Morphology of the fast variability in selected AGNs observed by XMM-Newton

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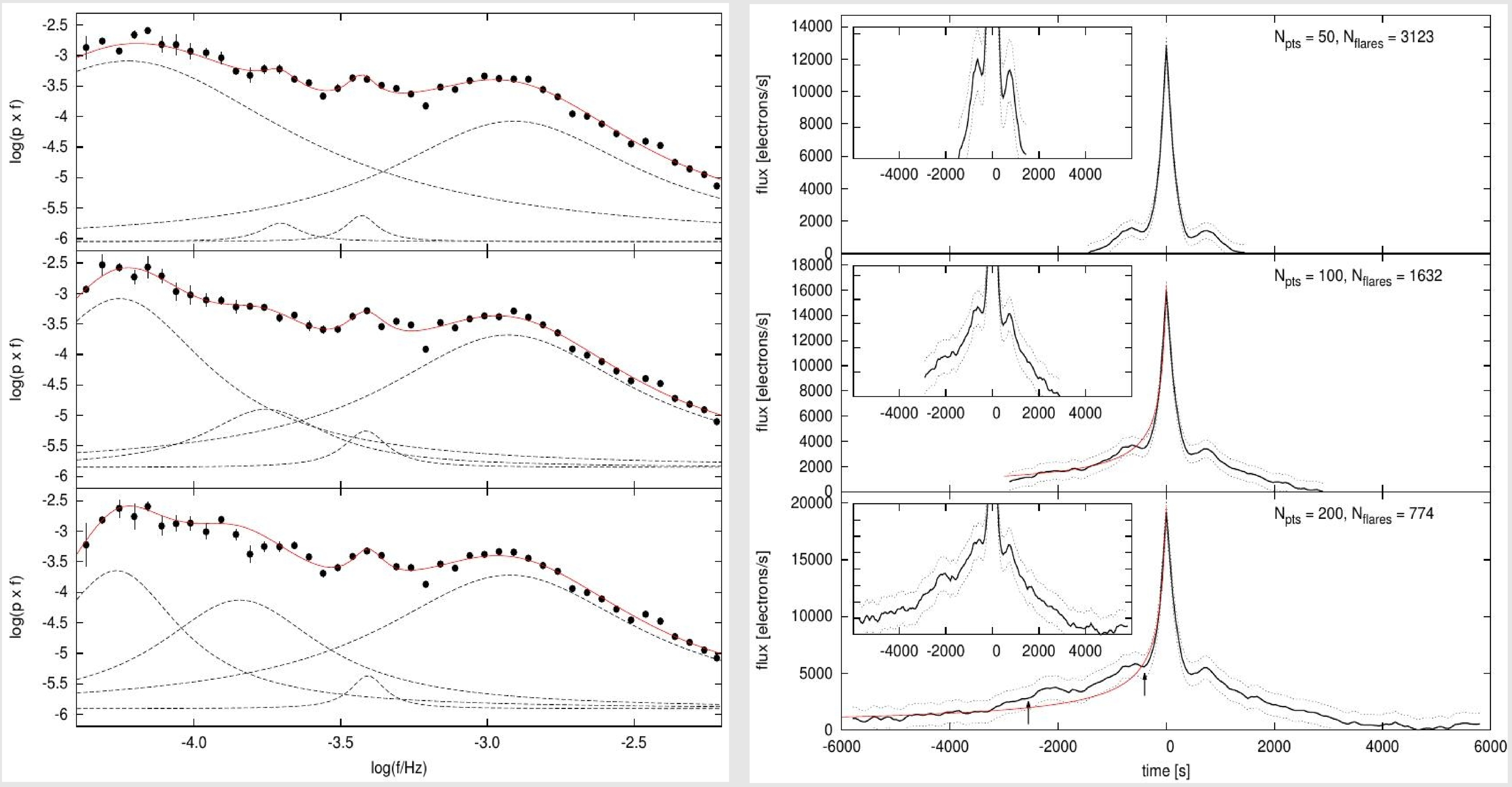
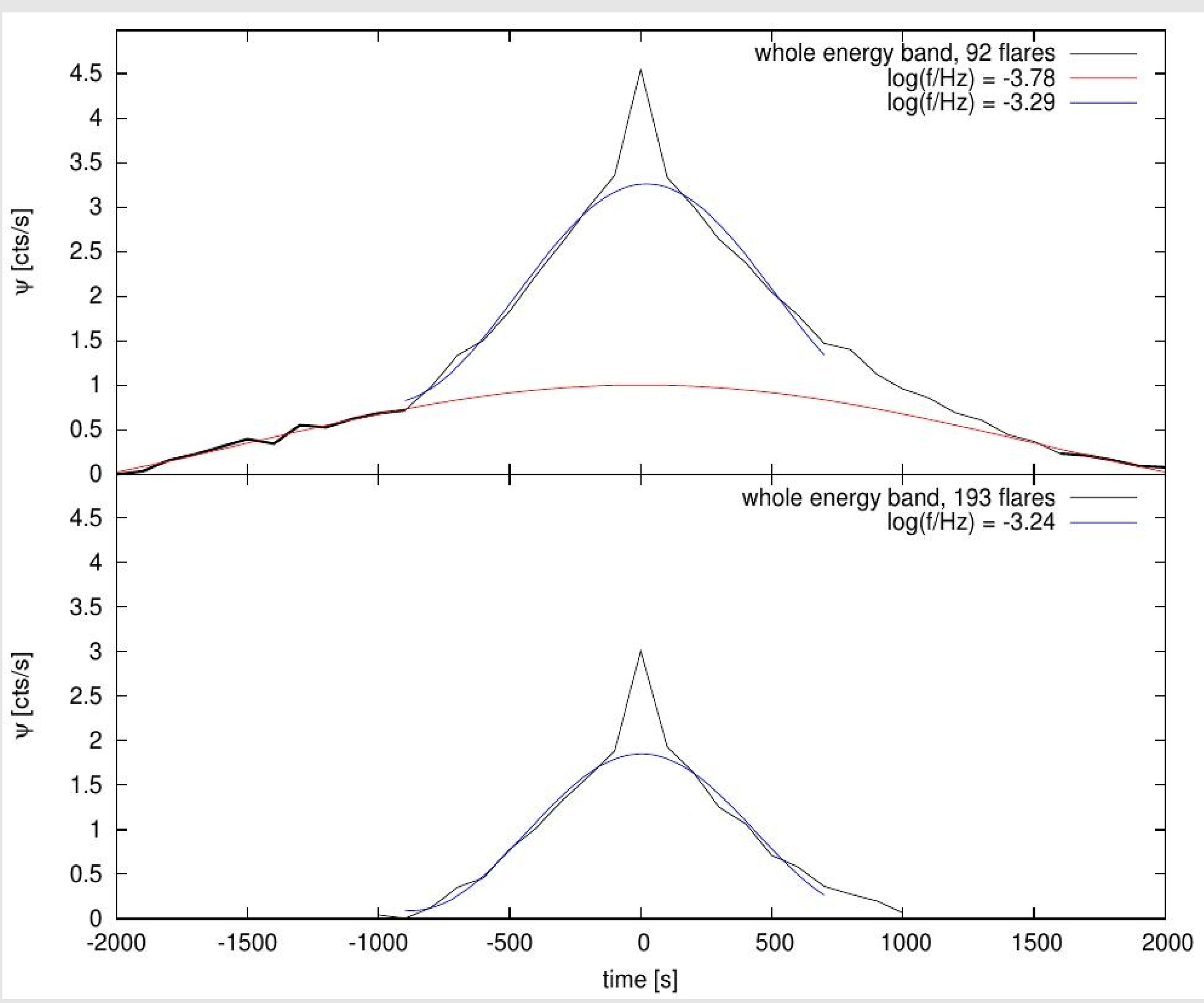
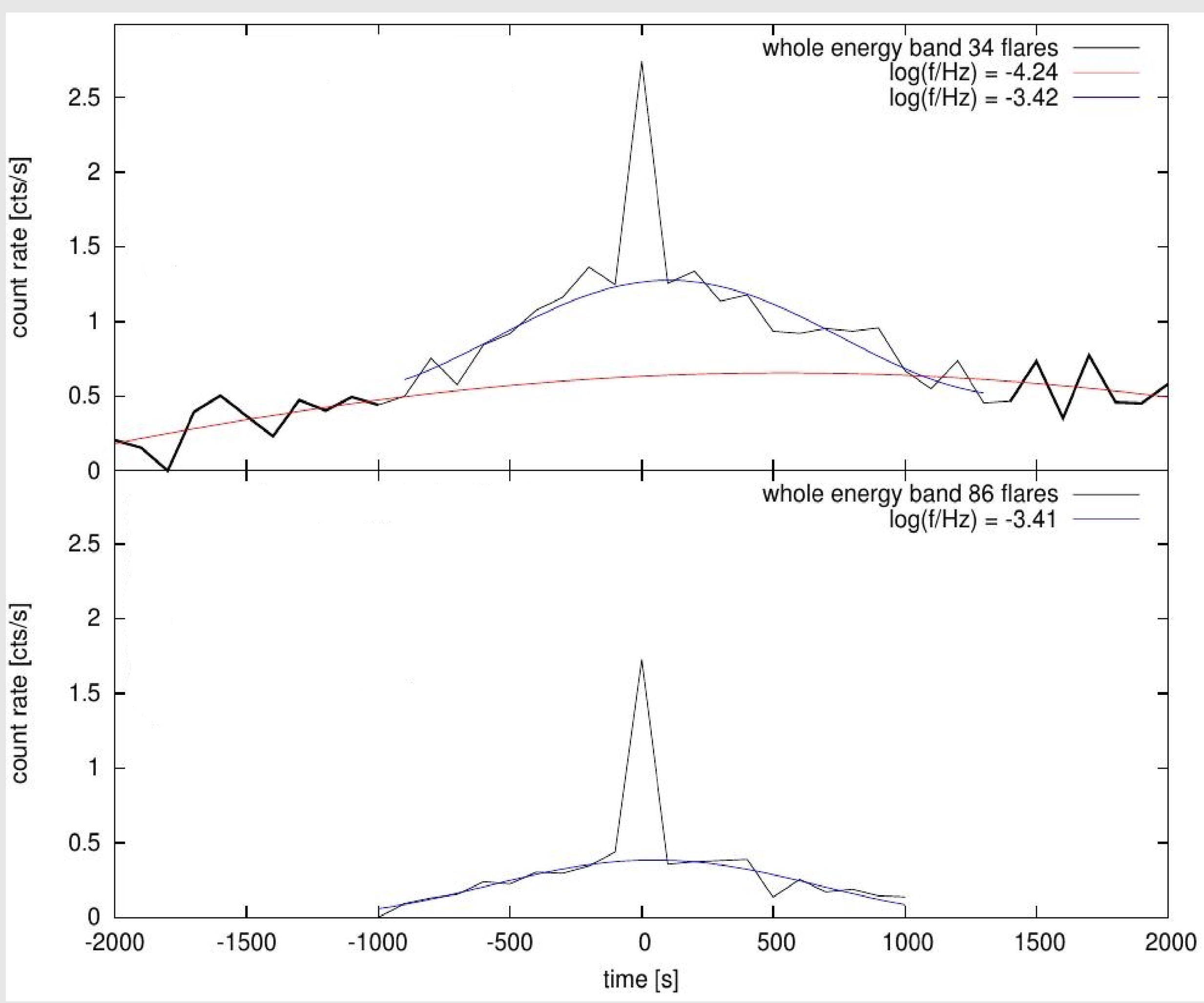
Motivation: Light curves of AGNs show fast variability like in X-ray binaries or cataclysmic variables. Many authors search for break frequencies in PDSs of AGNs in order to find correlation with black hole mass. Mohan & Mangalam (2014) performed such search in XMM observations of several AGNs, including MRK 766, NGC 3516 and MRK 509. We selected these objects because of longest observations needed for our analysis method. The break frequencies in these objects are diverse (MRK 766: -3.17, -3.34, -3.38, -3.41, -3.74, NGC 3516: -2.68, -2.70, -2.72, -2.73, -3.93, -4.24) and hard to connect with a single frequency scalling with a black hole mass.

Inspiration by previous works: Negoro et al. (1994) applied new technique of timing study to Ginga data of Cyg X-1, the so called averaged shot profile (many flares/shots are superposed and a mean profile is calculated), and found complicated structure of the shots. i.e. two side lobes and central spike. The same performed Sasada et al. (2017) with Kepler data of blazar W2R 1926+42 and found the same profile structure, just the time scales are different. We applied the same method to Kepler data of MV Lyr (Dobrotka et al. 2018) and the result is very comparable, i.e. side lobes and central spike. Using the averaged profile to light curve simulations and subsequent PDS calculation, we found the same multicomponent PDS structure as found by Scaringi et al. (2012) in Kepler data. This means that all PDS components represent substructures of the shot profile.



