K2 Director's Discretionary Time proposal for Field 9 (due 10 December 2015)

Kepler's Only Novae in Eruption: V5666 Sgr & V5667 Sgr

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We are proposing to have *Kepler* look with high cadence at two recent novae in Field 9, with these likely to be the only novae in eruption that *Kepler* will ever see,

Nova Sgr 2015 No. 1 (V5667 Sgr) was discovered on February 12 of this year, reaching a peak at V=9.0 in late February. We have been following this nova with BVRIJHK measures on 143 nights (see SMARTS website under Walter et al. 2012 and see the figure below). Our light curve shows week-long large-amplitude jitters starting around the time of peak, and hence it is a 'J' class nova (Strope, Schaefer, & Henden 2010). The time to decline by 3.0 magnitudes from peak (t_3) is 137 days, pointing to a slow nova. We have also been taking optical spectra, with the nova showing P Cyg lines of Fe II and Hα, with absorption peaking at -100 km/s and extending out to -500 km/s, hence V5667 Sgr is an ordinary slow nova of the FeII spectral class. The J class, long t_3, low-excitation iron spectrum, and low expansion velocities are all pointing to a low-mass white dwarf that will have a long and slow decline.

We are proposing to include V5667 Sgr as a target in *K2* Field 9. During the time of observation (April to July 2016), we expect the nova to be around V=14.0. (This is based on J class novae with t_3~137 days fading from its current V=13.4 at the observed rate of around 0.003 mag/day, as shown in the catalog paper Strope, Schaefer, & Henden 2010.) At this brightness level, a single 1-minute *K2* integration will give ~0.003 mag accuracy. V5667 Sgr has a quiescent magnitude of V>21 (as it does not appear on any of the Palomar plates), so during the *K2* Field 9 observations, the nova will be >7 mags above quiescent level. That is, *K2* will catch this nova while it is still bright in eruption.

Nova Sgr 2014 (V5666 Sgr) was discovered on 15 April 2014, peaking at V=9.8. Our SMARTS BVRIJHK light curve (119 nights over two observing seasons - see below) shows many bright week-long jitters that faded by three magnitudes in 135 days after peak, for a classification of J135 (Strope, Schaefer, & Henden 2010). V5666 Sgr is an Fe II nova, with no high excitation lines, so, along with the 'J' classification, we expect a relatively low-mass white dwarf and a very slow decline. We observe that V5666 Sgr has reently had a V-band decline at 0.005 mag/day and a recent magnitude of V=14.84. With this, the nova will be 16.2 to 16.7 mag. At the middle of this brightness level, a single 1-minute *K2* integration will give ~0.010 mag accuracy. V5666 Sgr will be ~6.8 mag below peak and >5 mag above quiescence, so it will be seen by Kepler in eruption.

The *Kepler* spacecraft has never seen any nova in eruption. After these two recent novae in Field 9, the statistics point to *Kepler* never having any opportunity to ever see any other nova in eruption. On the basis that V5666 Sgr and V5667 Sgr will be *Kepler's* only novae in eruption, so we think that these targets are unique and important enough to be accepted as a DDT target. We are proposing for short cadence observations, because novae show several types of variations on time scales much faster than 30 minutes;

including white dwarf rotations (like for DQ Her stars), eclipses, the startling flares in the middle of the eruption light curve (as discovered for U Sco), and flickering.

Historically, many nova have had nightly photometry to keep track of the overall shape of the light curve (e.g., Walter et al. 2012). But up until the 2010 eruption of U Sco, *zero* novae *in eruption* had ever had any sort of fast time series photometry. (See Strope, Schaefer, & Henden 2010 for an exhaustive compilation of all magnitudes from the 93 best observed novae.) This changed for the predicted eruption of U Sco, where prior arrangements plus an enormous response from AAVSO observers produced 36,776 magnitudes throughout its entire 67 days of eruption, with nearly gap-free coverage averaging one observation every 2.6 minutes (Schaefer et al. 2011). In addition, we obtained X-ray, UV, U, B, V, y, R, I, J, H, and K coverage throughout the entire eclipse with at least daily coverage (Pagnotta et al. 2015). This new way of looking at novae led to the discovery of *three new phenomena, unexpected and previously unrealized*: **First**, late in the tail, U Sco showed irregular fast-changing dips, now thought to be from plumes rising above the reforming disk, analogous to X-ray Dippers. **Second**, around the time of the transition region, startling hour-long flares of half a magnitude amplitude brightened the nova light, with theorists still being completely baffled by these. **Third**, a *second* plateau in the light curve was discovered, with such having never before been seen, and there is still no theory explanation.

The history shows only one nova in eruption having long-and-fast time series, and this produced the discovery of three completely new phenomena. Now *Kepler* has a chance to get a long-and-fast time series of *two* nova in eruption, with greatly better photometric accuracy and cadence. With greatly better data and with V5666 Sgr and V5667 Sgr being as dissimilar from U Sco as novae can get, it is reasonable to expect discoveries of completely new phenomena.

Pagnotta, A., Schaefer, B. E., Clem, J. et al. 2015, ApJ, 811, 32.
Schaefer, B. E., Pagnotta, A., LaCluyze, A. et al. 2011, ApJ, 742, 113.
Strope, R., Schaefer, B. E., & Henden, A. A. 2010, AJ, 140, 34.
Walter, F. M., Battisit, A., Towers, S. et al. 2012, PASP, 920, 1057; with full data and frequent updates at http://www.astro.sunysb.edu/fwalter/SMARTS/NovaAtlas/