MASH-II and an OGLE-II Search for Binarity

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Summary. We report on the first supplement to the Macquarie/AAO/Strasbourg Hα planetary nebula catalogue (MASH) which we denote MASH-II. MASH-II contains $\sim$240 new, spectroscopically confirmed planetary nebulae (PNe) uncovered with semi-automated discovery techniques applied to the entire AAO/UKST SuperCOSMOS Hα Survey (SHS). A preliminary investigation of MASH PNe diameters and morphologies suggests an asymmetric fraction of at least $\sim$40 per cent. A small case study was performed using OGLE-II photometry to find binary central stars of Galactic Bulge PNe. OGLE-II seems to be more suitable towards finding longer-period variables such as those in symbiotic systems, and although a few PNe may exhibit variations, interpretation is complicated by systematic errors common to large photometric surveys.

Key words: Planetary nebulae, binary central stars, OGLE-II

1 MASH-II

The recent publication of the Macquarie/AAO/Strasbourg Hα catalogue (MASH;[12]) has improved Galactic PNe numbers significantly by $\sim$900, but there is still a discrepancy between the estimated total population (8,000–140,000) and the known population ($\sim$2500) [3]. Although extinction plays the largest role in this discrepancy, survey techniques also play a major role. Most MASH PNe were discovered via visual examination of the AAO/UKST SuperCOSMOS Hα Survey (SHS;[11]) of the Southern Galactic Plane under a microscope. Some analysis of the digital data was also made however these searches had some limitations. To address the low fraction of stellar-like and very low surface-brightness PNe in MASH we embarked on a re-evaluation of the SHS digital data.

1.1 Discovery Techniques

The first supplement to MASH, which we denote MASH-II, contains $\sim$240 new, spectroscopically confirmed PNe. MASH-II discovery techniques applied

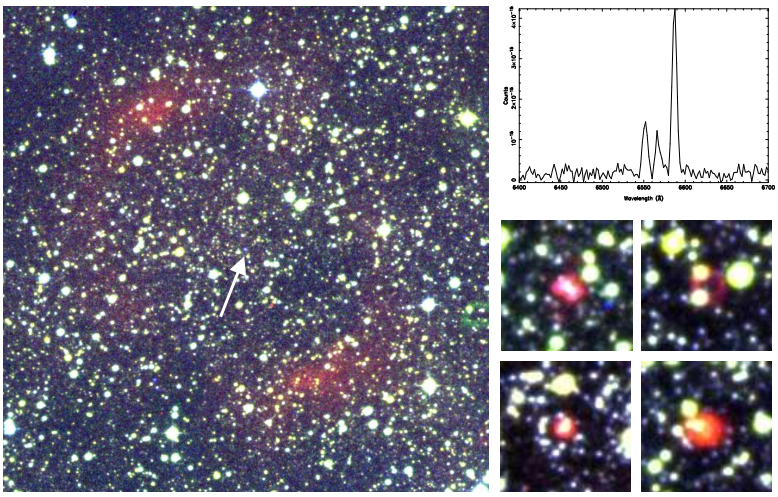

Fig. 1. A sample of PNe from MASH-II. At left is the 7.8 arcmin diameter PN G015.5+02.8 with its blue central star indicated and spectrum at top right showing high [NII]/Hα. At bottom right are some smaller MASH-II PNe.

to all 233 SHS fields consisted of two stages: (i) The Image Analysis Mode (IAM) photometry generated by the SHS pipeline [5] was used to target stellar-like or compact PNe, and (ii) Quotient images of the blocked-down survey fields were used to target low surface-brightness PNe. Whilst the majority of MASH-II PNe are compact, $\sim$10 per cent exhibit blue cental star (CS) candidates and have arcminute size low surface-brightness nebulae. Some of the brighter central stars will be the focus of future work looking for binarity.

A key feature of MASH-II is the incorporation of the UKST SuperCOSMOS B_J image. The depth of the B_J image reveals faint blue CS candidates up to $\sim$20 mag and also acts as a weak [OIII]/Hβ filter. We create false-colour composite images with RGB channels taken from Hα, SR and B_J images respectively. Such images can help find PNe otherwise missed in other surveys, for example, otherwise inconspicuous regions of Hα emission may show a blue CS candidate and the pink/purple (strong [OIII]) or red/orange (weak or absent [OIII]) PNe colours can help in cases of unclean subtraction/division of the Hα image (Fig. 1).

Full details of MASH-II will be presented elsewhere [8].

1.2 Diameters and Morphologies of MASH PNe

A useful measurement to obtain an overview of the MASH sample is the diameter (Fig. 2). It is clear that MASH-II has considerably increased the fraction of small, mostly resolved PNe due to the IAM photometry. Concerning the large PNe (arcminute sized) the distribution of diameters seems to be

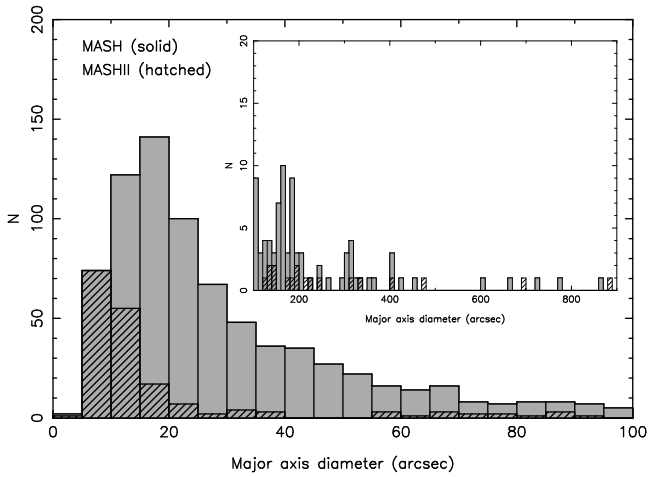

Fig. 2. Major-axis diameters of non-stellar MASH and MASH-II PNe.

mostly complete because MASH-II has uncovered large, very low surface-brightness PNe. However we remain somewhat insensitive to PNe that may be situated within large HII regions because of the rather coarse resolution of the blocked-down fields (11 arcsec/pix).

