A new population of planetary nebulae candidates towards the Galactic bulge

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Introduction

A significant new population of Galactic bulge planetary nebulae (PNe) candidates (> 300) was discovered from careful review of bulge imaging taken with the Mosaic II CCD imager on the CTIO's 4 m Blanco telescope. Bona fide PNe amongst this new population will refine the known Galactic PNe population and provide a more statistically complete bulge [O III] planetary nebula luminosity function (PNLF).

Bulge [O III] Survey

Methodical review of the bulge survey FITS files of Kovacevic (2011) revealed a new PNe candidate population. Each FITS file contains data from a single pointing, a (8192×8192) pixel mosaicked image. Covering a $36' \times 36'$ field of view at the Blanco's prime focus, this corresponds to a Mosaic II image resolution of $\approx 2.7 \times 10^{-1}\,''\,\mathrm{pixel}^{-1}$. Kovacevic (2011) observed each field through a narrow-band [O III] emission line filter and off-band filter. In total, 125 survey fields were available for review, comprised of 119 unique pointings, all located in a $10^\circ \times 10^\circ$ region around the Galactic centre.

Candidate Discovery

Through the use of metaprogrammed DS9 scripting, the bulge survey FITS dataset was automatically RGB stacked ([O III] on-band R, off-band G), segmented and interleaved with corresponding difference images produced by Kovacevic (2011). The image segments were then reviewed for new PNe. In general, the RGB images were best for identifying bright, compact PNe, which would stand out in red against a background of yellow stars. The difference images, generated by subtracting off-band from on-band data, to isolate PNe from stellar and background continuum flux, were best for fainter PNe. Being bulge fields of typically high source density, visual evaluation of each field was non-trivial. However, interleaving segmented images of subscreen size allowed complementary image blinking and efficient PNe candidate identification (Stenborg, this meeting).

Once PNe candidates were identified in a survey field, they were cross-checked for discovery status in SIMBAD. Confirmatory spectroscopy and data reduction is under way. Candidates with a correlated, if previously unnoticed, SuperCOSMOS Hα survey (Parker et al., 2005) emission are prioritised as probable PNe.

New Nebulae Candidates

The new population contains many candidates likely undiscovered due to extreme faintness, even in difference images, or small apparent radius leaving them morphologically indistinguishable from stellar sources. Mosaic II images indicative of the population are given in Fig. 1. An example semi-reduced candidate spectra showing characteristic PNe emission is given in Fig. 2.

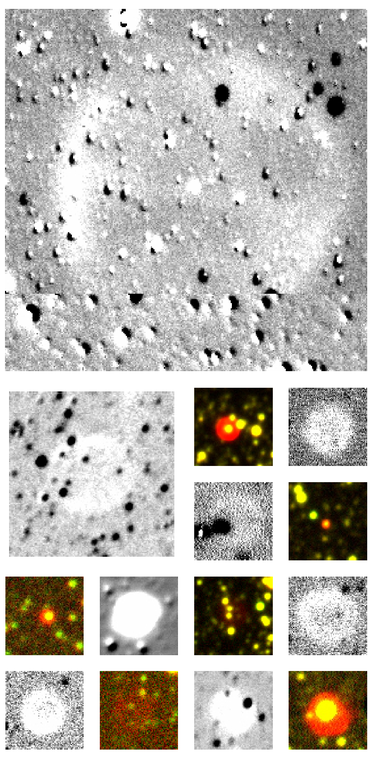

Figure 1: RGB stacked and difference images of typical bulge PNe candidates.

Figure 2: Semi-reduced 3.9 m AAT AAOmega spectra showing suspected [O III] $\lambda\lambda 4959, 5007$ (left), Hα $\lambda 6563$, [N II] $\lambda 6584$ (right) emission.

A significant proportion of candidate PNe apparent sizes were on or below the average seeing limit of the survey. This is reflected in the skewed population properties presented (Figure. 3) towards low normalised apparent sizes. Such sources could simply be noise or other image artifacts. It was deemed prudent to record possible, even unlikely, PNe candidates that are dismissed during confirmatory spectroscopy, rather than ignore such sources and later have some confirmed by another party. It is estimated up to a third of the candidates will eventually be dismissed, leaving a total new bulge PNe population ∼200, c.f. the current bulge PNe population ∼500 (Boumis et al., 2006).

Population Properties

The new bulge PNe population is characterised here by a normalised apparent size (axial sum) probability histogram, Figure. 3, and morphological distribution chart, Figure. 4. The largest apparent size candidates are likely not bulge sources, but new PNe in the direction of the bulge.

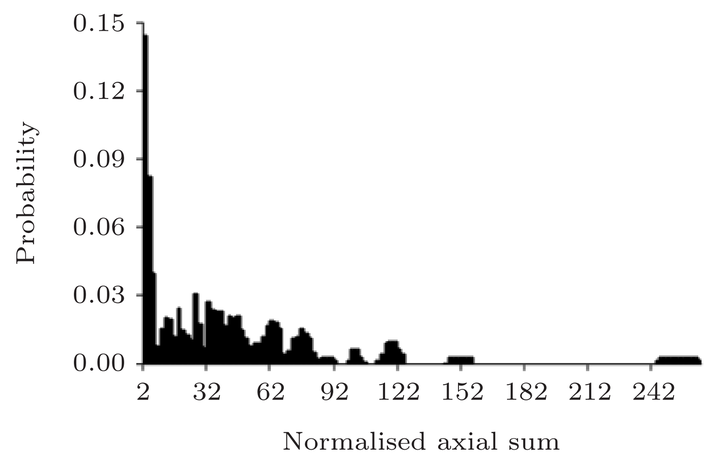

Figure 3: Normalised apparent size probability histogram for the candidate bulge PNe.

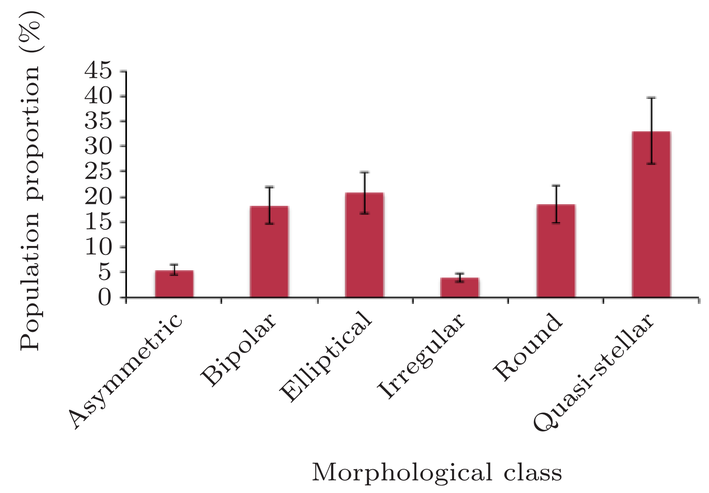

Figure 4: Morphological distribution of the candidate bulge PNe.

Extrapolating from population spectroscopy taken so far and assigned candidate confidence levels assumed, it seems likely this new population of PNe candidates will increase the Galactic bulge PNe population by some ∼20–40%. Where associated flux measurements can be added to the flux data of Kovacevic (2011), a significantly more statistically complete bulge [O III] PNLF may be constructed, probing especially the moderate to faint magnitude region. This in turn will test current models of PNLF structure, such as the Henize & Westerlund (1963) exponential fit to the PNLF faint end.

References

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