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:

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:

Type I Seyfert galaxies will be examined using data provided by the NASA Extragalactic Database (NED)—specifically, galaxies which were imaged by both SDSS and GALEX will be studied. 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 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 (hundreds or perhaps thousands) of 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 AGNs 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 their color indices. This, along with their redshifts, will allow greater confidence in determining their distances from the earth.

Education and Outreach Goals:

The procedures and results of this project will be disseminated to the community in several ways:

1. Outreach to the public will be achieved by giving several talks over the course of the project and after. The main public venue will be presentations in front of local astronomy clubs, such as the Bays Mountain Astronomy Club at Bays Mountain Park and Planetarium and the Bristol Astronomy Club at King College.
2. Education programs will be given in the form of teacher workshops to other teachers in the district as well as to teachers in other surrounding districts. Also, a couple of talks will be given at two local universities (East Tennessee State University and the University of Tennessee) to their education majors as well as a Physics Dept. seminar.
3. Students will present the results of this research project to the local school board and will publish the results in a suitable venue—in Tennessee, the *Journal of the Tennessee Junior Academy of Sciences* is a possible choice-- my current research students publish their papers there.