AGN Variability Studies with K2 Field 1

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Abstract: We propose a list of 159 confirmed Seyfert 1s/quasars and 24 blazars/blazar candidates to be observed in K2 Field 1. This will quintuple the sample of AGN observed with Kepler, vastly improving our statistical leverage for charactering AGN variability.

Kepler's initial unparalleled optical active galactic nuclei (AGN) light curves established that AGN 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 yielded extraordinary data on a single BL Lac object (Edelson et al. 2013, ApJ, 751, 52; Figure 1).

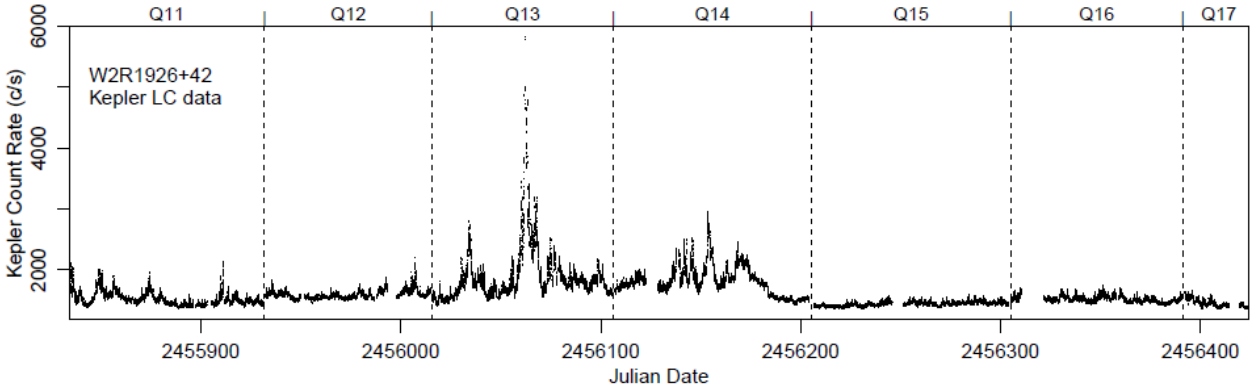

Figure 1: The only rapidly variable blazar so far observed by Kepler, W2R1926+42, exhibits "microvariability" consisting of significant variations on timescales as short as a single cadence interspersed with quiescent periods lasting weeks or longer. Previous nightly blazar light curve snippets have only hinted at this picture, now apparent thanks to Kepler's extraordinary duration and duty cycle. This dataset, which shows a strong rms/flux correlation (larger variations when brighter) and a highly non-Gaussian, lognormal flux distribution, is so rich that it cannot be fully described by standard time-series analysis tools such as the PSD (Edelson et al. 2013).

Because K2 Field 1 is the first Kepler observation well outside the Galactic plane, we can use deep, large-sky extragalactic surveys such as SDSS to find AGN. The Veron-Cetty & Veron (2010, A&A, 518, 10) catalog yielded 159 spectroscopically confirmed broad-line AGN (149 Seyfert 1s/quasars and 10 "unclassified AGN") with $K_p < 18$ in Field 1. This sample is much larger and more comprehensive than the ~30 AGN identified and observed by our group in the original Kepler field and K2 Field 0. These observations will more than ***quintuple*** the number of confirmed AGN with Kepler light curves. This larger, deeper sample with shorter light curves is an ideal complement to Kepler's previous long duration AGN light curves. In particular, nearly 25% of the sample has $z > 1$ so these data will extend the high luminosity AGN luminosity/variability amplitude correlation (e.g., McLeod et al. 2010, ApJ, 721, 1014) to much shorter timescales than previously accessible. These higher luminosities also mean that the fractional starlight contribution will be smaller than in the original Kepler AGN, enabling us to measure smaller intrinsic variability amplitudes at the same S/N. We have ~50 nights of simultaneous Kepler and LCOGT time for *ugriz* monitoring of suitable targets (e.g. UM 425 and Q 1146-0128), which will allow us to probe the accretion disk T(r) profiles and measure the product of black hole parameters $M_* \dot{M}$.

We have also used BZCAT (Massaro et al. A&A, 209, 681) to identify 24 blazars and blazar candidates in K2 Field 1. At least five are known to vary in WISE. These are given highest priority even though they are generally slightly fainter than the Seyfert 1s/quasars (most have $K_p < 18.5$, but seven have $K_p > 19$), because Kepler light curves even a few more blazars would greatly extend our understanding blazar optical microvariability. Next, the Sy1s/quasars are prioritized by K_p, followed by unclassified AGN. Because Field 1 is by far the most favorable extragalactic field observed by Kepler, approving this full request is crucial for enhancing Kepler's already prodigious legacy for AGN variability studies.