# BT\_api\_tutorial

September 22, 2020

```
In [1]: %pylab inline
    import requests
    import json
```

ID:

Populating the interactive namespace from numpy and matplotlib

## 1 Get basic snapshot info

237 FileName: PIG\_237

216 FileName: PIG\_216

```
In [2]: # This is our base url
      base = "http://vm063.bridges.psc.edu:8001/"
      response = requests.get(base)
      print(response.url)
      print(response.json())
http://vm063.bridges.psc.edu:8001/
{'msg': 'COSMO, a REST API for the BlueTides3 Cosmology Simulation Data'}
  Now we want to look at the available snapshots and their basic information:
In [3]: pig_url = base + "pig/"
      response = requests.get(pig_url)
      pig_list = json.loads(response.text)['LIST']
      for i in range(len(pig_list)):
          print('ID: ', pig_list[i]['id'],\
               ' FileName: ', pig_list[i]['name'], \
               ' Num halos: ', pig_list[i]['num_halos'], \
               ' Redshift: %.2f'%(pig_list[i]['time']))
Num halos: 267649410 Redshift: 7.00
    208 FileName: PIG_208
    230 FileName: PIG 230
ID:
                         Num halos: 276771522 Redshift: 6.85
```

ID: 265 FileName: PIG\_265 Num halos: 292040891 Redshift: 6.60

Num halos: 279858719 Redshift: 6.80

Num halos: 271256543 Redshift: 6.94

```
244 FileName: PIG_244 Num halos: 282939566 Redshift: 6.75
    271 FileName: PIG_271 Num halos: 294288056 Redshift: 6.56
ID:
    258 FileName: PIG_258
ID:
                           Num halos: 289106271
                                                Redshift: 6.65
ID:
    222 FileName: PIG 222
                           Num halos: 273696821
                                                Redshift: 6.90
ID: 251 FileName: PIG 251
                           Num halos: 286036300 Redshift: 6.70
ID:
    184 FileName: PIG 184
                           Num halos: 255434058
                                                Redshift: 7.20
ID: 197 FileName: PIG 197
                           Num halos: 261596356 Redshift: 7.10
```

### 1.1 Read output from Snapshot/Single Halo

Before reading the data, let's first look at available particle types and fields within this snapshot

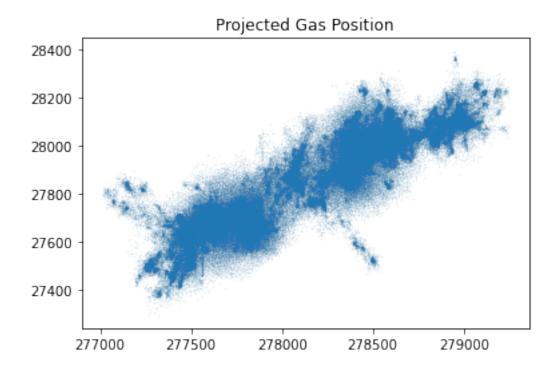
We see that there are 4 types of particles(subdirectories) within snapshot 251, let's examine 'gas' first:

```
In [5]: field_url = ptype_url + '/gas'
        requests.get(field_url).json()
Out[5]: {'id': 251,
         'ptype': 'gas',
         'subdirs': ['JUV',
          'Mass',
          'Density',
          'Potential',
           'ElectronAbundance',
          'Pressure',
           'SmoothingLength',
           'H2Fraction',
           'Position',
           'GroupID',
           'InternalEnergy',
           'StarFormationRate',
           'EgyWtDensity',
           'Entropy',
          'ID',
           'Generation',
           'Metallicity',
           'NeutralHydrogenFraction',
           'Velocity']}
```

Now we get the available fields(subdirectories) of gas particles. Take a look at the position of the first halo:

In [6]: # this is a function for getting requested field as a numpy array import time def get\_group\_data(group\_url): t1 = time.time() response = requests.get(group\_url) key = list(response.json().keys())[0] response\_arr = json.loads(response.json()[key]) response\_arr = np.array(response\_arr) t2 = time.time() print('Time to fetch from '+group\_url+': %.2f s'%( t2-t1)) return response\_arr In [8]: # url for positions of gas particles within Halo#1 in Snapshot#251 url = field\_url + "/Position/1" gas\_pos = get\_group\_data(url) plt.scatter(gas\_pos[:,0],gas\_pos[:,1],s=0.001) plt.title('Projected Gas Position') plt.show() Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/gas/Position/1: 3.49 s



