Optical variability in Active Galactic Nuclei

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AGN are among the most powerful objects in the Universe. The compact size of their optical emitting regions allows them to be variable on timescales as short as hours. Since the discovery of AGN, much work has been done on studying the optical variability in blazars, where the variable optical emission is thought to be produced by relativistically beamed emission from shocks in the jet. However, there has been only limited study of the optical variability in the less-variable non-beamed AGN, e.g. radio-quiet quasars, where the optical emission and hence the variability must come from the accretion disc itself. If we can probe the variations of the accretion flow directly, we can set significant constraints on fundamental properties of AGN accretion discs, such as the alpha viscosity parameter Starling et al. (2004, MNRAS 347) and correlate the disc variability properties with key parameters such as black hole mass and accretion rate. In addition, one can probe the physical cause of the variability as shown by Kelly et al. (2009, ApJ 698). But so far, optical variability studies have been done with either very sparse sampling, for large samples of AGN with a few better-sampled monitoring campaigns on smaller samples of a few dozen objects. Furthermore, in all the studies of large samples so far, the observed cadences and photometric sensitivity can only sample longer time-scales of weeks to years.

Large efforts have been made in the last decades to study samples of AGN in low cadence (on timescales from months to days). For example the well defined sample of Palomar-Green quasars has been observed for 7 years with the Wise observatory (Giveon et al. 2009, MNRAS 306). More recently the Sloan Digital Sky survey (SDSS) observed one region of the sky (stripe 82) repeatedly to look for variability (Sesar et al. 2007, AJ 134). In both cases mainly long timescale variability can be probed. For a review of variability surveys see Becker et al. (2004, ApJ 611). Optical variability studies of AGN have been restricted by the fact that with ground based telescopes one can only observe during nights, and thus continuous short cadence observations typically last only a few hours and the atmospheric seeing conditions create significant photometric errors that can mask the real intrinsic variability (e.g., Mushotzky et al. 2011, ApJ 743). A small number of AGN have already been observed with the *Kepler* satellite (~ 20 AGN). It should be noted that these individual targeted observations of bright AGN are only probing a small subset of the known population of AGN and that only in the local universe. Thus, up to now there are only a few available *Kepler* observations of hand picked AGN, limiting the possibility to probe the population of AGN in the Universe.

As outlined above, there are several large variability surveys focused on long cadence observations. However, the properties of optical variability on short timescales are virtually unexplored for the population of AGN. Furthermore, this lack of knowledge about the short time-scale variability hinders our interpretation of the long time-scale data, since due to aliasing effects it is not possible to accurately model the long-term variability (e.g. via the power spectrum) if short-term variations are not sampled well: we simply cannot disentangle variability close to the sampling time-scale from variability on shorter time-scales. Here, we propose to observe a flux limited sample of AGN with the K2 mission to study the properties of the population of AGN at short timescales and also feed this information back into our understanding of the longer-time-scale variability. Variability amplitudes, characteristic timescales and probably also the power law index in the PSD depend on the intrinsic parameters of an AGN like the black hole mass and luminosity. Thus, in order to understand the variability properties of AGN, one has to observe a sufficiently large and representative population of sources that it covers a significant part of the parameter space.

Target selection: A flux limited sample was selected from the "Million Quasars Catalog, Version 3.7" Flesch et al. (2013, PASA 30). Inside the 12 degree cone of the K2 mission field, there are 4942 quasar candidates. By selecting only sources with a known R band magnitude brighter than 19 that have a probability of being a quasar greater than 75 % we arrive at 547 candidates. We propose to observe the 200 brightest Quasars that fall on silicon. As we are statistically probing at least 3 parameters (mass, accretion rate, redshift), we request hundreds of sources. If sources are cut, priority is given to brightness. If more targets are observed, this proposal would gain as the significance would increase.