Co-Evolving Across Time: Black Holes as Regulators of Their Host Galaxy Properties

Gardner, Sarah (School: Ossining High School)

Correlations between central black hole (BH) mass and certain physical properties of their host galaxies suggest BH feedback may have substantial impacts on galactic evolution. However, a lack of consensus regarding these associations' magnitude, as well as the use of small datasets biased towards high-mass cosmic objects, has greatly limited the overall understanding of these relationships. This study analyzed data from the Sloan Digital Sky Survey using Jupyter Notebook and AstroDataLab to further clarify these correlations. Compared with previous research, a larger and more diverse sample was compiled, containing 2,648 massive galaxies with BH masses ranging from ≈ 4.6–9.1 log10 solar masses, and 166 dwarf galaxies. Moderate positive associations were found between BH mass and both total galaxy stellar mass ($r \approx .525$, $p < .0001$) and velocity dispersion ($r \approx .479$, $p < .0001$). No correlations were found between BH accretion rate and those same properties, indicating independence from central BH activity. BH mass and SFR upheld the strongest correlations within isolated dwarf galaxies ($r \approx .572$, $p < .0001$). Strong correlations across the entire galaxy mass spectrum were found between BH mass and total galaxy stellar mass ($r \approx .677$, $p < .0001$). Additionally, a systematic offset of 0.4 dex was found between the stellar mass methodologies of previous research, indicating inconsistencies within widely accepted models. These findings provide insight on the relationship between BHs and their host galaxies, with applications to constraining scaling relations for high redshift systems lacking direct measurement of key observational properties.

Awards Won:

Second Award of $2,000