Investigating the M-Sigma Relation: An Analysis of Active Galactic Nuclei Mass Evolution Patterns

Bence, Ciana-Lei (School: Kamehameha Schools Hawaii Campus)

The M-Sigma relation is a well-known empirical correlation discovered between black holes and their host galaxies relating the mass of a black hole to its surrounding bulge. The conventional theory explains this correlation through the process of Active Galactic Nuclei (AGN) excreting relativistic jets of energy as the matter is heated through the accretion disk. This results in the loss of energy and matter used for star formation, thus limiting and eventually halting star formation within a galaxy. However, this theory doesn't have the necessary evidence to support it. Due to this, I conducted an observational study of AGN mass using emission line spectra to analyze the relationship between mass and age of AGN to determine possible patterns of AGN mass that are present throughout its lifespan. Instead of using official mass and age of AGN, I used relative values which were estimated using the redshift of a galaxy and line width of emission lines of specific elements since redshift is correlated to the age of a galaxy and line width is correlated to mass of the AGN. Results that reject the null hypothesis could be used in accordance with the feedback theory to gain better insight into its veracity as the theory would imply physical differences in AGN in relation to its age. The data collected showed an upward trend between AGN mass and redshift, however, statistical tests proved these results to be insignificant. This can be explained by a few factors including small sample size, unknown ages of sample galaxies, and unknown events within each galaxy's lifespan. The slight positive upward trend could be interpreted as a systemic bias due to the ability of telescopes to only capture the brightest and in turn larger galaxies at a higher redshift.