**Science Justification: Measuring the Binary Fraction of Planetary Nebula Central Stars**

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All common stars like the Sun are thought to evolve through the main-sequence, red-giant, and asymptotic giant branch phases, eventually becoming white dwarfs. Between the AGB and the WD phases, they go through a short (~50,000 yr) planetary nebula (PN) phase. This is the "textbook" picture of stellar evolution. Over the last decade, evidence has accumulated to suggest that the PN phase is not common and special circumstances (e.g., binary interactions) may be required. De Marco (2009) summarized the arguments why PNe may preferentially form from binaries.

We monitored all 6 PN central stars in Kepler's field in cycle 3. One in 5-6 PN are expected to be close binaries with photometric variability amplitude >0.1 mag (Miszalski et al. 2009). None of our sample is a known binary from the ground. With improved photometric precision, we detected low amplitude periodic variability in 4 PN central stars, providing new insight to the binary fraction in the <0.05 mag amplitude regime.

Of the six observed objects, two are clearly binary; one of these must be close to pole on. Both have highly periodic, well-behaved light curves with very low amplitudes that are undetectable from the ground, demonstrating that such objects are waiting to be discovered. Two objects are non-variable (both in round PN), and two others are odd, having some characteristics of a nearby companion; one has a quasi-periodic behavior reminiscent of a dwarf nova, and the other exhibits high-Q periodicities of 0.619d, 1.238d, both, or neither at various times.

The existing sample is too small to constrain the statistics of the low amplitude binary population. Thus, we request that Kepler includes the targets listed for the K2 "Campaign 0" mission, which likely will double the number of targets. The first 5 are all within range of the bore sight position, and the remaining 8 extend to radii of 12 deg. We plan to request additional targets in subsequent campaigns with the goal of observing 20-25 PNe (Field 2 is especially well placed) to allow the sample statistics to approach other binary PN surveys (Miszalski et al 2009; De Marco et al 2013).

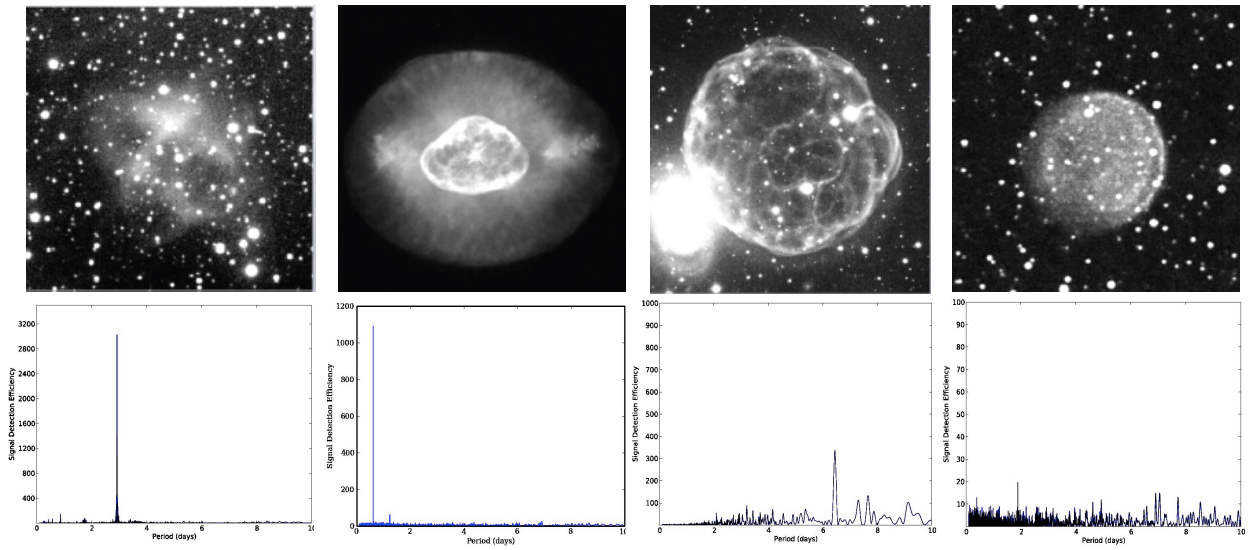


Figure: Examples of the PNe studied and their periodograms. From left to right, J19411+4324 @ 2.928$^{d}$ (image from Aller+), NGC 6826 @ 0.619$^{d}$, 1.238$^{d}$ (image from Balick), KN 61 @ ~6.4$^{d}$ (image from Rector), and Abell 61, a round non-variable (image from Shuder).

**References**:

Aller, A. et al, 2011, in Planetary Nebulae: An Eye to the Future, IAU Symp. 283.
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