

# Discovery of new planetary nebulae in the Small Magellanic Cloud

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**Abstract.** We present six new planetary nebulae (PNe) discovered in the Small Magellanic Cloud (SMC) from deep UK Schmidt telescope (UKST) narrow band H $\alpha$  and broad-band short-red “SR” continuum images and confirmed spectroscopically. These 6 preliminary discoveries provide a 6% increase to the previously known SMC PN population of  $\sim 100$ . Once spectroscopic follow-up of all our newly identified candidates is complete, we expect to increase the total number of known SMC PNe by up to 50%. This will permit a significant improvement to determination of the SMC PN luminosity function (PNLF) and enable further insights into the chemical evolution and kinematics of the SMC PN population.

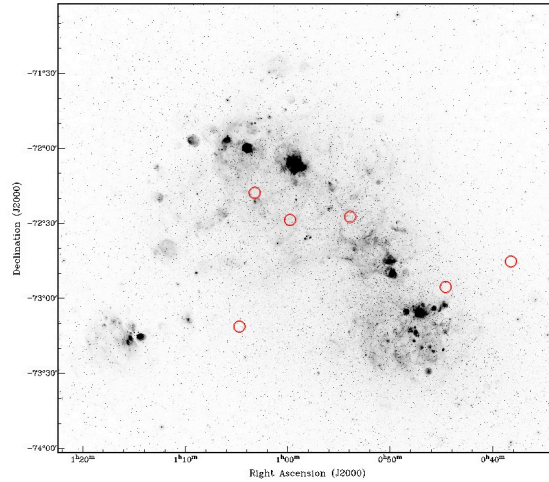
## 1. Introduction

Planetary nebulae (PNe) play a crucial role in understanding mass loss for low and intermediate mass stars, they influence chemical evolution of galaxies through interstellar enrichment and are a major Galactic dust factory. Their strong emission lines are laboratories for plasma physics and provide accurate radial velocities for Galactic kinematics while the PNLF in external galaxies is a powerful cosmological distance indicator.

The SMC is a gas rich, late type dwarf irregular galaxy with an average gas/dust ratio a factor of  $\sim 30$  below the Galactic value [1]. The SMC’s accurately determined distance of  $61 \pm 1$  kpc [2] allows derivation of true PNe physical parameters from optical spectra. With a small angular extent of  $5^\circ 20' \times 3^\circ 05'$ , it can be easily studied in its entirety. SMC reddening and extinction is relatively low and uniform, enabling absolute nebula luminosity estimates.

## 2. Discovery technique

We have carefully examined UKST H $\alpha$  and SR SMC image data for  $\sim 120$  deg<sup>2</sup>. We adopted the same powerful and proven colour merging technique successfully applied to the LMC by [3][4][5]. Using the KARMA visualisation software package, we surveyed these fields and created merged false-colour images, combining H $\alpha$  (coloured in blue) and SR (coloured in red). All images were systematically visual scanned, looking for a faint, compact or barely resolved objects. By carefully choosing the image combination parameters we could balance the intensity of H $\alpha$  and SR red matching images, allowing only specific features of one or other pass-band to be seen. In our scheme emission objects such as PNe and H II regions appear with a uniform strong blue



**Figure 1.** Positions of six new PNe discovered in the SMC.

colour, whereas normal continuum stars are a uniform pink-purple colour. Emission-line stars usually have a strong continuum component and so are easily detected by the narrow extent of their blue halos around a strong pink core [3][4].

### 3. Conclusions

Confirmatory spectra of six preliminary PNe candidates are quite homogenous. Each was confirmed as an emission-line source with no obvious stellar continuum. This eliminates confusion with emission-line stars for compact sources. Each candidate also gave high  $[N II]$  to  $H\alpha$  ratios ( $\sim 2$  to  $7$ ) [6] not observed in H II regions, which are the most likely contaminants [7]. The presence of only narrow diagnostic lines also removes the confusion with supernova remnants. These preliminary results demonstrate the strength and promise of our techniques for providing high-quality PNe candidates.

We expect to increase SMC PNe by 20 to 50% after spectroscopic follow-up of our candidates and refinement of identification of all known SMC emission-line sources. This will include multi-wavelength analysis and spectroscopic confirmation (or rejection) of objects previously listed as SMC PNe. Our survey will permit more extreme ends of the PNLF to be explored, especially at the faint end, and enable us to study underrepresented evolutionary stages of SMC PNe. This sample will have a major impact on improving rates of elemental enhancement in lower mass stars within a low-metallicity environment. Other advances will come from the improved SMC kinematical data from over 300 emission-line objects uncovered.

### References

- [1] Stanimirovic S, Staveley-Smith L, van der Hulst J M, Bontekoe T R, Kester D J M and Jones P A 2000 *MNRAS* **315** 791
- [2] Hilditch R W, Howarth I D and Harries T J 2005 *MNRAS* **357** 304
- [3] Reid W A and Parker Q A 2006 *MNRAS* **365** 401
- [4] Reid W A and Parker Q A 2006 *MNRAS* **373** 521
- [5] Reid W A and Parker Q A 2013 *MNRAS* **436** 604
- [6] Draskovic D, Parker Q A, Reid W A and Stupar M 2015 *MNRAS* **452** 1402
- [7] Kennicutt Jr R C, Bresolin F, French H and Martin P 2000 *ApJ* **537** 589