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

G. Jacoby (GMTO), M. Kronberger (DSH), D. Patchick (DSH), O. De Marco (Macquarie Univ), J. Long (Pomona College), T. Hillwig (Valparaiso), S. Howell (NASA Ames)

This is a continuing program from campaign 0 where 3 "on silicon" targets were submitted. We wish to significantly improve the statistics of a naturally limited sample of 6 objects in the original Kepler mission. For campaign 2, we request 5 additional targets.

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 is expected to be a close binary with a variability amplitude >0.1 mag (Miszalski et al. 2009). None of our sample is a known binary from the ground. With Kepler's, we detected periodic variability in 4 PN central stars, providing 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 binaries. Thus, we request that Kepler includes our targets for the "Campaign 2" mission which, with Campaign 0 data, will bring the PN count from 6 to 14. Further targets may be requested later with the goal of 20-25 PNe, comparable to statistics of other binary PN surveys (Miszalski et al 2009; De Marco et al 2013).

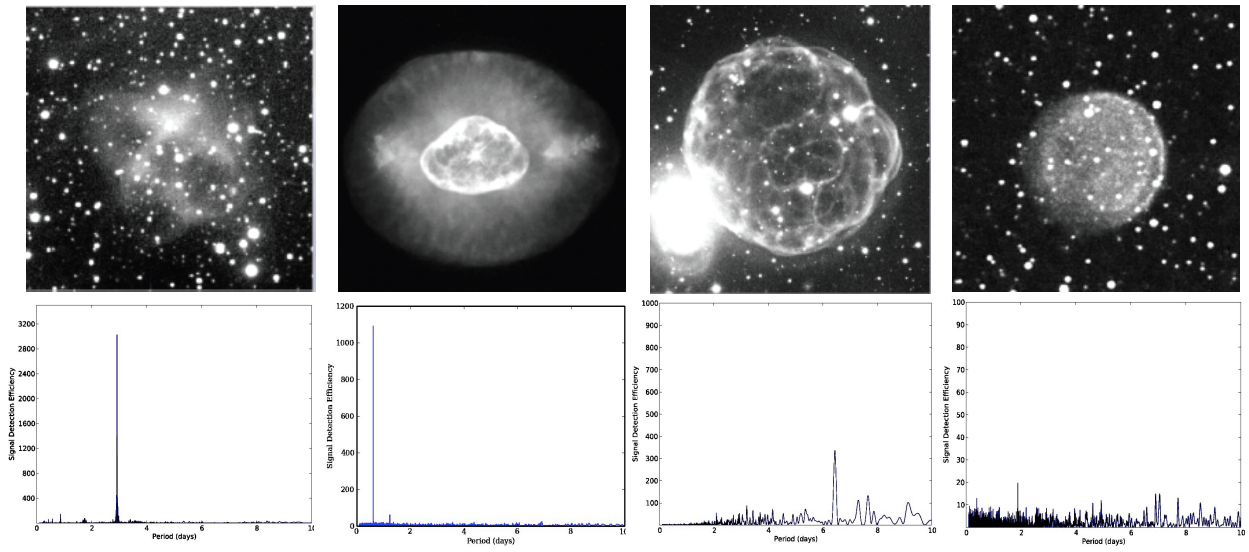

Figure: Examples of the PNe studied and their periodograms. From left to right, J19411+4324 @ 2.928^{d} (image from Aller+), NGC 6826 @ 0.619^{d}, 1.238^{d} (image from Balick), KN 61 @ ~6.4^{d} (image from Rector), and Abell 61, a round non-variable (image from Shuder).

References:

Aller, A. et al, 2011, in Planetary Nebulae: An Eye to the Future, IAU Symp. 283.
De Marco, O., 2009. PASP, 121, 316
De Marco, O. et al., 2013, MNRAS 428, 2118
Miszalski, B. et al., 2009, A&A 496, 813