CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
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Project Number
S1822

Project Title
Confirming the Coevolution of Supermassive Black Holes and Dark Matter Halos by Analyzing the Structure of Galaxy Bulges

Abstract

Objectives/Goals
I have reexamined the coevolution between supermassive black holes and dark matter halos by utilizing a unique method through a series of correlations. The first correlation is a relationship between the masses of supermassive black holes of galaxies and their respective galaxy bulge masses. The second correlation is a relationship between the masses of galaxy bulges and the circular rotation velocities of the galaxies. Using these two correlations, an indirect relationship between supermassive black holes and dark matter halos can be accomplished for all galaxies.

Methods/Materials
Data for supermassive black hole and galaxy bulge masses in solar masses is obtained from Kormendy & Ho (2013), and the MASSIVE Galaxy Survey. Data for the circular rotation velocities (km/sec) of galaxies was obtained from Bovy et al. (2012), Schulze & Gebhardt (2013), Sun et al. (2013), Kormendy & Ho (2013), and Saliba et al. (2015). In order to represent the galactic dark matter halos, I use circular rotation velocity because matter on the outskirts of galaxies is influenced by hypothesized dark matter halos that cause matter to rotate around the galactic centers at higher velocities than theoretical values suggest. Microsoft Excel was used for data analysis. For the first correlation, galaxy bulge mass(x-axis) is plotted against supermassive black hole mass(y-axis). For the second correlation, the circular rotation velocity(x-axis) is plotted against the galaxy bulge mass(y-axis), the data is segregated by galaxy morphology (Ellipticals, Spirals, or Lenticulars), and then the R^2 values are identified for each set of galaxies.

Results
The first correlation of supermassive black hole and dark matter halos of galaxies displayed a direct relationship for all galaxies with an R^2 value of 57.00% . The second correlation of the galaxy bulges and circular rotation velocities of galaxies showed an R^2 value of 61.95% for lenticular galaxies, and insignificant correlations for spiral and elliptical galaxies.

Conclusions/Discussion
My study demonstrates that my hypothesis was partially correct. There is a coevolutionary relationship between the supermassive black holes and dark matter halos for only lenticular galaxies. This finding demonstrates a greater understanding of dark matter and its influences on baryonic matter in galaxies as they evolve.

Summary Statement
I demonstrated a coevolutionary relationship between supermassive black holes and dark matter halos for lenticular galaxies through utilizing their galaxy bulges.

Help Received
Mrs. Messenger guided me through the research process. Mr. Messenger assisted me by providing feedback.