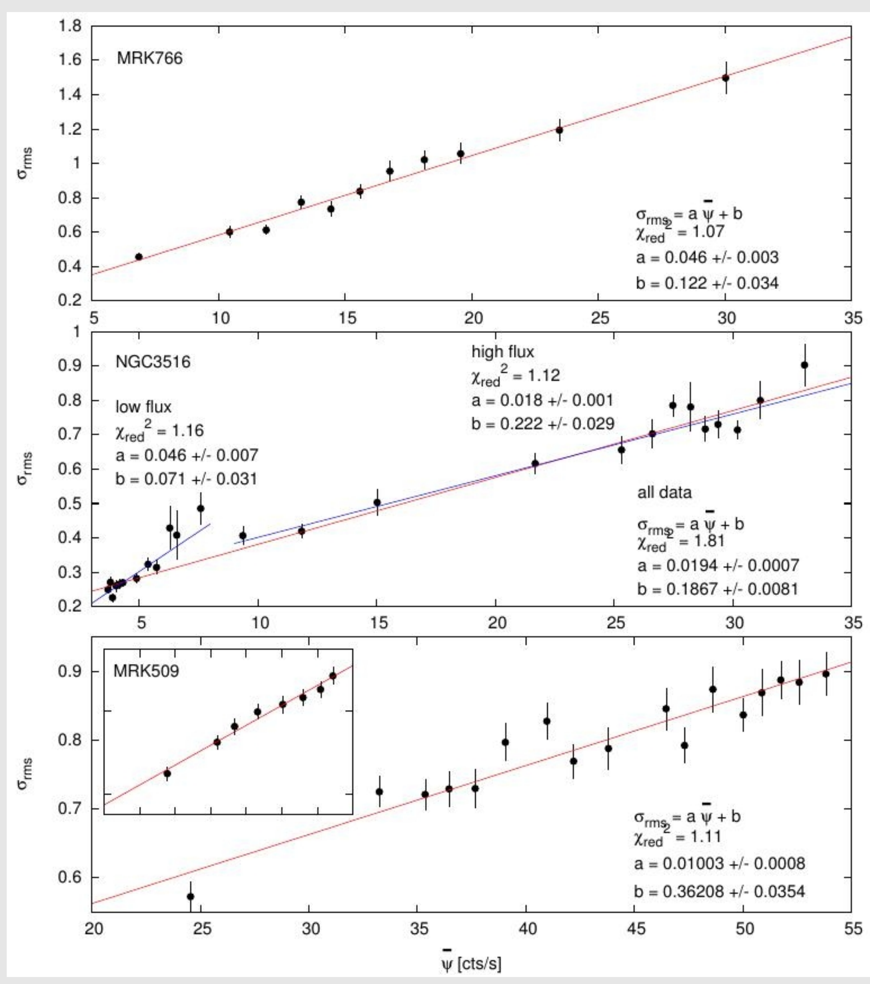
MV Lyr case, simulated PDSs with individual Lorentzian components and averaged shot profile with different selection criteria, from Dobrotka et al. (2018, submitted to MNRAS)

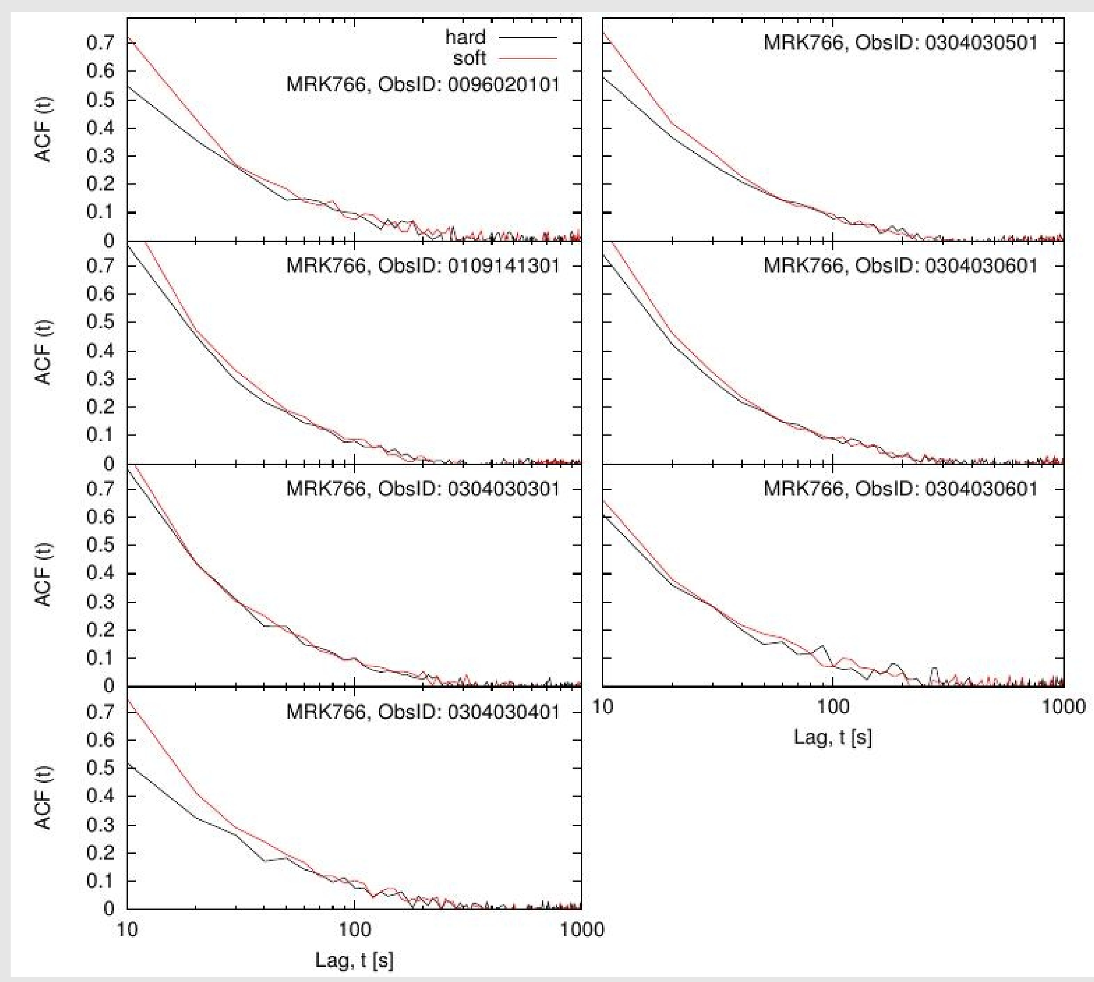




Application to three AGNs: We recalculated PDSs with a different method and searched for multifrequency behaviour. We calculated also the averaged shot profile a fitted individual components with a sine functions. We found multiple frequency candidates in agreement with diverse values detected by Mohan & Mangalam (2014). However, our frequencies found are present in all observations and are simultaneous. Moreover, it iseems that at least part of them represents individual components of the averaged shot profile.

Additional results: AGNs, X-ray binaries and cataclysmic variables are accretion powered with fast variability as finger print of the underlying physics. We searched for some additional indications of common physical origin of the variability. The propagating accretion fluctuation model requires linear rms-flux relation (Uttley et al. 2005). This is fulfilled in all three selected AGNs. ACF of harder X-ray band in Cyg X-1 is narrower than softer ACF (Maccarone et al. 2000). Such qualitative argument supporting idea of cool blobs drifting inward through an inhomogeneous hot disc/corona (form of propagating mass accretion fluctuation) was found almost in all selected AGNs observations (except low flux of NGC 3516, but here we know that different physics plays role).





Conclusion: We propose a scenario, where various characteristic frequencies are substructures of a complicated shot profile, and it is not trivial to select the correct one representing the break frequency searched by many authors in order to search for black hole mass correlation. A broad Lorentzian PDS component can be easily fitted as a break frequency. All detected frequencies are probably present simultaneously in all observations, and different values found by Mohan & Mangalam (2014) are just different solutions of the fitting process with only single break frequency as searched parameter. All shot profile components should be and are seen in PDS like in MV Lyr or Cyg X-1. This proposed phenomenology can explain why Mohan & Mangalam (2014) did not find consistency between the break timescales and reported black hole masses. Probable origin of several characteristic frequencies found is the unstable mass accretion rate through the disc or corona.