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A PILE OF NEW PLANETARY NEBULAE IN THE GALACTIC PLANE

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RESUMEN

El cartografiado IPHAS (Isaac Newton Telescope Photometric H-alpha Survey; http://www.iphas.org) está casi terminado. Las imágenes, tomadas en los filtros Hα, r' e i' con un límite de completitud mejor que r'=20 mag, cubren una banda de diez grados a lo largo del plano galáctico, con resolución de 1 segarc. IPHAS está encontrando las nebulosas planetarias (PNe) que faltaban en el plano galáctico; esperamos triplicar el número de PNe conocidas allí. Hemos descubierto cientos de candidatos a PNe, tanto pequeños (<10 arcsec) como extensos; algunos de ellos están situados en regiones clave, como el anticentro. Presentamos aquí un primer estudio de la región entre RA=18 y 20^h, donde las observaciones ya están completas.

ABSTRACT

The INT photometric H-alpha Survey (IPHAS; http://www.iphas.org) is now near completion. A band of 10 degrees along the Northern Galactic Plane is being imaged in Hα, r' and i' filters with typically 1 arcsec resolution and a completeness limit better than r'=20 mag. IPHAS is filling in the currently existing gap in the Planetary Nebulae (PNe) population of the Plane: we are on course to tripling the number of PNe known in the northern plane. Many hundreds of candidate PNe, both small diameter (<10 arcsec) and extended, have been identified; some are located in areas of particular interest as the Anticenter region. A preliminary analysis of the region from RA=18 to 20^h, where the observations are already complete, is presented.

Key Words: planetary nebulae: general — stars: mass loss — stars: pre-main sequence — surveys

1. INTRODUCTION

The first Planetary Nebula (PN) was discovered from Paris, France, on July 12, 1764 by Charles Messier, followed, some twenty years later, by the comprehensive survey by the Herschels (Caroline, Williams, and John) from Bath, England, where many nebulae were found and the name "Planetary nebula" was coined. Again from France, but 240 years later, the Strasbourg-ESO Catalogue by Agnes Acker and collaborators compiled many previous discoveries, totalling 1142 Galactic Planetary Nebulae. Finally, a new catalogue appeared last year, but this time from Australia, with over 1200 PNe, located in a 20 degrees band around the southern galactic plane (MASH-I and II Catalogues by Quentin Parker and collaborators). All in all, some 2500 galactic PNe are known. So, why searching for more?

There are indeed good reasons to keep on searching: (1) The total population of PNe in the Galaxy, extrapolating from the number of bright PNe observed and assuming an "universal" PN luminosity function, is ~8000, i.e. much smaller than the theoretically expected number ~50,000. This supports the conjecture that only binary systems can form observable PNe (Moe & De Marco 2006). But the giant extrapolations made are obviously dangerous, and the question stands: Are there or not *many* more than 2500 observable PNe? (2) Out of those 2500 PNe only a few are known in key galactic regions, as the halo or the anticenter. This severely limits the knowledge of important parameters, like the galactic abundance gradient. (3) PNe are classified according to their morphology (Round, Elliptical, Bipolar, Quadrupolar, Point-symmetric, Irregular, etc.), to their evolutionary stage (from proto-PN to evolved PNe), and to their chemical composition and galactic distribution (the Peimbert's types I to V). So, many subgroups are defined, and some are very scarcely populated. Therefore, unique or infrequent objects might be biasing the knowledge of key physical processes occurring during the late stellar evolution.

2. PLANETARY NEBULAE IN IPHAS

IPHAS is mapping a band between $b^{II} = -5$ to +5 deg of the Northern Galactic plane using the INT Wide Field Camera at the Observatorio del Roque de los Muchachos (ORM, La Palma, Spain). A narrow-band Hα and two Sloan r', i' filters are used for matched 120, 30, and 10 s exposures, respectively, spanning the range r'=13 to 20 mag for point