With the whole MASH sample we can look at the fraction of asymmetric PNe in a new light. The depth alone of the SHS provides insights into external structures and asymmetry despite its relatively modest resolution (for compact PNe). In Fig. 3 we present the fraction of MASH PNe with morphological classifications based on the 'ERBIAS' scheme (for details see [12]). The Figure shows a remarkably similar bipolar fraction (∼10 per cent) between the two samples and a more dominant 'Round' fraction in MASH-II. For a more useful measure of the fraction of asymmetric PNe we need to look at the subclasses 'a' (asymmetric) and 'm' (external structure). The percentage of PNe with 'a' and 'm' are ∼25 per cent (each) and 7 (MASH) and 16 (MASH-II) per cent respectively. Thus an approximation of the asymmetric fraction is ∼40 per cent. A more critical analysis will be presented in future MASH papers.

2 An OGLE-II Search for Binarity in the Galactic Bulge

The most probable origin of asymmetric structure is suspected to be a binary central star (CSPN). Only 23 binary CSPN are well established, with a high proportion of close binaries, but the proportion of binary CSPN is expected to be much higher [2]. Therefore, we conducted a small case study to find short periodic variations, presumably due to binarity, in large numbers of Galactic Bulge PNe.

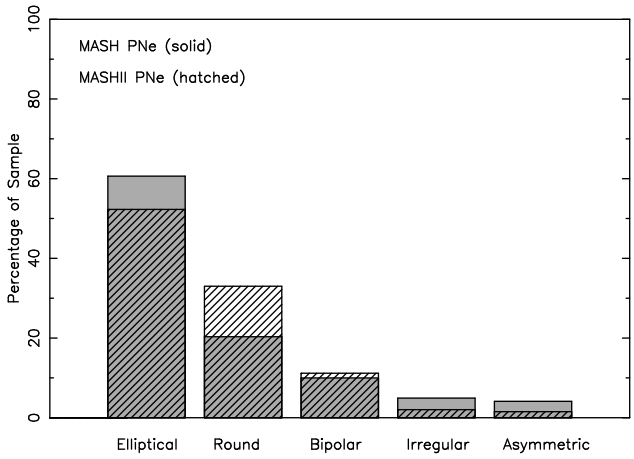

Fig. 3. Global morphologies of non-stellar MASH and MASH-II PNe.

2.1 Method

The OGLE-II project monitored 49 Bulge fields (Fig. 4) using a modified I-band filter every 1-3 nights during 1997–2000 with the 1.3 metre Warsaw telescope at Las Campanas Observatory, Chile [14]. We submitted all known, MASH and MASH-II PNe to the OGLE field finder[5] to obtain OGLE-II field names and (x, y) coordinates for ∼80 PNe within the survey. For each PN we inspected carefully I-band finder charts and photometry [15] for an exact I-band match leaving us ∼20 PNe with available photometry [13]. Periods were searched for using the PERIOD04 software [6].

2.2 Results and Conclusion

We found 4 objects classified as PN to show variations. One misclassified PN appears to be a symbiotic system that exhibits long-period variability. We note that JaSt2-6 appears to be a Mira variable [4, 7]. Unfortunately, the majority of our PNe seem to be non-variable or dominated by systematic errors. Even though we found 2 PNe classified as transients in the OGLE-II catalogue, they may be part of the 10 per cent of suspected artefacts [16]. Indeed, such large, multi-epoch photometric databases are susceptible to many different systematic errors which complicate the interpretation of the light curves. Such systematic errors include crowding effects [10], and various colour and atmospheric transmission effects (e.g. [15, 1]), the latter of which we have seen in our sample.

[5] http://ogledb.astrouw.edu.pl/∼ogle/photdb/phot_query.html

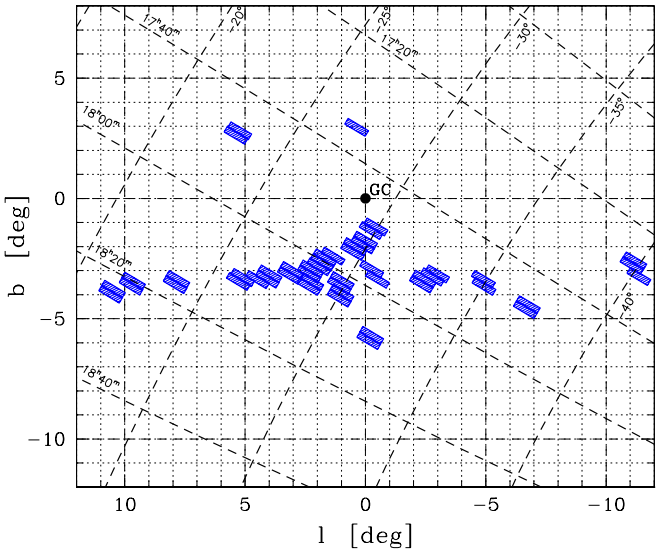

Fig. 4. Field coverage of OGLE-II [15].

Our case study suggests OGLE-II is more suited to finding long-period variations for symbiotic systems or perhaps late-type binary companions, however a larger sample is needed to reach a definitive conclusion. Further details will be presented elsewhere [9].

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