Astronomy 350: Cepheid Period-Luminosity Lab

- 0. If youd rather program in another language thats ok too.
- 1. Work in pairs. Become familiar with the basics of FORTRAN: start with the simple fortran program you compiled in one of the previous Unix labs.
- 2. So develop this program to read in two numbers stored in a file, add them and print out the result.
- 3. Develop this program to read in a file with 10 pairs of numbers, add each pair and print out the result.
- 4. Find out about arrays in FORTRAN and repeat the previous step with arrays.
- 5. The data for this project is on my machine 129.3.17.53:/home/shashi/ast350. First practice logging into this machine from moxie: see me if you have forgotten your password. The dataset is in the above directory. Practice logging in, cding to that directory and back. In the data directory, you should see 4 data files. This is the OGLE II survey Cepheid dataset in the V, I bands for LMC/SMC Cepheids.
- 5a. The data consists of 4 columns. Column 1 is a name, a so called character variable, column 2 is an error and columns 3 and 4 are the logarithm of the period and the magnitude respectively. The error in column 2 is the observational error on the magnitude. The *V.dat and *I.dat contain V and I band data respectively. Make sure you understand this.
- 5b. Look up how to read in character variables in FORTRAN if you are using FORTRAN.
- 5c. Look at the dataset LMC_V.dat. Develop your program to read in this dataset and print it out. You just need to read in the last two columns for this dataset.
- 6. Do the same for the dataset SMC_V.dat.
- 7. Derive formulae for the coefficients a, b in a line $y = a + bx$ fit using the method of least squares to the data.
- 7a. For data $(x_i, y_i), i = 1, ..., N$, the least squares estimates of a, b in the linear model $y = a + bx$ are given by those values of a, b that minimize

$$S = \sum_{i=1}^{i=N} (y_i - a - bx_i)^2.$$

- 7b. Find expressions for $\partial S/\partial a$ and $\partial S/\partial b$, set these to be zero and hence derive expressions for the least squares estimates of a, b.
- 8. Implement this in your FORTRAN program and plot the fitted line against the original data for both the LMC and SMC. Are the two lines different?
- 8a. Describe the idea of hypothesis testing and describe a $t - test$.
- 9. Do a $t$test of the hypothesis that the SMC and LMC slopes are the same.
- 9a. What assumptions does the $t - test$ require? Can you check to see if these assumptions are valid?
- 10. Describe how the PL relation is used to estimate distances and describe what assumptions are made?
- 11. Is the PL relation universal?