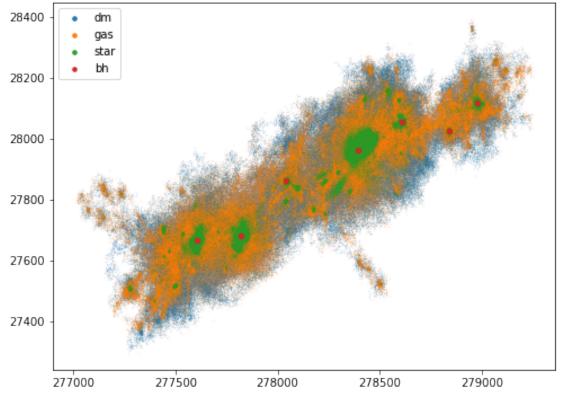


Now let's add other particles to the plot:

```
In [9]: ptype = ['dm','gas','star','bh']
    fig,ax = plt.subplots(figsize=(8,6))
    for p in ptype:
        data_url = pig_url + '251/' + p + '/Position/1'
        pos = get_group_data(data_url)
        if p=='bh':
            ax.scatter(pos[:,0],pos[:,1],s=80,marker='.',label=p)
        else:
            ax.scatter(pos[:,0],pos[:,1],s=0.01,marker='.',label=p)
    plt.title('Particles in Snapshot 251 Halo 1')
    leg = ax.legend()
    for ll in leg.legendHandles:
        ll._sizes = [50]
    plt.show()
```

Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/dm/Position/1: 3.31 s Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/gas/Position/1: 2.65 s Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/star/Position/1: 3.69 s Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/Position/1: 0.22 s

## Particles in Snapshot 251 Halo 1



#### 1.1.1 Mass functions

```
In [7]: def mass_func(m,Lbox,lim_min,lim_max,nbin):
            mbin = np.logspace(lim_min,lim_max,nbin)
            binmid=np.log10(mbin)[:-1]+np.diff(np.log10(mbin))/2
            mhis = np.histogram(m,mbin)
            mask = mhis[0]>0
            Volumndlog = np.diff(np.log10(mbin))*(Lbox/hh)**3
            yy = mhis[0]/Volumndlog
            err = yy[mask]/np.sqrt(mhis[0][mask])
            y1 = np.log10(yy[mask]+err)
            y2 = yy[mask]-err
            y2[y2 \le 0] = 1e-50
            return (binmid[mask]),np.log10(yy[mask]), y1, np.log10(y2)
In [8]: fof_url = pig_url + "251/fofgroup"
In [9]: requests.get(fof_url).json()
Out[9]: {'id': 251,
         'fof_subdirs': ['Imom',
          'GroupID',
          'Mass',
          'Jmom',
          'OffsetByType',
          'BlackholeMass',
          'LengthByType',
          'FirstPos',
          'MassCenterPosition',
          'BlackholeAccretionRate',
          'MinID',
          'MassByType',
          'MassCenterVelocity',
          'StarFormationRate']}
In [10]: gas_mass_url = fof_url + '/MassByType/all'
         response = requests.get(gas_mass_url).json()
In [11]: response
Out[11]: {'detail': [{'loc': ['path', 'group_id'],
            'msg': 'value is not a valid integer',
            'type': 'type_error.integer'}]}
```

#### 1.1.2 Advanced Queries

**getting haloid and data by criterion** Now let's see how we can search for particular halos by their BH mass

This query returns the list of halo ids in which the total BH mass is between  $10^8$  and  $10^9~M_{\odot}$ 

```
In [20]: t1 = time.time()
    # this is the url to get haloid of halos whose total bhmass is between 1e8 and 1e9 Ms
    response = requests.get(pig_url + "251/search_id/bh/MassByType",params={"min_range":1et2 = time.time()
        print('Time to fetch from '+response.url+': %.2f s'%( t2-t1))
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/search_id/bh/MassByType?min_range
```

```
[0, 2, 3, 4, 5, 7, 9, 10, 11, 13, 14, 15, 16, 18, 19, 20, 22, 24, 25, 26, 28, 32, 35, 36, 37,
```

With the list above, we can then look at different kinds of data from those halos with BH mass between  $10^8$  and  $10^9$   $M_{\odot}$ 

For example, let's fetch the accretion rate of all BHs within those halos

```
In [41]: # url for positions of gas particles within Halo#1 in Snapshot#251
    url = [pig_url + "251/bh/BlackholeAccretionRate/"+str(i+1) for i in haloid_list]
    mdot = [get_group_data(u) for u in url]
```

```
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/1: 0.54
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/3: 0.01
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/4: 0.01
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/5: 0.01
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/6: 0.01
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/8: 0.01
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/10: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/11: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/12: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/14: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/15: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/16: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/17: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/19: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/20: 0.0
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Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/23: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/25: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/26: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/27: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/29: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/33: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/36: 0.0
```

Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/37: 0.0 Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/38: 0.0

```
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/41: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/45: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/48: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/50: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/54: 0.0
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/57: 0.0
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Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/642: 0.
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/659: 0.
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Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/661: 0.
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Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/804: 0.
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/812: 0.
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/838: 0.
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/918: 0.
Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/937: 0.
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Time to fetch from http://vm063.bridges.psc.edu:8001/pig/251/bh/BlackholeAccretionRate/134266:
```

directly access data by criterion or we can directly fetch data with a given criterion