Optical Survey of Planetary Nebulae in the northern Galactic Bulge

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Abstract

We present preliminary results of an optical survey for Planetary Nebulae (PNe) in the northern part of the Galactic Bulge. In particular, observations at wavelengths corresponding to the [OIII] 5007 emission line have been carried out with the 0.3 m telescope at Skinakas Observatory, where we have detected several new PNe and have rediscovered known and known-possible PNe from that region.

1 Introduction

The Galactic Planetary Nebulae (PNe) are always under high investigation because of our difficulties to determine their properties (like their number, distance, chemical composition, morphology and kinematics), which play a very important role to the chemical enrichment history of the interstellar medium as well as to the star formation and evolution of our Galaxy. The Galactic Bulge is covered by the region of Galactic longitude $l = \pm 15^o$ and Galactic latitude $b = \pm 10^o$ (dimensions ∼2 Kpc toward and ∼1.5 perpendicular the Galactic plane - Weiland et al. 1993). In total, the Bulge contains about 10^{11} stars of Population II as well as gas ($\sim 10^6 M_\odot$) and dust (mass ∼100 times less than the mass of the gas - Morison & Harding 1993). It is generally accepted that a big number of PNe exist in the Galactic Bulge, but because of the interstellar extinction, only a small number of them (less than 300) have been discovered (Köppen & Vergely 1998). According to Acker et al (1992a) and Zijlstra & Pottasch (1991), the total number of PNe in the Galaxy can be estimated between 15,000 to 30,000. Up to date, less than 2,500 PNe have been discovered (Acker et al. 1992b, 1996), which means that only a small amount of the total PNe have already been detected. In a very recent catalogue, Kohoutek (2001) present an additional 169 new PNe which were discovered through different surveys between the years 1995-1999.

Systematic [O III] 5007 Å surveys have already been done in the past to identify PNe in other galaxies, and their results were very promising, since ∼1600 new PN detection were made (Feldmeier et al. 1997 and references therein). The above results show that the right combination of the telescope size and the CCD camera, which have been used for PN detections at different distances, result to a lot of new discoveries. Therefore, we suggest that a large number of new PNe can be detected in the Galactic Bulge by using a 0.3 m telescope of large field of view (combined with a high quality CCD camera) and a narrow [O III] 5007 Å filter. We must note that a PN discovery has already been done in the past using this configuration (Xilouris et al. 1994). Take in account the fact that a PNe survey in the bulge has never been done in the past using this emission line except from a limited number of images, the [O III] 5007 Å emission line was chosen for our survey.

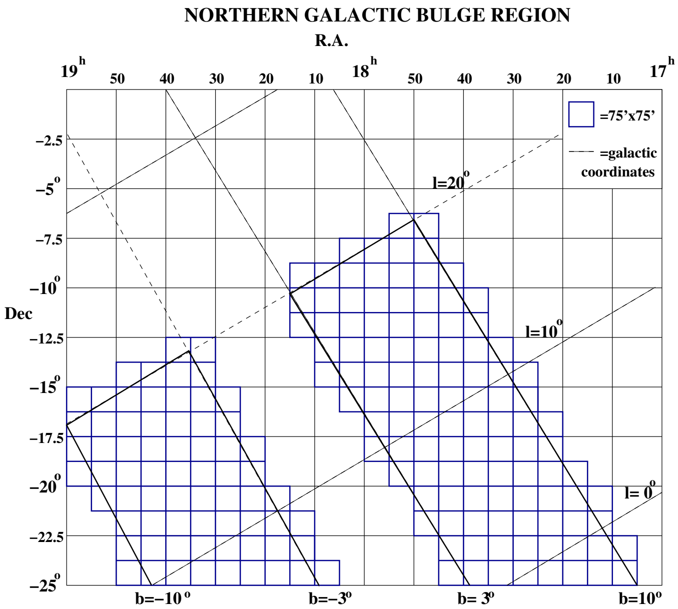

Figure 1. Optical imaging survey grid in equatorial coordinates. Galactic coordinates are also including (dash lines) to permit an accurate drawing of the selected Bulge region (bold solid lines). The small empty rectangles represent the observed fields.

2 Observations

The observations were made with the 0.3 m Schmidt-Cassegrain (f/3.2) telescope at Skinakas Observatory in Crete, Greece. In our survey we decided to observe the regions $10^o < l < 20^o$, $-10^o < b < -3^o$ and $0^o < l < 20^o$, $3^o < b < 10^o$ (see Fig. 1). The reasons to do that was (a) the site of the Observatory which allow us to observe down to -25^o declination and (b) the high interstellar extinction in the [O III] 5007 Å emission line between $-3^o < b < 3^o$. In Fig. 1, the optical imaging survey grid in equatorial coordinates is shown. Galactic coordinates are also included (dash lines), while the small empty rectangles represent the observed fields. We must note that we covered at first a spesific region of the proposed grid to make sure that our discovery method works well. Two exposures in [O III] 5007 Å of 1200 s and three exposures in the nearby Continuum Red of 180 s were taken to make sure that the cosmic rays will be removed correctly.

