AGN Variability Studies with K2 Field 0

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Abstract: We propose a list of 47 confirmed Seyfert 1s, blazars and AGN candidates to be observed in Kepler K2 Field 0. This will augment our previous observations, probing AGN variability on shorter timescales than any other telescope can access and enhancing our picture of the physical conditions close to the supermassive black hole.

Kepler produces unparalleled optical active galactic nuclei (AGN) light curves, with fast (30 min) sampling, high (>90%) duty cycle, and excellent precision (~0.1% for a ~16th magnitude source). The Kepler initial mission phase established that AGN fluctuation power spectral density functions (PSDs) have steep power-law slopes $\alpha \sim -3$, much steeper than seen in the X-rays or predicted by theory (Mushotzky et al. 2011, ApJ, 743, L12; Edelson et al. 2014, in prep.); possible evidence of a turnover at long timescales (e.g., Carini & Ryle 2012, ApJ, 749, 70); the clearest measure to date of optical variations lagging behind the X-rays (Horne et al. 2014, in prep.); and a single extraordinary light curve of the only BL Lac object observed with Kepler, W2R1926+42, a dataset much too rich to fully describe with current tools such as the PSD (Edelson et al. 2013, ApJ, 751, 52; Figure 1).

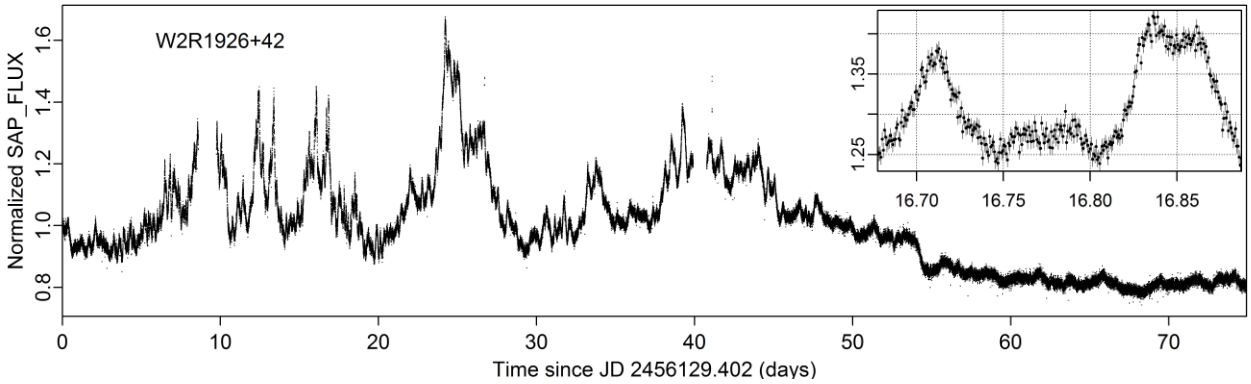

Figure 1: Q14 SC light curve of W2R1926+42, the only rapidly-variable BL Lac so far observed by Kepler. This has >125,000 points and the inset shows how clearly Kepler can resolve flares separated by just a few hours. Because of K2's superior sky coverage, a well-planned campaign should observe a number of such sources.

The K2 mission offers a unique opportunity to increase the sample of AGN with Kepler light curves well beyond the ~3 dozen AGN identified and observed by our group. K2 will have ~8 or more pointings, albeit for only ~80 day durations. In some respects this is even better for AGN as the increased and more favorable sky coverage will yield a much larger sample. Our proven identification techniques could allow K2 to observe hundreds of AGN. This will improve our statistical leverage in studying the short-term variability properties, which should be dominated by conditions near the black hole. We also hope to identify more of the much rarer highly-variable BL Lac objects. We will propose for subsequent K2 fields, which will generally have the advantage for extragalactic studies of being away from the plane.

For Field 0, we used three sources to derive a list of 47 AGN and AGN candidates within 12^o of $06^h47^m00^s$ $+21^o22'47"$: 1) 21 known, confirmed AGN from the "VCV" catalog (Véron-Cetty & Véron, 2010, A&A, 518, 10); 2) 25 Seyfert 1 candidates from the WISE/2MASS/Rosat "W2R" sample of Edelson & Malkan (2012, ApJ, 751, 52). This method yielded the vast bulk of AGN observed in Kepler phase 1, but we expect a somewhat lower success rate because K2 Field 0 is closer to the galactic plane and more susceptible to stellar contamination; 3) Five sources known to vary in WISE from the BZCAT catalog of blazars and blazar candidates (Massaro et al. 2013, ApJS, 206, 12). (Four sources are common to both VCV and W2R catalogs.) B, V, J magnitudes were converted to R using standard AGN colors and only sources with R < 18.3 were included to assure adequate S/N. Because the final K2 Field 0 is ~110 sq. deg., roughly ~1/4 the size of the search cone, only ~12 of these sources will ultimately be observable. We will obtain ground-based spectra of all sources on this list observed with Kepler.