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PHOTOMETRIC VARIATIONS OF THE CENTRAL STAR OF M 1-77 AND SUSPECTED VARIABILITY OF THE CENTRAL STAR OF VV 3-5

In recent years, more and more "cool" central stars of planetary nebulae were discovered to show irregular or, at best, semi-regular photometric variations. Currently, 10 such objects were reported in the literature, namely the central stars of NGC 40, NGC 6543, NGC 6826, IC 418, IC 2149, IC 3568, IC 4593, Hu 2-1, He 2-131 and He 2-138 (Bond & Ciardullo, 1991, Hutton & Méndez, 1993). Most of these objects do not appear to be binaries, and their variability is attributed to either wind variations or pulsations by the different authors.

In order to examine the reason for the variability of these stars, we have started a photometric search for related objects enabling us to learn more about possible group properties. Here we report the discovery of light variations in the central star of M 1-77 and suspected variability of the central star of VV 3-5.

Our observations were carried out in August 1995, with the Texas two-channel photometer attached to the 0.9 m telescope at McDonald Observatory, employing only channel 1 to acquire differential photometry. All our target stars have small nebulae, allowing us to include the whole nebula in the aperture. This prevents variable influence of the nebular background.

We chose two comparison stars (C1 and C2) for each object, measuring them together with the planetary nebula (PN) in the order: C1–PN–C2–C1–PN–C2–... The comparison stars, typically of 9–10 mag, were integrated for about 60 seconds, the planetary nebula about 120–180 seconds, depending on its magnitude. A Johnson V filter was mainly used, in order to minimize the nebular contribution to the data without losing too many photons from the central star.

All data were corrected for sky background and for extinction. No dead-time correction was applied, since the count rates were lower than 15 000 counts per second. The relative zeropoints of the measurements of the different stars were calculated for the first night and subtracted from the data except for a small offset for plotting purposes. These relative zeropoints were applied for all other nights of observation. The resulting light curves were analysed for variability.

Let us first describe our findings for M 1-77 in detail; its light curve can be found in Figure 1. M 1-77 appeared to be variable already in the first night we observed it. However, since the light modulation was very well correlated with air mass, we first suspected that we could be confronted with an artifact caused by strong nebular emission, i.e. we could be measuring the central star at an effective wavelength different from that of the comparison stars.

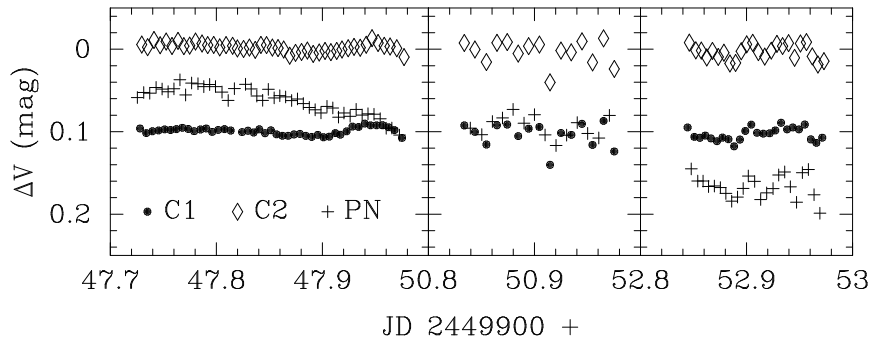

Figure 1: Differential time-series photometry of M 1-77 (PN), SAO 50704 (C1) and SAO 50708 (C2). M 1-77 is clearly variable.

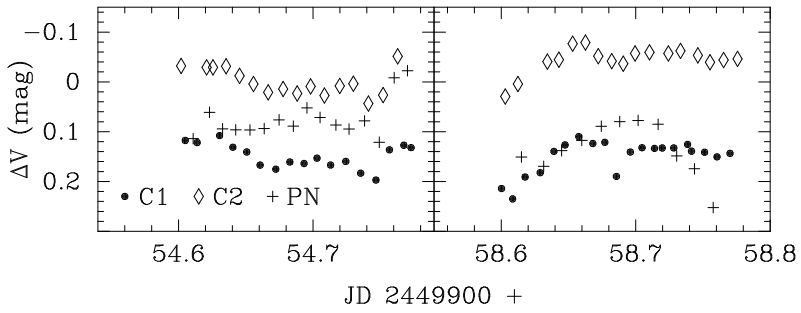

Figure 2: Differential time-series photometry of VV 3-5 (PN), SAO 161649 (C1) and SAO 187052 (C2). We suspect that VV 3-5 is variable.

Therefore, we re-observed the star with both the V and the y filter three nights later. The y filter is almost a continuum filter for planetary nebulae, and since M 1-77 is bright, we did not have to increase the integration time too much. In this night, the star did not appear to be variable (middle panel of Figure 1) on time scales of hours. However, it was constant in *both* filters, convincing us that the variations in the first night were intrinsic. Note that the mean magnitude of the star has changed from the first night to the second night. We again observed the star two nights later, finding that it was even dimmer than on the second night. Thus, we consider its variability to be well established. Moreover, M 1-77 behaves very similarly to the best investigated "cool" variable central star, HD 35914, the central star of IC 418 (Méndez et al., 1986).

Our observations of VV 3-5 are somewhat harder to interpret. First, we note that the star has a companion about 1.5 magnitudes brighter in approximately 20 arcseconds distance. This companion was always carefully excluded from the aperture. Since telescope tracking was excellent, VV 3-5 or the companion did not move towards the edge of the aperture during the integration. However, the photometric quality of the nights during which VV 3-5 was observed was not as good as those we spent on M 1-77. Our light curves are displayed in Figure 2.

In both nights, the light curves of VV 3-5 did not follow those of the comparison stars closely. Moreover, the zeropoints were also not the same in the different nights. On the other hand, the magnitude difference of the comparison stars also changed slightly. This can be attributed to bad photometric quality or to intrinsic variability of at least one of the comparison stars. The latter would be somewhat surprising, since both comparison stars have spectral types of B8.

Consequently, we can only suspect that VV 3-5 is intrinsically variable. We strongly suggest further observations of this star, preferably with CCDs because of the companion mentioned above.

The first part of our survey for photometric variations among "cool" central stars of planetary nebulae increased the number of variables to 11, maybe 12. The relatively large number of variables suggests that light modulation might be a rather common phenomenon for these stars. Therefore, the discovery of further related objects is rather of statistical interest, but should not be considered as a great surprise.

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