3 Detection method

Our detection method is similar but not the same to that followed by Beaulieu et al. (1999). In particular, after having the correct scaling, we subtracted both the two [OIII] images by the corresponding continuum image for each field. Then, the initial PN identification was performed by "blinking" each subtracted [OIII] frame by the continuum. Given that our pixels have an angular size of ~ 4 arcsec if projected on the sky, the PN candidates at the bulge appeared as point (or sometimes extended) positive sources on the [OIII] images, but were absent on the continuum. As it was mentioned above, the resulting positive sources could be a PN candidate as well as a cosmic ray. To make sure that no cosmic rays were included among the candidates, we checked individually the [OIII] frames for each field. Objects that appeared bright on the first frame but they were invisible on the second, counted as cosmic rays because a real emission source must be appeared in both the [OIII] images. The procedure of how the PN candidates were look like through the different steps can be seen in Fig. 2. The first set of images (a) is a known PN which was found and presented for comparison reasons; the other set (b) is new discovery.

After finding the PN candidates, the next step was to perform an astrometric solution for all the images containing one or more candidates. In order to calculate the equatorial (and Galactic) coordinates of the PN candidates we used the Hubble Space Telescope (HST) Guide Star Catalog (Lasker et al. 1999) and IRAF routines (Image package). The coordinates for the PN candidates were then calculated. Based on the stars of our frames and the HST Guide stars, we also estimate the error in one frame astrometry to be less than $1.2''$. The new objects were then checked in order to identify the already known PNe. For that purpose we used any up-to-date published catalogue which is related to planetary nebulae. In the near future (Boumis et al. 2001) detailed results (imaging and spectroscopy) for the newly discovered PNe found in our survey will be presented.

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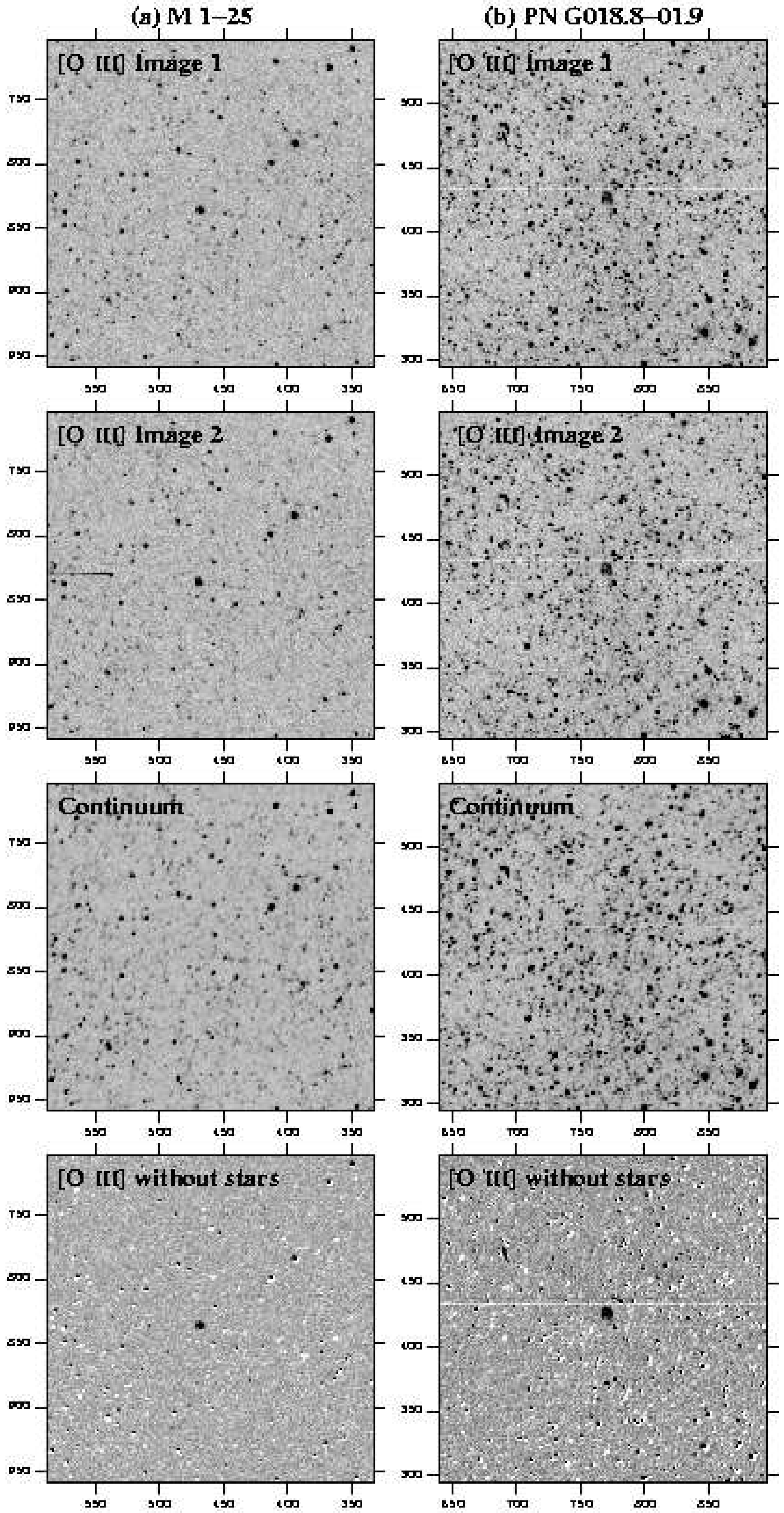

Figure 2. Examples of images (17′ on both sides each) for two different objects which show our survey's typical discoveries. The first set of images (a) is a known PN which was found and presented for comparison reasons; the other set (b) is a new discovery. Note that the remaining black dots in the last image of each set (except the PNe) are cosmic rays and stars which did not remove with the continuum subtruction. North is at the top, East to the left.