Capstone Project Proposal

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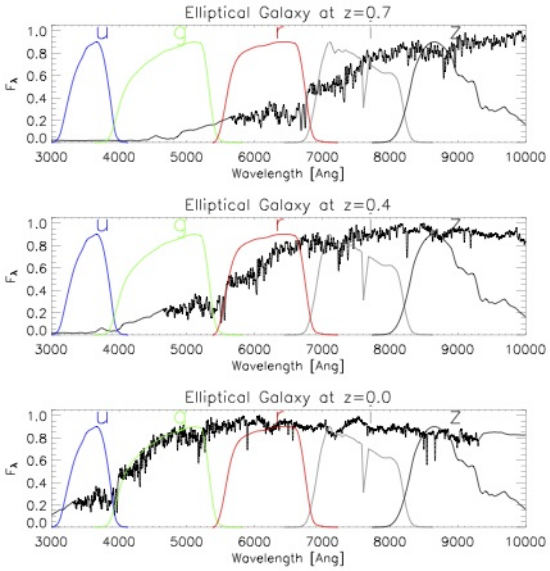

Figure 1: The figures show the spectra of elliptical galaxies at different redshifts and the windows in wavelength for some bands (U, G, R, I and Z). The solid curves are the spectra. The "z" value is the redshift. You can see that in this case the galaxy becomes dimmer and dimmer in the blue bands as the redshift increases. The figure is taken from Padmanabhan (2007).

1 Short Description

The proposal is to develop a method for measuring the redshift of galaxies in astronomical observations using the brightness of the galaxies in a series of bands or filters. These are commonly called *photometric redshifts* as apposed to *spectroscopic redshifts* which require a full spectrum of the galaxy.

2 Some Background

As the Universe expands the light coming to us from distant galaxies is stretched to longer wavelengths, or *red shifted*, by the expansion of space-time. In visible light they appear redder than they would if the Universe were not expanding. The further away they are the more redshifted they they will be. This is a way of measuring the expansion of the universe, the distance to individual galaxies and of mapping the distribution of galaxies in three dimensions.

The redshift of a galaxy can (usually) be unambiguously measured if the spectrum (energy received within small intervals of wavelength) of the galaxy is observed. Some examples are shown in figure 1. When the full spectrum is known atomic emission lines and absorption lines can be identified. The dips in the spectra shown are absorption lines. Since the wavelengths of these features before redshifting is known from laboratory experiments and calculations the redshift can be deduced from the spectrum.

Measuring the spectrum of faint galaxies requires a great deal of telescope time so it is not feasible to measure the spectrographic redshift of a very large number of galaxies. It takes much less time to measure the brightness of a galaxy through a filter. The filter lets only light within a range of wavelengths through. The transparency of some standard filters are shown in the figure. With several filters one can get a kind of coarse spectrum. There is a large variety of galactic spectra depending on what was happening within the galaxy. It in know that features in the spectrum correlate with morphilogical properties of the galaxy as measured in images.

3 The problem and the client

Galaxy surveys are becoming larger and larger. They will soon reach billions of galaxies with each measured in several (~ 3 - 10) bands. The problem is to come up with a way of measuring the redshift using only the *photometry*, the fluxes in the bands. Special purpose methods have already been developed for this so I know it is possible and perhaps some improvements

can be made.

The method must return a redshift estimate and some measure of the error in that estimate for each galaxy given 5 to 10 fluxes. After training, it should be able to process of order 1 billion galaxies and be robust against variable levels of noise.

4 the data

The Sloan Digidal Sky Survey (SDSS) was a spectroscopic survey of tens of thousands of galaxies. The redshift, fluxes in bands and images of each galaxy is available through an SQL data base (http://www.sdss3.org/). These data will be used for training and validation.

5 the method

I hope to use as many methods as I have time to try (random forest, neural nets, etc.) and learn how the methods work and which ones might be best for this problem. If time permits, I would like to include morphological characteristics of the galaxy as variables to see if this can improve redshift estimate. The primary goal is to learn about the methods rather than produce an optimal or applicable code.