1.Download the file “fermi_lat_grbs.dat” from today’s exercise page on the website. It contains 1000 gamma-ray bursts observed by the Fermi satellite between 2010 and 2018. 2. Use the astropy.io.ascii.read() routine to read the file into a table. You need to specify the header_start, data_start, and delimiter arguments. 3. Display the column headers using the columns or colnames method

In [101…

```
import numpy as np
import astropy
from astropy import units as units
from astropy.table import Table

data = astropy.io.ascii.read(r"C:\Users\eklav\OneDrive - University of Illinois - U

data.columns
```

Out[101…

```
<TableColumns names=('col0','name','ra','dec','trigger_time','t90','t90_error','t9
0_start','fluence','fluence_error','flux_1024','flux_1024_error','flux_1024_tim
e','flux_64','flux_64_error','flnc_band_ampl','flnc_band_ampl_pos_err','flnc_band_
ampl_neg_err','flnc_band_epeak','flnc_band_epeak_pos_err','flnc_band_epeak_neg_er
r','flnc_band_alpha','flnc_band_alpha_pos_err','flnc_band_alpha_neg_err','flnc_ban
d_beta','flnc_band_beta_pos_err','flnc_band_beta_neg_err','flnc_spectrum_start','f
lnc_spectrum_stop','pflx_best_fitting_model','pflx_best_model_redchisq','flnc_best
_fitting_model','flnc_best_model_redchisq','_1')>
```

Notice that RA and DEC are in sexagesimal format, represented as strings. Use astropy.coordinates.Angle to convert them to decimal degrees. Print the table

In [102…

```
from astropy import coordinates
from astropy import units as u
x = data['ra']
y = data['dec']

# ra_units = [coordinates.Angle(i, unit=u.hour) for i in x]
# dec_units = [coordinates.Angle(i, unit=u.deg) for i in x]
data['ra'] = coordinates.Angle(data['ra'],unit = u.hour)

data['dec'] = coordinates.Angle(data['dec'],unit = u.deg)

data['ra'] = (data['ra']).to(u.deg)
data['dec'] = (data['dec']).to(u.deg)

print(data['ra'])
print(data['dec'])
# print(y)
```

```
        ra
       deg
------------------
337.86999999999995
356.95916666666665
211.21999999999997
            209.14
2.8999999999999995
 9.479999999999999
244.03999999999996
20.722916666666666
 311.3299999999999
160.42999999999998
               ...
            308.56
235.66999999999996
159.91083333333333
              52.3
202.26999999999995
 304.9599999999999
246.66083333333327
             59.72
184.44499999999996
284.67999999999995
Length = 1000 rows
        dec
        deg
-------------------
 -80.03999999999999
            -79.905
             -79.69
              -79.1
             -79.01
              -78.2
             -77.86
 -77.78388888888888
              -74.5
             -74.28
                ...
             -39.36
             -39.34
 -39.32805555555556
             -39.21
              -39.2
             -39.18
 -39.15888888888889
              -37.2
-37.086111111111116
             -37.03
Length = 1000 rows
```

Do some brief analysis: a) Construct a boolean mask array that selects only those bursts with durations (t90) < 2 seconds and relative errors in the duration (t90_error/t90) < 50%. b) Construct a second boolean mask array that selects t90 > 2 seconds with the same relative error. c) Compare the median peak energy (flnc_band_epeak) of the two samples. Use the NumPy median function to compute the values

In [83]:
```
mask_short_bursts = (data['t90'] < 2) & ((data['t90_error'] / data['t90']) < 0.5)
mask_long_bursts = (data['t90'] > 2) & ((data['t90_error'] / data['t90']) < 0.5)
short_bursts_epeak = data['flnc_band_epeak'][mask_short_bursts]
long_bursts_epeak = data['flnc_band_epeak'][mask_long_bursts]
median_peak_energy_short = np.median(short_bursts_epeak)
median_peak_energy_long = np.median(long_bursts_epeak)
median_peak_energy_short, median_peak_energy_long
```

Out[83]:
```
(359.3643, 135.48020000000002)
```

Download the files “mcxc.dat” and “mcxc.readme” from today’s exercise page on the web site. These files contain a catalog of X-ray-detected clusters of galaxies from Piffaretti et al. (2011) obtained through the VizieR service at the University of Strasbourg. 1.Use astropy.io.ascii.read() to read the table and its metadata into Python. This table is in “CDS” format, and you specify the metadata file using the readme argument. 2.Extract the log of L500 (luminosity in units of 1044 erg/s), log of M500 (mass in 10 14 solar masses), and z (redshift) columns from the data into 1D arrays. Create a mask array selecting those clusters with redshift < 0.1. 3.Now construct the array containing . The X- ray luminosity and mass of galaxy clusters are correlated roughly such that , so the range in is small. r r = log L − 1.64 log M L ∝ M 5/3 r

