Coding in advance of the May 6, 2019 class

For this exercise, we will analyze the same data set as in exercise 13: the set is given as data14_1.txt on the website.

The file description14.txt, which is identical to description13.txt, describes the data.

Your task for this exercise will be to modify the affine-invariant MCMC code that I sent you to fit a broken power law model to the data (see guide.txt for specific things you can do). In this model, the flux is

$$\Phi = \Phi_0 (E_{\rm avg}/100\ {\rm GeV})^{-\gamma_1} \left[1 + (E_{\rm avg}/E_b)^{-(\gamma_1-\gamma_2)/\Delta}\right]^{-\Delta}\ . \qquad (1)$$

Here $\Delta = 0.1$ and the parameters in your model are Φ_0, γ_1, γ_2, and E_b.

You should:

1. Compute the maximum log likelihood $\ln \mathcal{L}_{\rm max}$ using the model.
2. Output the values of Φ_0, γ_1, γ_2, and E_b that maximize the log likelihood.
3. Plot the best fit against the data. **This should be a plot of the $\log_{10}$ of the flux versus the $\log_{10}$ of the energy.**
4. Use Wilks' Theorem, $\ln \mathcal{L}_{\rm max}$ for this model, and the maximum log likelihood for last week's simple power law model, to determine whether the improvement to the fit is enough to justify the extra parameters.
5. Use the output of the code, following the description in Lecture 14, to output one-dimensional posteriors for each of the four parameters.

Good luck!