CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S1812

Project Title

Using a Novel Methodology to Constrain the Supermassive Black Hole-Galaxy Coevolution and Analyze the Selection Bias

Abstract

Objectives/Goals

The primary objective of this project is to see if the convolution methodology truly reveals the supermassive black hole (SMBH)-galaxy coevolution. In doing so, we also directly compare stellar velocity dispersion and mass constructions to discover new inherent property correlations. Additionally, we evaluate the extent of the selection bias proposed by Shankar et al. (2016).

Methods/Materials

The only material we use is a laptop computer with Python IDE. Note that all Python modules are created by us. We utilize a modified convolution function that was previously proposed, though never executed or analyzed. We then construct number density models in relation to established galaxy properties, applying the convolution in the process. With those models and estimations in redshift evolution, we juxtapose evolutionary pathways to examine coevolution. Furthermore, we compile a 542 galaxy database to empirically analyze relations and the selection bias.

Results

We find evident concurrence in SMBH and galaxy growth histories, proving the existence of coevolution. Analyzing different black hole mass function constructions, we discover tight agreement between velocity dispersion and stellar mass properties. By testing biased and unbiased relations, we show negligible differences in our results.

Conclusions/Discussion

Using this novel methodology, we provide entirely new evidence on coevolution. The agreements in velocity dispersion and stellar mass express a stronger link between those two properties than previously believed. Our analysis then argues that Shankar's bias is actually not as impactful as he proposes. We conclude that the galaxy sample is a fair representation of the local universe and advocate that our number density and scaling relations have incredible potential to be employed in constraining relevant mechanisms for galaxy formation. Due to our novel convolution, property comparison, bias test, and evidence, we emphasize this very comprehensive study on the SMBH-galaxy coevolution.

Summary Statement

We use a novel convolution methodology to prove the supermassive black hole-galaxy coevolution, directly compare galaxy properties, and evaluate the selection bias.

Help Received

The work was conducted at UCSC where we discussed the implications with Dr. Aldo Rodriguez-Puebla, Prof. Joel Primack, and other astrophysicists. The hypotheses were pre-established, but all analyses and calculations were done by ourselves.