In [93]:
```
data = astropy.io.ascii.read(r"C:\Users\eklav\OneDrive - University of Illinois - U

log_L500 = data['L500'].data
log_M500 = data['M500'].data
z = data['z'].data
mask = z < 0.1
filtered_log_L500 = log_L500[mask]
filtered_log_M500 = log_M500[mask]
filtered_z = z[mask]
r = filtered_log_L500 - 1.64 * filtered_log_M500
```

In [94]:
```
r
```

```
Out[94]: array([-1.012892, -0.48837 , -1.528762, -1.997207, -1.614681, -1.169538,
       -2.294202, -2.34182 , -1.294671, -1.260939, -1.572374, -1.259829,
       -1.815282, -1.163526, -2.483263, -2.112338, -1.616338, -2.366497,
       -2.387405, -0.699704, -1.025122, -1.309052, -0.592733, -2.145387,
       -3.618647, -2.754706, -1.25405 , -2.210964, -2.621285, -1.921318,
       -1.446881, -1.106659, -2.60272 , -1.785156, -0.581953, -2.558346,
       -0.998769, -1.604541, -1.954547, -0.983408, -0.593058, -0.32764 ,
       -1.021002, -0.178581, -1.577728, -0.715587, -0.590573, -1.981609,
       -0.534731, -0.860869, -0.043123, -2.062197, -0.5445  , -0.403451,
       -0.583102, -1.208672, -0.183307, -1.104538, -0.645966, -1.256982,
       -0.876203, -1.530939, -0.069357, -2.206527, -2.042895, -1.776408,
       -0.426818, -1.00719 , -0.865692, -1.663936, -1.736471, -1.315752,
       -1.438803, -0.918986, -1.672694, -1.453302, -0.356023, -1.798011,
       -1.379327, -1.92645 , -0.648112, -0.673878, -2.154409, -0.482401,
       -1.09285 , -3.369212, -3.503389, -2.219902, -1.219815, -0.930073,
       -0.432375, -1.306341, -1.331942, -2.218432, -3.391544, -3.869953,
       -1.255464, -1.508218, -1.741421, -0.542563, -0.355047, -2.528991,
       -2.307222, -0.32651 , -0.517275, -1.214832, -0.284539, -3.204957,
       -0.9648  , -0.090326, -1.218576, -1.082294, -1.518311, -1.461554,
       -3.223212, -1.592785, -1.671387, -2.394637, -0.943087, -1.844747,
       -3.317772, -1.939197, -0.976622, -0.745411, -2.34049 , -0.890905,
       -3.497623, -2.922362, -1.819904, -1.163596, -1.522558, -2.19611 ,
       -2.197663, -1.08186 , -0.869286, -0.178018, -1.59701 , -1.923204,
       -2.122688, -0.973175, -1.925145, -1.714234, -1.774218, -2.240331,
       -2.259316, -1.416953, -1.001587, -2.12274 , -1.555549, -1.964482,
       -1.149787, -0.7182  , -0.928189, -1.715283, -1.933003, -2.913932,
       -1.283885, -0.627164, -2.244168, -1.438697, -2.624765, -1.303362,
       -1.131413, -2.16163 , -1.25296 , -0.843688, -0.915835, -2.384241,
       -1.982299, -2.558719, -1.611904, -2.691456, -1.885201, -3.264093,
       -3.280667, -2.373267, -2.561801, -1.697878, -2.214359, -0.631168,
       -1.419727, -1.411281, -2.954324, -1.9997  , -1.523089, -0.455232,
       -1.627533, -1.653678, -2.425365, -0.934185, -0.741919, -0.611806,
       -1.742705, -1.43583 , -2.213051, -1.329487, -1.311914, -2.889733,
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       -2.42164 , -1.170518, -0.489681, -3.227834, -0.388534, -0.208667,
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       -1.38983 , -0.2386  , -0.590108, -1.463845, -1.829536, -1.444607,
       -2.126429, -1.731004, -1.139978, -0.478544, -0.967418, -0.61147 ,
       -1.198072, -1.991015, -0.198721, -1.319409, -1.893787, -0.515603,
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       -1.510017, -1.850323, -0.392465, -0.635819, -0.560194, -0.860873,
       -1.471095, -1.762714, -0.666579, -0.842487, -2.234448, -2.260766,
       -0.791851, -1.358076, -0.019137, -0.165794, -1.229306, -0.6343  ,
       -0.378619, -1.158739, -0.568373, -1.090561, -1.263052, -2.867855,
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       -1.558019, -0.302538, -1.661832, -0.408616, -1.921694, -1.608531,
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       -1.895551, -3.350619, -3.571188, -0.656331, -0.497962, -1.873914,
```

```
-1.892853, -2.147914, -0.342392, -1.551815, -2.105045, -1.700304,
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-1.792802, -1.964453, -3.425885, -0.103347, -1.051602, -0.21325 ,
-3.606211, -1.866195, -0.42053 , -1.895131, -1.504949, -2.700463,
-3.153695, -0.31148 , -0.692401, -0.958589, -1.601445, -0.265687,
-1.584555, -0.64816 , -1.230331, -1.128903, -1.651972, -1.834474,
-1.792488, -0.939038, -0.540875, -1.955043, -1.416027, -1.495058,
-1.3877  , -1.905384, -1.077056, -2.709489, -0.321519, -0.635124,
-2.668089, -2.249986, -2.102249, -2.018373, -1.545485, -1.698908,
-0.724762, -1.374567, -2.10386 , -2.62333 , -2.90388 , -2.726209,
-1.526178, -1.195995, -2.232193, -2.052756, -1.769778, -3.321541,
-2.053815, -1.2781  , -2.323064, -3.090323, -1.226374, -3.065216,
-0.46924 , -0.692919, -2.517618, -2.725523, -2.670822, -2.110539,
-1.914086, -2.762536, -2.042309, -0.711583, -2.144658, -1.577506,
-2.077412, -0.893511, -2.101287, -1.124154, -0.963665, -3.008839,
-0.457373, -3.098251, -0.476041, -2.612046, -0.736442, -1.291315,
-1.710905, -1.398658, -1.503314, -2.55116 , -2.823661, -0.825819,
-2.352053, -1.668644, -1.346296, -1.338956, -0.86651 , -2.596195,
-0.465179, -2.078877, -1.753874, -2.615996, -2.260918, -1.755869,
-3.300709, -1.317805, -2.962304, -1.476309, -1.658059, -1.231028,
-1.609297, -2.092455, -1.551878, -2.77563 , -2.167596, -0.369748,
-2.313311, -2.208298, -2.201311, -2.461703, -0.566465, -1.980936,
-1.373977, -2.74229 , -2.179097])
```

