

## **HR4AGN 2012 Proposal Tom Doyle Version 1**

### **Background**

In general the term ‘active galactic nucleus’ or AGN, refers to energetic phenomena in the nuclei, or central regions, of galaxies, which cannot be attributed clearly and directly to stars. The two largest subclasses of AGNs are Seyfert galaxies and quasars, and the distinction between them is to some degree a matter of semantics. The fundamental difference between these two subclasses is in the amount of radiation emitted by the compact central source; in the case of a typical Seyfert galaxy, the total energy emitted by the nuclear source at visible wavelengths is comparable to all of the stars in the galaxy (ie. about  $10^{11}$  times the luminosity of the sun), but in a typical quasar the nuclear source is brighter than the stars by a factor of 100 or more.

There are two distinct subclasses of Seyfert galaxies which are distinguished by the presence or absence of broad hydrogen emission lines. Type I Seyfert galaxies have two sets of emission lines. One set of lines is characteristic of a low density ionized gas with widths corresponding to velocities of several hundred kilometers per second which are referred to as the ‘narrow lines’. A second set of lines characteristic of high density hydrogen gas corresponding to velocities of  $10^4$  kilometers per second which are referred to as the ‘broad lines’. Type II Seyfert galaxies differ from Seyfert I galaxies in that only narrow lines are present.

### **Scientific Goals**

The Hertzsprung-Russell diagram shows the differences between classes of stars and in terms of stellar evolution, separate them into developmental sequences. The goal of our project is to find a correlation between color and magnitude for AGN and use this relationship to determine the luminosity in order to create a color magnitude diagram for AGN. In essence we are looking to see how the luminosity of the dust grains are related to the temperature of the accretion disc. From magnitude we will get absolute magnitude and luminosity. This will similarly help understand the variation in AGN and the physics that drives them. Attempts to find this correlation has been investigated previously, the current study will focus on Type 1 quasars at redshift  $0.1 < z < 0.5$  using data from:

- i. WISE at magnitude 4.6  $\mu\text{m}$  vs GALEX magnitude 227.5 nm – SDSS u-band magnitude 355.1 nm
- ii. WISE 12  $\mu\text{m}$  vs, GALEX 277.5 nm – SDSS u-band 355.1 nm
- iii. WISE 22  $\mu\text{m}$  vs, GALEX 277.5 nm – SDSS u-band 355.1 nm

This attempt will;

- i. Focus on Type I quasars in order to minimize obscuration associated with the dust torus in Type II quasars using data from WISE, GALEX, and SDSS.
- ii. Use data from GALEX near UV and SDSS both of which have a large number of targets bright enough with low signal to noise ratio. In addition the GALEX near UV does not have interference from redshifted Ly  $\alpha$  lines. There is also minimal UV contamination from the host galaxy.
- iii. Additional combinations of magnitudes may be used if the correlation between IR and UV is not apparent.

### Education Goals

The following research activities are designed to give students experience conducting true and meaningful scientific research and inquiry through the collection and analysis of data.

I. Using NED to create a velocity/distance diagram and determine the age of the universe.

1. From NED choose "By Name" and enter the name of the galaxy.
2. The redshift is listed for each target, this is the formula

$$z = \frac{\text{observed wavelength} - \text{rest wavelength}}{\text{rest wavelength}} = \text{redshift}$$

3. velocity = speed of light X redshift

$$v = cz$$

4. From the Hubble constant  $\sim 72 \text{ km/s/Mpc}$  and the formula for velocity you will get the distance

$$v = Hd \quad d = v/H$$

**Example Target 1.** 2MASX J00413204-2238379

Redshift  $z=0.018670$

$V=cz$

$$300000 \times 0.018670 = 5601 \text{ km/s}$$

$d=v/H$

$$d= 5601 \text{ km/s} / 70 \text{ km/s/Mpc}$$

$$d= 80 \text{ km/s/Mpc}$$

5. Please find the velocity and distance for the targets I have assigned to you and put your answers on the spreadsheet I sent. When completed email your results back to me.

## II. Determination of power-law spectral index

From Galex data we can obtain redshift and magnitudes of various AGNs at 155 nm and 227.5 nm. We then use the distance modulus equation to obtain the absolute magnitude,

$$m - M = 5 \log \frac{cz}{H} + 25$$

If we now assume that we can compare  $M$  with the absolute magnitude of the sun at visible wavelength we can obtain the luminosity at the two wavelengths,

$$M_v - M(\text{sun}) = -2.5 \log \frac{L_v}{L(\text{sun})}$$

The spectral energy density of an AGN is given as a power law,

$$F_v = C v^{-\alpha}$$

If we now assume that  $F_v$  (in units of  $\text{ergs s}^{-1} \text{cm}^{-2} \text{Hz}^{-1}$ ) is proportional to  $L_v$ ,

$$L_\nu = C' \nu^{-\alpha}$$

We can use Galex data to obtain the spectral index  $\alpha$ . In general the spectral index is a value between 0 to 1 and depends upon the spectral range.