Using_pyCloudy_2

August 6, 2025

[1]:
```
import numpy as np
import matplotlib.pyplot as plt
import os
home_dir = os.environ['HOME'] + '/'
```

[2]:
```
import pyCloudy as pc
```

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warng pyCloudy config: pyCloudy works better with matplotlib Triangulation
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[3]:
```
# Changing the location and version of the cloudy executable.
pc.config.cloudy_exe = '/usr/local/Cloudy/c25.00_rc2/source/cloudy.exe'
```

[4]:
```
# We define a function that will manage the input files of Cloudy.
# This allow to easily change some parameters, very usefull to do a grid.
def make_model(dir_, model_name, dens, ab_O):
        full_model_name = '{0}_{1:.0f}_{2:.2f}'.format(model_name, dens, ab_O)
        r_min = 5e16
        dist = 1.26
        Teff = 45000
        qH = 47.
        options = ('no molecules',
                   'no level2 lines',
                   'no fine opacities',
                   'atom h-like levels small',
                   'atom he-like levels small',
                   'COSMIC RAY BACKGROUND',
                   'element limit off -8',
                   )
        emis_tab = ['H  1  4861.32A',
                'H  1  6562.80A',
                'Ca B  5875.64A',
                'N  2  6583.45A',
                'O  1  6300.30A',
                'O  2  3726.03A',
                'O  2  3728.81A',
                'O  3  5007.84A',
                'O  3  4363.21A',
                'O 3R  4363.00A',
                'O 3C  4363.00A',
                'S  2  6716.44A',
                'S  2  6730.82A',
                'Cl 3  5517.71A',
                'Cl 3  5537.87A',
                'O  1  63.1679m',
                'O  1  145.495m',
                'C  2  157.636m']
        abund = {'He' : -0.92, 'C' : -3.15, 'N' : -4.0, 'Ne' : -4.00,
             'S' : -5.35, 'Ar' : -5.80, 'Fe' : -7.4, 'Cl' : -7.00}
        abund['O'] = ab_O
        # Defining the object that will manage the input file for Cloudy
        c_input = pc.CloudyInput('{0}{1}'.format(dir_, full_model_name))
        # Filling the object with the parameters
        # Defining the ionizing SED: Effective temperature and luminosity.
        # The lumi_unit is one of the Cloudy options, like "luminosity solar",␣
↪"q(H)", "ionization parameter", etc...
        c_input.set_BB(Teff = Teff, lumi_unit = 'q(h)', lumi_value = qH)
        # Defining the density. You may also use set_dlaw(parameters) if you␣
↪have a density law defined in dense_fabden.cpp.
        c_input.set_cste_density(dens)
        # Defining the inner radius. A second parameter would be the outer␣
↪radius (matter-bounded nebula).
        c_input.set_radius(np.log10(r_min))
        c_input.set_abund(ab_dict = abund, nograins = True)
        c_input.set_other(options)
        c_input.set_iterate() # (0) for no iteration, () for one iteration, (N)␣
↪for N iterations.
        c_input.set_sphere() # () or (True) : sphere, or (False): open geometry.
        c_input.set_emis_tab(emis_tab)
        c_input.set_distance(dist, 'kpc')
        c_input.print_input(to_file = True, verbose = False)
```

[5]:
```
# The directory in which we will have the model
# You may want to change this to a different place so that the current directory
# will not receive all the Cloudy files.
dir_ = '/tmp/models/'
```

[6]:
```
#writing the makefile in the directory dir_
pc.print_make_file(dir_ = dir_)
```

[7]:
```
# setting verbosity to medium level, change to 3 for high verbosity
pc.log_.level = 2
```

[8]:
```
# Generic name of the models
model_name = 'model_2'
```

```
[9]: # tables for the values of the density and the log(O/H)
tab_dens = [3, 4, 5, 6]
tab_ab_O = [-3.1, -3.25, -3.4, -3.55, -3.7]
```

```
[10]: # defining the models and writing 20 input files
for dens in tab_dens:
    for ab_O in tab_ab_O:
        make_model(dir_, model_name, dens, ab_O)
```

```
[11]: # Running the models using the makefile and n_proc processors
n_proc = 8
# Take, care, this will run 20 cloudy models on 8 processors! May take some␣
 ↪time.
# If you run all the models togeter (n_proc = 20), you will need 10 Go RAM.
pc.run_cloudy(dir_ = dir_, n_proc = n_proc, model_name = model_name, use_make =␣
 ↪True)
```

