Notes for Krista Lynne Smith et al. "THE KEPLER LIGHT CURVES OF AGN: A DETAILED ANALYSIS"

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1. Introduction

There are many theories as to the origin of the optical variability of AGN light curves such as MHD turbulence driving MRI, Poissonian flares, microlensing, host galaxy starburst activity and a damped random walk of thermal flux within the disk.

from X-ray AGN varibility studies we know that characteristic timescales and candidate quasiperiodic oscillations have been detected in the power spectral density functions (PSDs) of X-ray AGN light curves. The characteristic timescales which are defined as the point at which the PSD "breaks," or flattens, towards low frequencies, have been found to correlate with the black hole mass in AGN. The break frequency seems to scale with the innermost stable orbit of the accretion disk.

Keplers PSD slopes seem too steep to be from a DRW model

Variability in the light curves happens at a 2-5% level from the mean flux. This is very difficult so observe with ground based telescopes at the moment.

The Power Spectral Density (PSD) functions shows the relative power in the variability as a function of temporal frequency. The variability of AGN is a red noise process, meaning that successive samples are correlated in time. The power spectra of such processes are well described by a power law, where the spectral density S varies with the temporal frequency as $S \propto f^{\alpha}$. The break in the PSD could be described by a steep power law at high frequencies and a shallower one at low frequencies. Often the slope $\alpha = -2$ is used for the high frequency regime, which is consistent with a DRW model for the AGN variability, it is also consistent with X-ray literature. Keplers slope seems to be steeper than this value and disagree with the optical results. To obtain the PSD a discrete Fourier transform was performed on a interpolated light curve. The data was fitted with a line to remove a linear trend which will remove the lowest-frequency component of the power spectrum. The mean was also subtracted before the Fourier transform. Monte Carlo methods is used to obtain the best fit slope and its uncertainty. The slope that can be rejected with the least confidence is the slope we consider to be the best fit for each object.

Variability seems to be correlated with redshift and anticorrelated with the luminosity.

PSD slopes tend to be steeper than -2 for the Kepler data though this might still fit for ground based data. The break time scale τ_{char} could be the point at which the behavior switches from a steep, red variability to a damped random walk or similar.

Consider that perhaps the PSD of an AGN becomes redder and redder due to a cyclic accretion-disk duty cycle akin to that in X-ray binaries, building towards a critical moment when the behavior switches to a damped random walk. The timescale on which this switch occurs depends on the black hole mass, with longer timescales for larger masses (i.e., larger disks in general). In this case, those objects with observed PSD breaks would have the reddest high-frequency slopes compared to the rest of the sample, which has been caught somewhere in the middle of its reddening phase.The mean value for the broken-PSD objects is $<\alpha>= -3.0$, compared to $<\alpha>= -2.3$ for the unbroken sample. α=2.0 seems to be true for luminous objects like quasars.

X-ray reprocessing is unlikely to be a large contributing factor to the 0.1-10% optical variability of AGN.

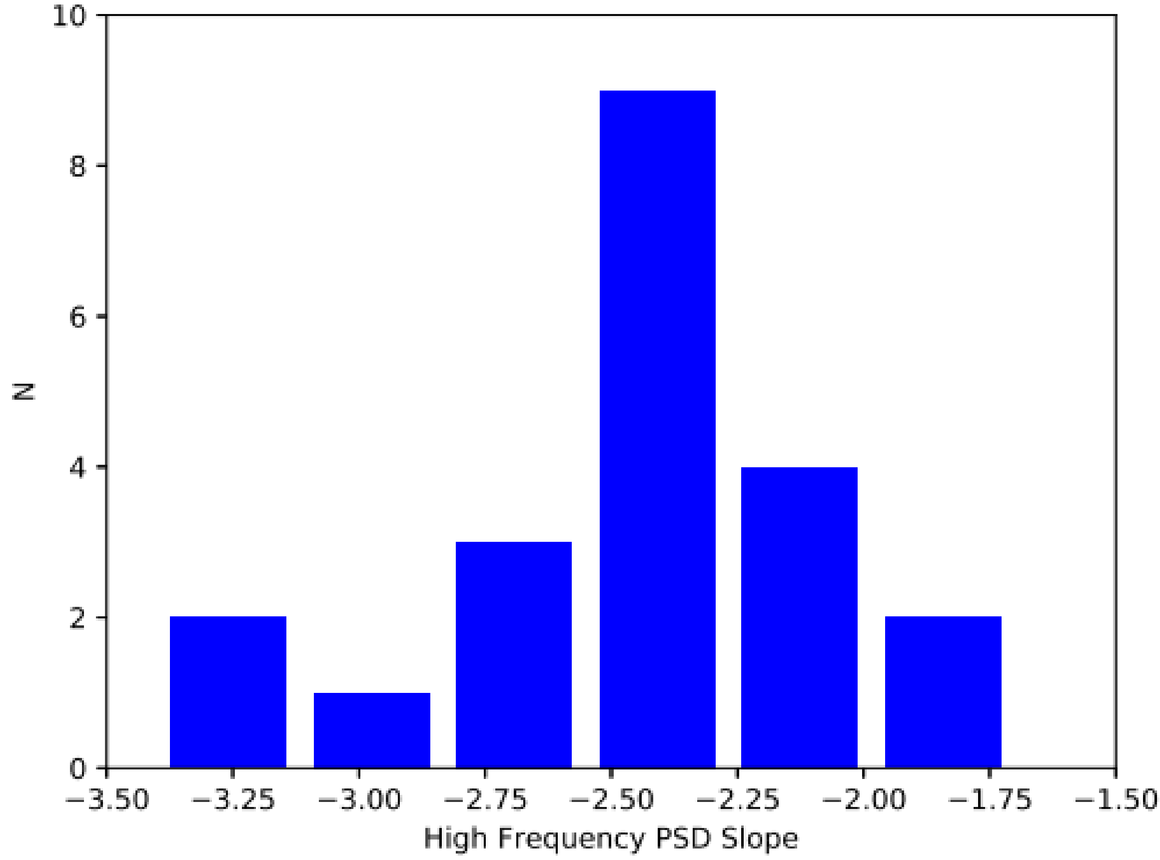

FIG. 8.— Histogram of the best-fitting high-frequency PSD slopes as measured by the simulations described in Section 5.