CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35718

Project Title

The Nature of Variability of the Ultraviolet and Optical Spectral Energy Distribution of Active Galactic Nuclei

Abstract

Objectives/Goals

Active galactic nuclei (AGNs) are powered by accretion of matter onto supermassive black holes (SMBHs) in a structure called the accretion disk. The biggest problem with this accretion disk theory is that the light intensity of the accretion disk varies enormously (by a factor of 10) on short time-scales (on the order of weeks). To understand how SMBHs eat material we need to understand this variability. The external illumination theory hypothesizes that X-rays heat the accretion disk and cause it to vary. This model predicts the relationship between variability in the optical and UV frequencies. In this study, the external illumination theory is evaluated as a possible means for energy generation in AGNs.

Methods/Materials

Optical photometric data from the International AGN Watch database and UV data from the International Ultraviolet Explorer of six extensively studied AGNs (3C 390.3, Fairall 9, NGC 3783, NGC 4151, NGC 5548, and NGC 7469) were used. Optical and UV fluxes were graphed to test the external illumination theory's three predictions for each AGN: 1) The loci in the plots are really curves, and the curvature increases as one goes to higher frequencies, 2) the loci give an overestimate of the SED's constant component (host galaxy starlight contamination), and this overestimate is greater as one goes to higher frequencies, and 3) there is a greater scatter in an AGN's photometric data in optical-UV plots as compared to photometric data in optical-optical plots.

Results

The results concluded that the external illumination theory is a good model to address optical and UV variability because the optical-UV plots exhibit significant scatter in the data and an overestimation of the constant component in comparison to estimates from Bentz et al. (2013). The data's scatter makes it difficult to predict the curvature of the optical-UV relationship, but the results are generally in agreement with the predicted curvature of the external illumination theory.

Conclusions/Discussion

The significance of this research is that it brings attention to studying AGN optical and UV variability together to understand the energy generation of AGNs. Observation campaigns in the past have generally focused only on optical or UV variability, but this research shows that looking at both kinds of variability raises interesting questions about AGNs and accretion disks.

Summary Statement

This project's main focus is to assess the validity of the external illumination theory, which predicts that high-energy flares in accretion disks play a role in active galactic nuclei energy generation.

Help Received

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