Master Thesis Notes: X-ray variability time scales in active galactic nuclei

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This is mainly used to obtain a guess for the variability timescale for x-ray/UV driving function. The order is around days for the x-ray, in the UV case obejcts were between 5-100 days

characteristic time scales derived in theframework of clumpy accretion flows. The value of the char-acteristic X-ray time scale τX, associated with the electron heat-ing/cooling process, corresponds to the typically observed value of the PSD break time scale,TB. The predicted time scale is shorter for small black hole mass and/or high accretion rate, cor-rectly reproducing the observed trend. The dependence on blackhole mass and accretion rate we derived in Eq. (7) agrees remark-ably with the observational relation found by McHardy et al.(2006), without additional parameters.In our picture, X-ray variability is attributed to both varia-tions in the seed photon population and density fluctuations in the upscattering medium, with a greater contribution from the latter. A break is expected in the power spectrum, since fluctua-tions on time scales shorter than the electron heating time are not observable. The associated X-ray time scale τX, directly related to the physical process of X-ray emission, may thus provide a possible interpretation of the PSD break time scale

The study of correlations between different energy bands are thought to provide information about emission processes and the causal links between different emission regions. Indeed, the UV and X-ray emissions are coupled through reprocessing of X-rays and/or upscattering of UV seed photons. Time lags with longer wavelengths leading shorter ones have been interpreted as fluc-tuations in the accretion disk, propagating from the outer opti-cal/UV emitting regions toward the innermost X-ray emitting region, on the viscous or thermal time scale. Several multi-wavelength monitoring campaigns have searched for correla-tions and time lags between the two energy bands, in a num-ber of AGNs. However, the sign of the time lag can be different from case to case, and even the existence of correlations has not been always confirmed (Nandra et al. 1998;Maoz et al. 2002;Marshall et al. 2008). The global picture is still quite confusing and the problem does not seem to be definitively settled yet.

In our cascade model, the two emitting media are coupled through the succession of shocks, which also determines the sign of the time lag: optically thick shocks provide the seed pho-tons that will later be upscattered by electrons heated in the optically thin shocks. Following the optically thick shock, UV photons are emitted and escape the region when the expanding clump reaches the size of the photosphere and becomes opti-cally thin, i.e. after τexp from the shock event. The expansion continues until neighboring envelopes overlap, leading to opti-cally thin shocks in which electrons gain energy on the charac-teristic heating time. X-rays are emitted as a result of the inter-action between photons, generated in the current event, and hot electrons, created in a previous optically thin event. Two distinct time lags are then expected: a nearly zero lag due to the im-mediate Comptonization process, and a longer lag related to the temporal evolution of electrons, with the UV photons leading the X-rays.

This might contradict the Shappee 2014 paper as that showed UV/optical lagging X-ray