A Comparison of the Characteristics of the Central Stars of M57 and NGC 6826.

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Introduction: In scientific and popular literature there has been a question of whether the central stars of planetary nebulae are variable. Due to the difficulties of observing these objects from ground based telescopes the answer to this question is only now being investigated. Without a space based instrument like Kepler obtaining high precision photometry, determining variability required a precision photometer or specialized CCD techniques and software. Even with these limitations in mind progress was made.

Grauer and Bond 1984[1] used a high speed photometer to discover low amplitude pulsations in PN of Kohoutek I-16. This study led to further discovery of 16 PN and 5 pulsating PN with binary central stars Bond[2,3]. Handler[4] points out 3 kinds of variability in central stars. Variability seems to be common in the stars studied but these studies are limited to a very small percentage of known PN due to the difficulty of observation.

M57and NGC 6826: In the fall of 2009 a short imaging run of 56 images was taken of PN M57with the 11" AAVSONET [5]telescope at Astrokolholz observatory in Cloudcroft, NM. Each image was a 90 second exposure using an I filter. The period is ≈.19 of a day, with a magnitude change of .6 magnitude. There are hints in the light curve of a possible close contact binary of a very short period, with lots of brightening and dimming that confuse the interpretation. However, the data run was of too short a duration and the telescope aperture was too small to feel confident in the results on its own merits. In fact this data would not be interesting at all if it wasn't for it's similarity to the Kepler data.

Now with the Kepler data (4 runs at this time) there is enough information on NGC 6826 to compare it with the ground based M57 data. NGC 6826 has a period of .619 of a day and a magnitude change of 10 mmag[6]. These figures are much more precise than what can be obtained by an 11" ground based telescope making direct comparison difficult. The time scale of the Kepler data stretches over days while the M57 data is only over 1.5 hours. However, there is still a similar pattern to the two light curves, a close approximation to the lightcurve of a contact binary interspersed with chaotic light spikes of an unknown nature. Douchin et al [6] confirms the binary properties of NGC6826 in a recent paper. This opens the possibility that M57 is also a binary system with a much faster period and greater magnitude fluctuation. Without more ground and space observations the astrophysics of these objects can only be speculated.

Conclusion: The question of variability has been definitively answered! There is obvious variability in some planetary nebulae. The next question is how widespread is this variability, as well as what is causing the variability. The current model of star formation and death may be challenged if it is found that a binary configuration is needed to cause the winds that define a planetary, Bond[7].

With the 5 PN in the Kepler FOV it may be possible to start answering this second set of questions over the next several years. The mmag precision and long periods of time that data is gathered should provide a great deal of information to process and from the subsequent light curves, better astrophysical information can be gleaned.

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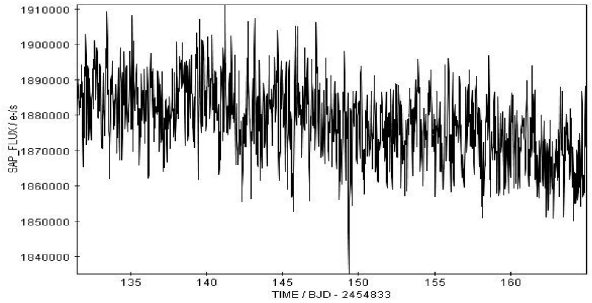
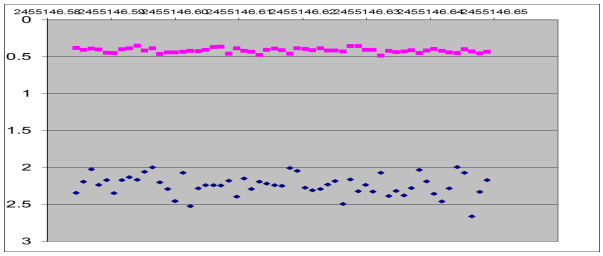
[1] Grauer and Bond 1984, APJ 277:211-215
[2] Bond and Meakes 1990 AJ, v100 # 3
[3] Bond and Ciardullo 1990 ASPC 11:529B
[4] Handler 1997 IAUS 180:109H
[5] AAVSO Wright 28
[6] Douchin and Jacoby 2011 Proceedings IAU Symposium #283
[7] Bond 2000 ASPC 199:115B

Further ground based observations are needed to complete a picture of the physics of these most interesting stars. Careful ground based photometry of a much larger sampling of PN are needed. Long time series taken over many nights of different PN's coupled with the precision of the Kepler data would at least begin to give a more complete model of the physics of the central stars of PN.



NGC 6826 Kepler Data from the first Kepler run



M 57 from the Wright 28 telescope with an I filter
Bottom graph is the variable and the top is the check stars.

References: