE  =                    T / file does conform to FITS standard             BITPIX  =
```

```
In [28]: # We can extract general info from the header cards like this:
         imgres = fits_file[0].header['CDELT2']
```

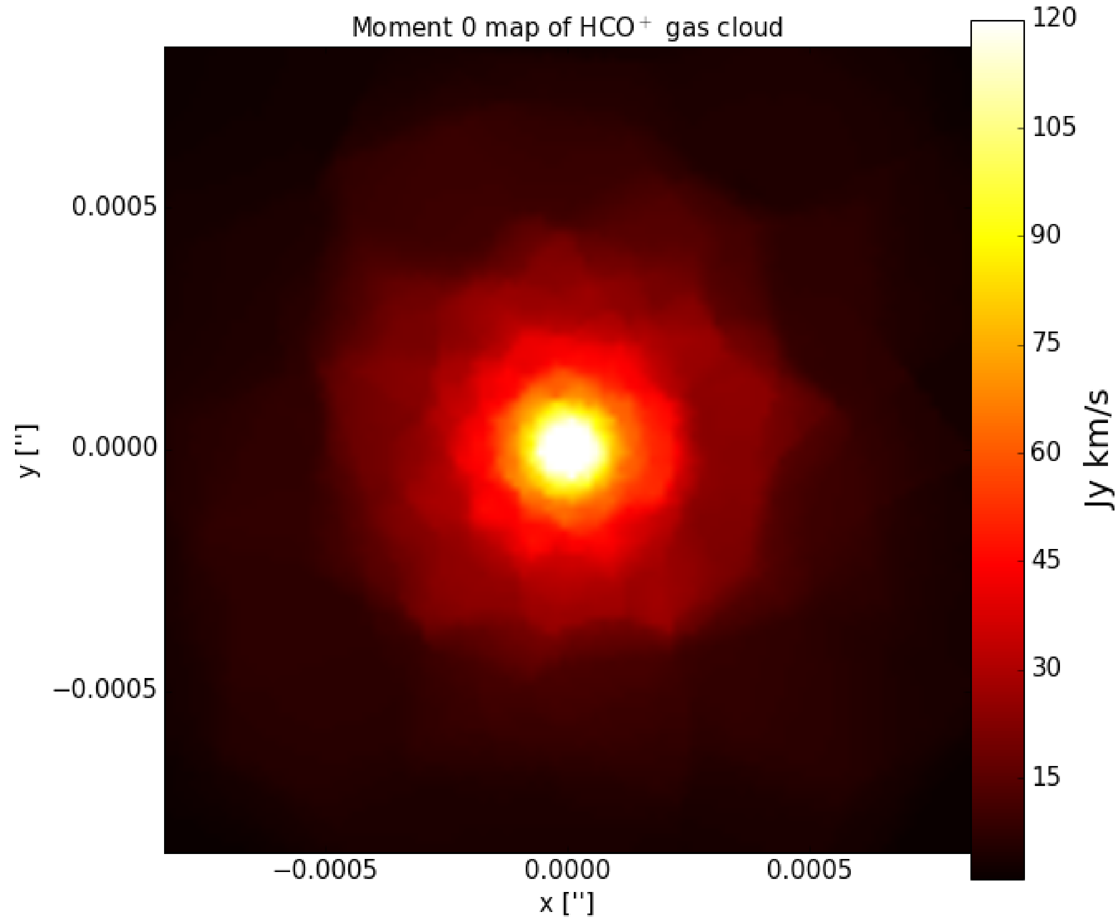
```
print('Image resolution: ' + str(imgres) + ' degrees')
npix = fits_file[0].header['NAXIS3']
print('Number of pixels on each side: ' + str(npix))
velres = fits_file[0].header['CDELT3']
print('Velocity resolution: ' + str(velres) + 'm/s')
fits_file[0].header['CDELT2']=2.0
print('Image resolution: ' + str(imgres) + ' degrees')
```

```
Image resolution: 2.77777778111e-05 degrees
Number of pixels on each side: 61
Velocity resolution: 500.0m/s
Image resolution: 2.77777778111e-05 degrees
```

In [29]:
```
# And the actual data is an attribute of data[0]
HCO_flux = fits_file[0].data # [velocity channels, x axis, y axis]
print(HCO_flux[0,50,50])
mom0 = HCO_flux.sum(axis=0)*velres/1000 # moment 0 map, Jy*km/s
```

```
0.463905
```

In [30]:
```
# Contour plot of data cube
import matplotlib.cm as cm
fig         =   plt.figure(1,figsize=(9,9))
ax1         =   fig.add_axes([0.15,0.1,0.75,0.8])
ax1.set_xlabel("x ['']",fontsize=15)
ax1.set_ylabel("y ['']",fontsize=15)
ax1.set_title("Moment 0 map of HCO$^+$ gas cloud",fontsize=15)
x1 = imgres*(np.arange(npix)-npix/2) # image axis
xmax = max(x1)
im = ax1.imshow(mom0,interpolation='bilinear',origin='lower',cmap=cm.hot,extent=(-xmax,xmax,-xm
cax = fig.add_axes([0.9,0.1,0.05,0.8])
cbar = plt.colorbar(im,cax=cax)
cbar.set_label('Jy km/s',size=20)
plt.show(block=False)
```




```
In [31]: print('\n ---- Saving python data for later! ----\n')
```

```
---- Saving python data for later! ----
```

```
In [32]: print('Save a numpy array!')
         # Say you have a numpy array that you want to save to a file and load later.
         # One way to do so is with numpy:
         np.save('test_data/spec_nparray',spec_nparray) # will get a 'npy' extension
         load_spec_nparray = np.load('test_data/spec_nparray.npy')
         load_spec_nparray[0,0] # test
```

```
Save a numpy array!
```

```
Out[32]: 10010000.0
```

```
In [33]: # You can also use pickle! Or cPickle, which is pickle written in C,
         # with several advantages.
         import cPickle as pickle
         pickle.dump(spec_nparray,open('test_data/spec_nparray_pickle','wb')) # no extension
         # 'wb' is the protocol and means to write to binary format
         load_spec_nparray = pickle.load(open('test_data/spec_nparray_pickle','rb'))
         load_spec_nparray[0,0] # test
```

Out[33]: 10010000.0

```
In [34]: # You can also use pandas to save a dataframe with pickle:
         spec_dataframe.to_pickle('test_data/spec_dataframe_pickle') # no extension
         load_spec_dataframe_pickle = pd.read_pickle('test_data/spec_dataframe_pickle')
         load_spec_dataframe_pickle['time'][0] # test
```

Out[34]: 10010000.0

```
In [36]: # But the to_pickle attribute is specific to pandas and will not work on say a numpy array:
         spec_nparray.to_pickle('test_data/spec_dataframe_pickle')
```

```
---------------------------------------------------------------------------

AttributeError                            Traceback (most recent call last)

<ipython-input-36-1086fdb95070> in <module>()
      1 # But the to_pickle attribute is specific to pandas and will not work on say a numpy array:
----> 2 spec_nparray.to_pickle('test_data/spec_dataframe_pickle')


AttributeError: 'numpy.ndarray' object has no attribute 'to_pickle'
```

In [ ]: