The Close-Binary Fraction of Planetary Nebulae.

Zachary I. Edwards - Department of Physics & Astronomy, Louisiana State University
Email - Zedwar4@Tigers.lsu.edu

The common text book states that any single star, similar to our Sun, will eventually result in a Planetary Nebula (PN). Recently, however, theory suggests that PNe can only occur from close binary systems, indicating that a single star might not create a PN. Thus leaving the mass loss mechanism and fate of single stars, much like our Sun, unknown. To test the theory and differentiate between these two ideas one must measure the binary fraction of central stars in PNe. To date, there is an estimated binary fraction of $\sim$20% (Miszalski et al. 2009), however this might be due to the inefficiency of ground based periodicity searches. Kepler has proven to be much more efficient in detecting eclipses and ellipsoidal effects at millimag accuracy, thus allowing detection of binary systems with periods <10 days. As such, I propose to use Kepler to search two PNe in Field 0 for binarity.

There were at least six PNe located in the original Kepler field (Douchin et al. 2011). Kepler studies of these PNe found periodic variations in their light curves that indicate binarity. The periods of the central stars where determined to range between 0.17-1.47 days with orbital modulations at the 0.2-10 millimag level. Of these six PNe, the faintest star was at V=18.2 mag in the center of Kn 61. The recent situation of the Kepler mission now allows for multiple known PNe, along the ecliptic, to be observed throughout the course of the K2 operations. The K2 mission offers 9 fields, each potentially containing several PNe which can be studied with similar methods as Douchin et al. (2011). The increased sample size of PNe will allow for tighter constraints to be placed on the actual binary fraction of central stars in PNe.

There are three PNe in Field 0, of which two have central stars with reported brightness from Acker et al. (1992): 1) G194.2+02.5 (also cataloged as 'J 900') has an angular size of 0.32' by 0.25' with a central star at V=17.80 mag, 2) G189.8+07.7 (also cataloged as 'M 1-7') has an angular size of 0.42' by 0.39' with a central star at V= 19.64 mag. The central star of J 900 is brighter in comparison to Kn 61, suggesting that Kepler will have no difficulty measuring any periodicity of the faint central star. M 1-7 is fainter by a factor of $\sim$ 4 and will have 2 times worse single-to-noise ratio, however Kelper will still provide accuracy at the millimag level. I propose that the central stars of both M 1-7 & J 900 be observed with long cadence, 30-minute exposures, by the K2 mission. The J2000 coordinates, provided in the attached target list, displays the R.A. & Dec of the central star associated with the above mentioned PNe as reported by Kerber et al. (2009). This will be the first time a detailed photometric study of these two stars will be conducted and will allow possible periodic variations to be detected. The observations of these 2 PNe will add to the sample size and statistics of the previous 6 PNe in the original Kepler field, as well as add to the understanding of PN formation from a binary system.

References:

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