In [98]:
```python
from astropy.table import Table, MaskedColumn
r = data['L500'] - 1.64 * data['M500']
mask = data['z'] >= 0.1
r_column = MaskedColumn(r, mask=mask, name='r', description='r = log L - 1.64 log M
data.add_column(r_column)
print(data)
data.write(r'C:\Users\eklav\OneDrive - University of Illinois - Urbana\astro_310\la
```

```
    MCXC          OName              AName          ... L500r4          r
                                                    ...             1e+37 W
------------ ---------------- ------------------ ... ------ --------------------
J0000.1+0816 RXC J0000.1+0816          UGC 12890 ...     --            -1.012892
J0000.4-0237 RXC J0000.4-0237                 -- ...     -- -0.48836999999999997
J0001.6-1540 RXC J0001.6-1540                 -- ...     --                   --
J0001.9+1204 RXC J0001.9+1204              A2692 ...     --                   --
J0003.1-0605  RXCJ0003.1-0605              A2697 ...     --                   --
J0003.2-3555  RXCJ0003.2-3555              A2717 ...     --            -1.528762
J0003.8+0203  RXCJ0003.8+0203              A2700 ...     --  -1.9972069999999997
J0004.9+1142 RXC J0004.9+1142          UGC 00032 ...     --            -1.614681
J0005.3+1612 RXC J0005.3+1612              A2703 ...     --                   --
J0006.0-3443  RXCJ0006.0-3443              A2721 ...     --                   --
         ...              ...                ... ...    ...                  ...
J2354.2-1024  RXCJ2354.2-1024              A2670 ...     --   -2.461702999999999
J2355.1-1500      BVH2007 242          VMF98 223 ...     --  -0.5664649999999999
J2355.6+1120 RXC J2355.6+1120              A2675 ...     --  -1.9809359999999998
J2355.7+1138            A2678              A2678 ...     --  -1.3739769999999998
J2355.8+3423 RXC J2355.8+3423              A2677 ...     --                   --
J2357.0-3445  RXCJ2357.0-3445              A4059 ...     --             -2.74229
J2359.3-6042  RXCJ2359.3-6042              A4067 ...     --  -2.1790969999999996
J2359.4-3418    MS2356.9-3434                 -- ...     --                   --
J2359.5-3211  RX J2359.5-3211 BSe RXJ2359.5-3211 ...     --                   --
J2359.9-3928  RXCJ2359.9-3928              A4068 ...     --                   --
Length = 1743 rows
```