Lab 7 Worksheet

You are required to hand this worksheet in at the end of the lab.

Name:____________________ User Name:____________________

- All the example codes are at `/n/ursa/A288C/alien/python_template`.
- The places you need to put your answer in this worksheet are marked by "__________".

1. [**function**] GRB170827A has a spectrum that can be described by the following equation

$$f(E) = 9.90 \times 10^{-4} \left(\frac{E}{50\ \mathrm{keV}}\right)^{-1.215}, \tag{1}$$

   where f(E) is the photon flux at energy E, with units of photons $\mathrm{cm}^{-2}\ \mathrm{s}^{-1}\ \mathrm{KeV}^{-1}$.

   Follow example code `function_example.py` to write a function that returns the value of f(E). Using your code to find f(E) at E=100 keV.

   f(100 keV) = ____________________.

2. [**integration**] Follow the example code `integration.py` and write a code to calculate the the photon flux in the energy range of 15 keV to 150 keV by integrating eq. 1,

$$\text{Photon Flux } (15 - 150\ \text{keV}) = \int_{15\text{keV}}^{150\text{keV}} 9.90 \times 10^{-4} \left(\frac{\mathrm{E}}{50\ \mathrm{keV}}\right)^{-1.215} \mathrm{dE}, \tag{2}$$

   From your code, photon flux (15-150 keV) = ____________________.

   The unit of the photon flux is ____________________.

3. [**sanity check**] Integrate eq. 1 analytically, did you get the same answer as your code? Write down the equations of how you derive the analytical answer:

   ____

4. [**FITS file and 2d-array**] Follow the example code `fits_file_example.py` and do the following questions:

   (a) Download the 4-channel light curve of GRB170803A from the following link: `https://swift.gsfc.nasa.gov/results/batgrbcat/GRB170803A/data_product/00766081000-results/lc/sw00766081000b_4chan_1s.lc`

   (b) Print out the time relative to the BAT trigger time T0. That is, print out "time − T0".

   (c) Print the energy bands of the light curve to the screen.

   The energy ranges of this light curve are:

   ____________________,

   ____________________,

   ____________________,

   ____________________.

(d) Print out the rate number in 25-50 keV of time between T0 and T0+1 s. (You should find only one value.)
The rate is ____________________.

5. [**plotting**] Try to run the example code `plot_example.py`, and perform the following changes:

   (a) Change the line style to 'dashed line'.

   (b) Produce a scatter plot by changing the linestyle to "None", and add the option marker="o".

   (c) Based on the options in the matplotlib tutorial `https://matplotlib.org/users/pyplot_tutorial.html`, change the marker to star.

6. [**plot error bars**] Try to run the example code `plot_errorbar.py`, and perform the following changes:

   (a) Produce a scatter plot with error bars with the same set of data.

   (b) Based on the options in the matplotlib tutorial, change the range in the x-axis to [-20.0, 30.0].

7. [**bar plot (histogram)**] The example code `plot_histogram.py` shows an example of making a bar plot (histogram). Follow this example and use the GRB redshift list `https://swift.gsfc.nasa.gov/results/batgrbcat/summary_cflux/summary_general_info/GRBlist_redshift_BAT.txt` to make a histogram of redshift distribution with bin size of 0.1.