

Galaxies and Cosmology Homework #4
Due: February 19

In this homework you'll be exploring the out reaches of the Universe – no, that's not true. You'll just look at some nearby galaxies and use the characteristics of the Cepheid variables in them to determine their distances.

At the course website there is a little program that will show the distribution of Cepheids in various galaxies with the apparent magnitudes measured in different filter systems. There is also a blue line showing the standard slope for the Cepheid Period-Luminosity (P-L) relation that is appropriate for that filter system. Also indicated as a vertical red line is the location where $\text{Log } P=0$ and the absolute magnitude of a Cepheid with a $\text{Log } P$ value of 0 for that particular filter system (in blue, towards the left).

For each galaxy and for each filter system adjust the P-L line so that it fits the data in the best manner – since this is real data, the fit will not be perfect. There is a sliding scale on the right that will allow you to move the P-L line up and down.

Determine where the P-L line crosses the $\text{Log}=0$ line. Remember, magnitude increases downwards!

Use the apparent magnitude that is given and the absolute magnitude (in blue) to determine the distance to the galaxy – you'll actually get 4 values for distance for each galaxy, since there are 4 filters.

Remember the distance modulus formula is

$$m - M = -5 + 5 \log(d)$$

where m =apparent magnitude, M =absolute magnitude and d =distance in pc.

Average the four distances you get for each galaxy.

Make sure you provide all of the data that you get from the program, including the apparent magnitudes for each galaxy/filter, the distances for each galaxy/filter and the average distance for each galaxy.

And answer these questions –

- A. How consistent were the distance values for each galaxy across the range of filters? If you can you may want to quote statistical variances – or you can just describe the quality if you aren't into statistics.
- B. Which filters tended to have well-behaved data? By this I mean which filters had data that tended to lie close to the given P-L relationships.
- C. At the course website follow the link to the "Astronomy Abstract" service and call up the papers that are from the "Araucaria" survey – just use that word in the "Title Search" box. Amongst the list of papers that appear will be those that deal with the galaxies that you looked at. What are the distances quoted in these papers and how do they compare to

- your distances? In general the abstract will provide the distance either as $m-M$ or in Mpc.
- D. The P-L relationship that is used in this lab is based upon observations and the distance to Cepheids in the Milky Way. If the astronomers that determined the P-L relationship incorrectly accounted for the effects of dust and underestimated the absolute V magnitudes by 0.3 magnitudes (they are actually 0.3 magnitudes brighter), how much would that impact the distances you calculated? For simplicity just look at how that would change the result of one of the galaxy's V-magnitude based distances and the average distance. Is this a significant effect?