Coding in advance of the Apr 23, 2018 class

For this coding exercise, we will continue to analyze the same data set as last time: for continuity the set is given as data12_1.txt on the website.

Your task for this week will be to use the affine-invariant MCMC code you developed to fit the Ambrosi et al. (2017) smoothly broken power law model to the data, for which the flux is

$$\Phi = \Phi_0 (E/100 \text{ GeV})^{-\gamma_1} \left[1 + (E/E_b)^{-(\gamma_1 - \gamma_2)/\Delta}\right]^{-\Delta} . \quad (1)$$

Thus the four parameters in your model are the normalization Φ_0, the power-law indices γ_1 and γ_2, and the break energy E_b. Ambrosi et al. (2017) fix the smoothness parameter Δ to $\Delta = 0.1$. Please note that you need to do a completely new fit; you should not, for example, just use the values of Φ_0 and γ that you obtained last time.

Again, please feel free to use the output of your code to explore the credible regions of the parameters, but as before our main aim is to get the maximum likelihood for this model: what values of $\Phi_0, \gamma_1, \gamma_2$, and E_b maximize the log likelihood, and what is the value of that maximum log likelihood? Compare the maximum you get here with what you obtained with the simple single power law model from last week. Using Wilks' Theorem, do you conclude that the two extra parameters are needed?

Again, as a check on your fit, please plot your best-fit broken power law against the data; is it reasonable?

Good luck!