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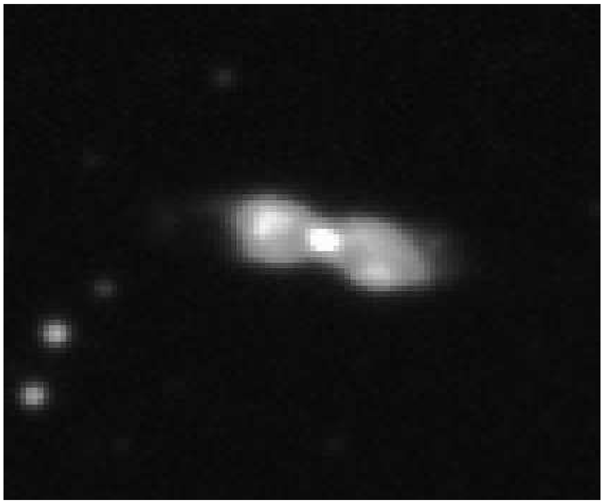

Fig. 1. Hα image of a new compact bipolar PN. N is up and E to the left.

sources. IPHAS is the first fully-photometric Hα survey of the Galactic plane. It will discover around 40,000 new emission-line stars, and thousands of ionized nebulae such as PNe, H-H objects, HII regions, SN remnants, etc., (Drew et al. 2005; Mampaso et al. 2006; González-Solares et al. 2008; Corradi et al. 2008; see also Corradi & Mampaso 2009).

Point-like and slightly-extended candidate PNe are selected from the automatically generated catalogue using a colour-colour diagram built with the three IPHAS bands. An example is shown in Figure 1. Large nebulae that are not detected by the automated photometry are searched on the Hα-r' mosaic images using two spatial binning of 1.5×1.5 and 5×5 arcsec^2. The mosaics are visually inspected by independent collaborators, and any extended nebula with a symmetrical, regular, or peculiar morphology is registered. Figure 2 shows a newly found nebula of size >10 arcmin.

Follow-up spectroscopy with the WHT and INT telescopes at ORM and the 2.1 m SPM-OAN (México) telescope of, up to now, 150 candidates allowed confirmation of over sixty of them as new PNe, whereas the rest are new Hα emission stars, including stars with the most extreme Hα emission, and several symbiotics.

3. RESULTS FOR THE REGION RA=$18^H \rightarrow 20^H$

We have discovered 289 new PNe candidates, and reidentified all 100 known PNe in this area. 37 of the new candidates are unresolved or barely resolved (size $\leq$1 arcsec) whereas the largest nebulae are over

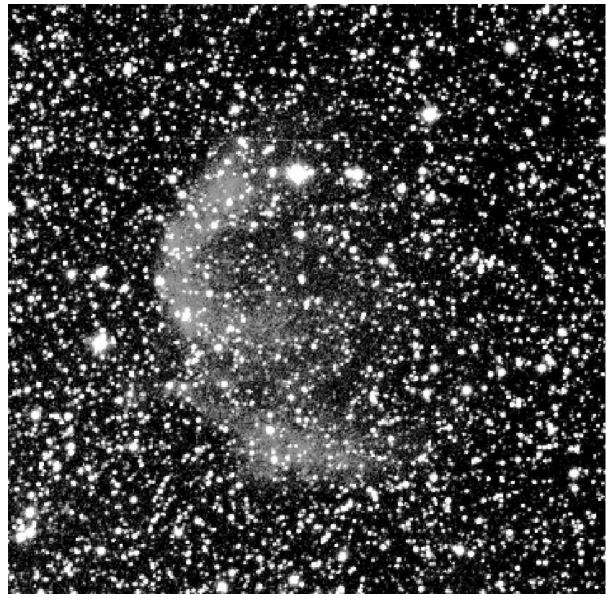

Fig. 2. Hα image of a large and faint PN candidate projected onto the heavily crowded galactic plane. N is up and E to the left.

500 arcsec in size. For 133 candidates the morphology of the nebulae is clear enough to be ascribed to one of the main morphological groups (Round, Elliptical, and Bipolar). Surprisingly (or not: Soker & Subag 2005), more than half of the new PNe candidates are roundish.

4. CONCLUSIONS

Using the IPHAS database, which is now >95% complete, we are finding and studying new Planetary Nebulae in the galactic plane to improve the knowledge on the PNe total number and distribution. Biases form bright, nearby and peculiar objects are minimized. Hundreds of faint PNe candidates have been discovered, including very compact (<1 arcsec), very large (>10 arcmin), and very distant nebulae (D_{GC} >13 Kpc). More than half of the new candidate planetary nebulae in the AR=18–20^h area, the first region fully searched so far, are round.

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