Phys 512 Problem Set 1

Due on github Friday October 4 at 4 PM. You may discuss problems, but everyone must write their own code.

1. a) Write a function that models the log base 2 of x valid from 0.5 to 1 to an accuracy in the region better than 10^{-6}. Please use a truncated Chebyshev polynomial fit to do this, and please write your own fit routine (instead of just calling the numpy one). How many terms do you need? Carry out a least squares polynomial fit of the same order, and overplot the residuals. How do the max errors compare? How about the RMS? Feel free to use a built-in routine for the second fit.

b) Now extend your function to take the log base 2 of any positive number. The function numpy.frexp may come in handy here.

2. a) Look at the file 229614158_PDCSAP_SC6.txt (thanks to Matt Lundy). This is an optical light curve from a flaring M-dwarf star observed by the HESS telescope. You can read the data with np.loadtxt('229614158_PDCSAP_SC6.txt',delimiter=','). The first column is time, the second column is flux, and I believe we can ignore the third column. We'll model the flare as an exponential decay starting sharply at some time. Is this model linear? What would your model look like, and what are approximate starting guess values? Plot the data and your starting guess, zoomed into the flare region (around t=1706).

b) Keeping the flare starting time fixed (floating that is tricky given that the time is discretized), write a function using Newton's method to fit flare parameters by minimizing χ^2. If your starting guess is reasonable, you should not need to switch to Levenberg-Marquardt. What are your best-fit parameters? Add your best-fit model to your zoomed-in plot from part a).

c) What are your estimates for the errors on the fit parameters? Please explain how you modelled them, and comment on if you think they are reasonable.

d) Looking at the full span of the data, do you trust the errors you came up with in part c)? Why or why not?