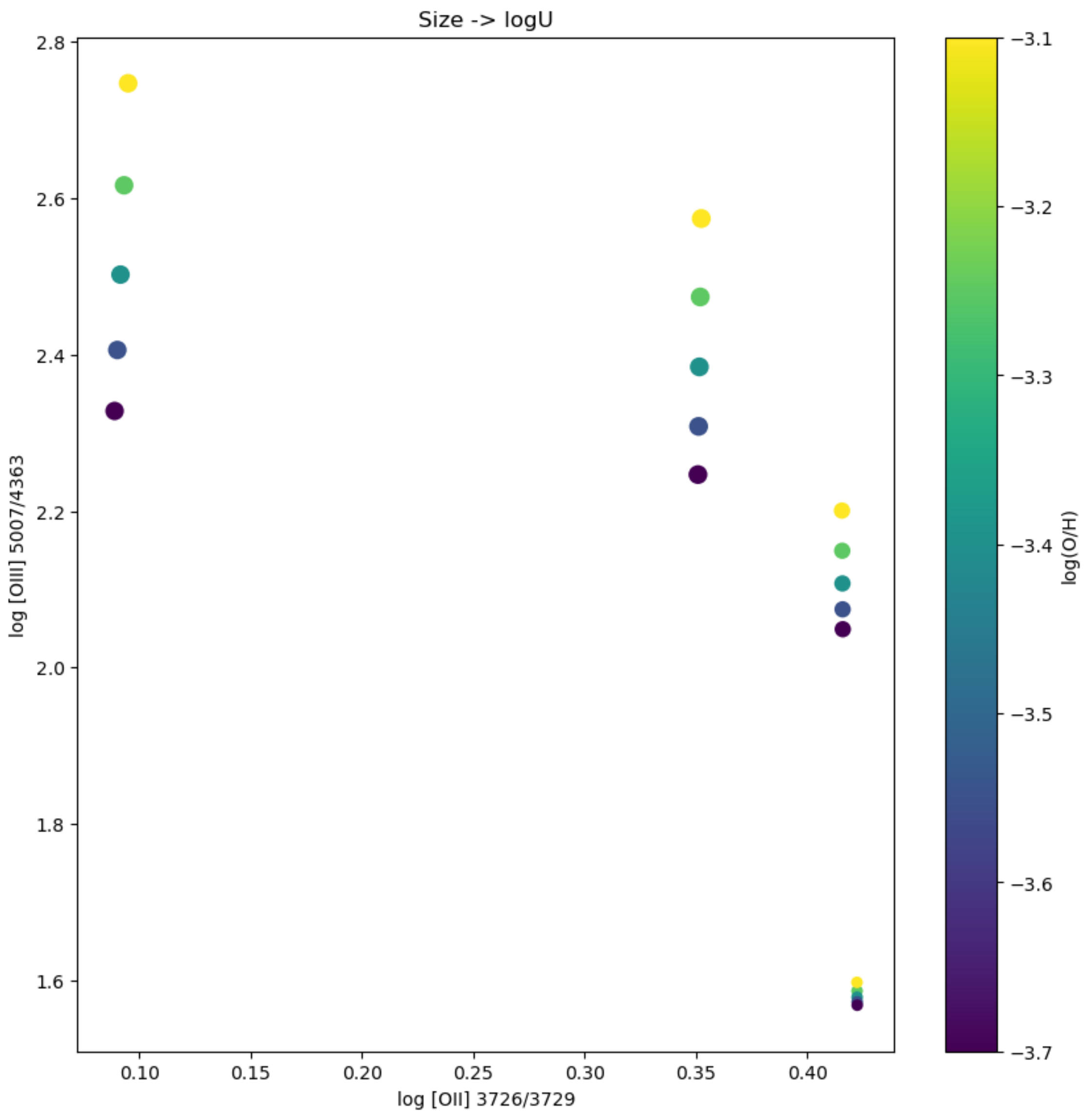
```
[12]: # reading the Cloudy outputs and putting them in a list of CloudyModel objects
Ms = pc.load_models('{0}{1}'.format(dir_, model_name), read_grains = False)
```

```
[13]: #Computing line intensity ratios
rO3 = [np.log10(M.get_emis_vol('O__3_500684A')/M.get_emis_vol('O__3_436321A'))␣
 ↪for M in Ms]
rO2 = [np.log10(M.get_emis_vol('O__2_372603A')/M.get_emis_vol('O__2_372881A'))␣
 ↪for M in Ms]
```

```
[14]: # defining the colors associated to the Oxygen abundances
col = [M.abund['O'] for M in Ms]
```

```
[15]: # defining the size as the density (at the first step, but in these models it's␣
 ↪constant)
#size = [np.log10(M.nH[0])*20 for M in Ms]
size = [40*(5+M.log_U_mean) for M in Ms]
```

```
[16]: plt.figure(figsize=(10,10))
plt.scatter(rO2, rO3, c=col, s=size, edgecolors = 'none')
plt.xlabel('log [OII] 3726/3729')
plt.ylabel('log [OIII] 5007/4363')
cb = plt.colorbar()
cb.set_label('log(O/H)')
plt.title('Size -> logU');
```


Size -> logU
log [OIII] 5007/4363
log [OII] 3726/3729
log(O/H)
2.8
2.6
2.4
2.2
2.0
1.8
1.6
0.10
0.15
0.20
0.25
0.30
0.35
0.40
−3.1
−3.2
−3.3
−3.4
−3.5
−3.6
−3.7

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[ ]:
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