Abstract:

Data from the Sloan Digital Sky Survey (SSDS) and the GALEX satellite will be combined in order to establish a color-magnitude relationship for Type I Seyfert galaxies (a type of AGN). SSDS made observations at multiple wavelengths—this project will utilize the 800nm “I” band as well as the 200nm ultraviolet-band from the GALEX satellite. A color index will be calculated using UV-I. When this color index is plotted against the AGNs brightness a type of “HR Diagram” will be produced allowing the distance to an AGN to be determined by measuring its color index.

Background:

An HR diagram is a graph, first constructed independently by Eljnar Hertzsprung and Henry Norris Russell in the early 1920s. On this graph, the colors (really their temperatures) were plotted against the brightnesses of many stars. The resulting diagram showed that most stars showed a very definite relationship between color and brightness, falling in a well-defined line on the graph. This then made it possible, by determining the color (temperature) of a star, to know its true brightness and from that calculate the distance to it.

Active galactic nuclei (AGNs) appear to be the result of supermassive black holes, located in the centers of some galaxies, emitting large amounts of radiation. This radiation is produced across the entire electromagnetic spectrum, but peaks in the UV. The power source of the AGN is the accretion disk of matter descending into the black hole’s very deep gravity well.

AGNs may be divided into several categories, but the two largest of those are quasars and Seyfert galaxies. The primary difference between quasars and Seyfert galaxies in in the amount of radiation produced in their cores. Quasars are extremely bright, having luminosities that exceed the stars in the parent galaxies by about 100 times (1013⊙)-- the light from the core is so bright that it overwhelms the light of the remainder of the galaxy. Seyfert galaxies are less luminous, having luminosities equal to that of all of the stars of the parent galaxy (1011⊙ ).

Seyfert galaxies were first classified by Carl Seyfert in 1943. The nuclei of Seyfert galaxies contain numerous emission lines. In Type I Seyferts, these emission lines tend to be broad; in Type II’s they are narrow. Modern terminolgy uses a decimal classification whereby the Seyfert galaxy is classified according to where it belongs on a continuum between the two types (Type 1.1, Type 1.2, etc, ending in Type II). Current thought is that all Seyfert galaxies are essentially the same, differing only in the angle at which they are viewed from the earth.

An AGN emits ultraviolet radiation from the infalling matter in the accretion disk, while it emits infrared radiation from the dust cloud surrounding the accretion disk. This dust cloud is energized by the UV radiation falling upon it; this energy is then re-emitted by the dust cloud in the form of infrared radiation. Since the output of UV radiation from the core varies, the infrared radiation from the dust disk should also vary, though some time later. This delay is due to the light travel time from the accretion disk to the dust torus. This time delay also provides a measure of the scale of the active nucleus.

The two primary instruments used in this project will be the Sloan Digital Sky Survey (SDSS) and the GALEX satellite. SDSS is a 2.5-meter telescope located in New Mexico which can operate either as a photometer or as a spectrometer. This project will involve photometry in the near-infrared (around 800nm) band. GALEX is the **Gal**axy **E**volution **Ex**plorer and is a space-born satellite which operates in the UV. This project will use GALEX data taken at 200nm in wavelength.

Procedure:

Using NED (the NASA/IPAC Extragalactic Database), Type I Seyfert galaxies that have been imaged by both SDSS and GALEX will be examined. Although the exact numbers are unknown as of this writing, it is hoped that several hundred to perhaps a few thousand AGNs will meet both criteria. This will provide both IR data (SDSS, 800nm) and UV data (GALEX, 200nm) from which a color-magnitude relationship will be determined.

The color index of each Seyfert galaxy will be determined using the formula:

*Color index = UV - IR*

Color indices are normally determined by subtracting the longer wavelength from the shorter wavelength. This gives a system in which “bluer” objects tend to have more positive values while “redder” objects tend to have less positive or even negative values.

When the color indices of numerous Seyfert galaxies are plotted against the absolute brightnesses of those same galaxies, a color-magnitude diagram will be the result. An HR diagram is this same type of color-magnitude diagram where the brightnesses of stars are plotted against their color indices (in this case, B-V).

Goals:

There should be a correlation between the AGN’s UV output and its IR output. An increase in UV radiation by the accretion disk should result in an increase in the temperature of the surrounding dust disk.

If a linear or logarithmic relationship for these two values can be shown, then such a diagram may allow the distances to other AGNs to be determined simply by looking at their color indices. This, along with their redshifts, will allow greater confidence in determining their distances from the earth.