Investigating Supermassive Black Holes and their variability by using a Structure Function

by

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Abstract

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Our universe is pockmarked with galaxies as far as we can currently observe from our humble planet. The currently accepted theoretical model is that at the center of these galaxies are super-massive black holes holding them together. This has been proven for a majority of these observable galaxies, including our own, and for some the central black hole is actively accreting matter. We call the galaxies hosting these black holes active galaxies. Active galaxies are of particular interest because they are some of the brightest objects in the night sky and yet their emission spectra are incredibly variable. Unfortunately since the data acquired from these objects is generally unevenly sampled, we cannot use a Fourier analysis as it suffers from windowing and aliasing. For these reasons we turn to the structure function which has a similar effect as the Fourier analysis but with the added benefits of remaining in the time domain and sporting a robustness against windowing and aliasing due to uneven sampling.

by *Derek Blue*

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Chapter 1

Introduction

When you look up into the night sky on a clear summer night, in parts of the world you can see our Milky Way with the naked eye. If you were to gaze out into the vast emptiness with a powerful enough telescope then you would be able to see other collections of bright little dots closely packed together. These collections are known as galaxies and they come in all sorts of shapes and sizes. One thing all these galaxies are theorized to have in common is the presence of a central supermassive black hole holding the galaxy together. In some galaxies we observe immense electromagnetic emission from the central region, we call these active galaxies and their centers are active galactic nuclei(AGN).

1.1 Overview

1.2 Galaxies, Active Galaxies, and Black Holes

1.2.1 Galaxies

Astronomical description of galaxies.

1.2.2 Active Galaxies

Astronomical description of active galaxies(AGN).

1.2.3 Black Holes

Astronomical description of black holes and super-massive black holes.

1.3 How AGN are observed

1.3.1 The Unified Model

A description of the unified model and how, if the model holds, we can observe the inner workings.

1.3.2 Orbital X-Ray telescopes

A description of the orbital observatories used and the bands of the EM spectrum they can observe

1.4 Expected achievements

What is expected to be achieved from this project

Chapter 2

The General Relativistic Description

2.1 General Relativity

An introduction to general relativity and its relation to black holes.

2.1.1 An introduction to Tensors

An introduction to tensors and their mathematical properties

2.1.2 The Metric Tensor

Role of the metric tensor

2.1.3 The Spacetime Interval

Role of the spacetime interval

2.2 The Kerr Spinning Black Hole

Description of the concept of the Kerr spinning black hole and its importance.

2.2.1 The Kerr Solution

The mathematics of the Kerr solution.

2.2.2 Properties of the Kerr Solution

Properties of the Kerr solution.

Chapter 3

Statistical Analysis

3.1 The Structure Function

(Peterson, 2001) (author1, year1) (author2, year2) What the structure function is and how it applies to this data sample. Why it was chosen.

3.2 The Data

An overview of the data. This section will contain many figures.

Chapter 4

Programming SFA

4.1 SFA usage and description

A description of what SFA was developed for and its usage.

4.2 The SFA algorithm

4.2.1 Process

The logical process SFA follows to generate the structure function

4.2.2 Cost and Complexity

An overview of the general running cost and Big-Oh order of SFA

4.3 Expected Output

What one should expect for results from running SFA

Chapter 5

Results and Conclusions

5.1 Results

A review of the results of running SFA on observational data

5.2 Conclusions

Theoretical conclusions based on the findings of SFA

Chapter 6

Future Work

Potential future work and applications of SFA

Appendix A

SFA

If you wanted an appendix, it would go in like this. It would be referenced using Appendix A.

Bibliography

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