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Chemical Composition of New Galactic Bulge Planetary Nebulae

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Abstract. We did photo-ionization modelling of 10 new Planetary Nebulae within 2° of the Galactic Center. We found that these PNe would originate mainly from low mass, old, metal poor stars.

1. Observations

Planetary Nebulae (PNe) are bright emission line objects and excellent probes of the chemical enrichment history of the ISM (Dopita et al. 1997). Our survey in [S III]λ9532 has uncovered 95 new PNe candidates in addition to the 34 previously known within 2° around the Galactic Center. 64 PNe were confirmed via optical spectroscopy at ESO 1.52-m and CTIO 4-m telescope. 11 PNe could not be identified. The PNe detected spectroscopically were observed with the Australia Telescope Compact Array simultaneously at 3 & 6 cm. These observations and results are published in Van de Steene & Jacoby (2001).

2. Modelling

The photo-ionization code Cloudy 94.0 is used to self-consistently derive the stellar and nebular parameters of the PNe. Generally, for our sample PNe, there were too few lines to constrain fully all aspects of the photo-ionisation model. Consequently we modeled each objects with the simplest set of parameters possible. Our basic model consisted of a hot blackbody central star centered in a spherical nebula having uniform density and containing dust grains typical of most PNe. The filling factor is taken to be unity and the distance assumed to be 7.8 kpc. We adopted a dust-to-gas ratio as in Cloudy. The dust composition is a mixture of silicate and graphite. The emission line ratios (or upper limits) with their error estimates (van Hoof & Van de Steene 1997) were used to deduce the abundances. For elements for which no observed lines were available we assumed standard abundances as in Cloudy, except for Neon, for which we the value given by Clegg (1993) for Galactic PNe, and Carbon. Carbon poses a problem because it has a significant influence on the ionisation structure of the nebula. We assumed a C-abundance of 8.6 and adjusted it, if necessary. The radio flux was used to constrain the total luminosity and the radio angular

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diameter determined the extent of the nebula. The inner radius was usually taken to be half the Strömgren radius.

3. Results

Their position in the HR diagram suggests that most left the AGB as Helium burners (Vassiliadis & Wood 1994). This may be in part a selection effect. Based on evolutionary models these PNe would have a core mass less than 0.6 $M_\odot$, originate from ~ 1 $M_\odot$ stars, and be 8 to 15 Gyr old. This is in agreement with the results for PN progenitors in the bulge (Van der Veen & Habing 1990).

The abundances of our sample PNe are similar to abundances of PNe in the Magellanic Clouds. Assuming that the same selection effect apply to [S III] as to [O III], they operate to favor the observation of low to moderate metallicity objects (Jacoby & Ciardullo, 1999). This would be even more true in a region with high extinction such as the Galactic Bulge.

These Galactic Bulge PNe have lower abundances than found by Ratag et al. (1997). Especially the nitrogen abundance is much lower. This difference may be caused in part by our use of photo-ionisation modelling compared to the ICF method (Alexander & Balick, 1998). However our comparison of abundances obtained for 5 bulge PNe common with Ratag showed no systematic difference (van Hoof & Van de Steene, 1999).

Argon remains unaffected by nuclear processing. When Argon is considered as representative for the metallicity of the progenitor, 8 of the 10 are metal poor. Our mean metallicity ([Ar/H]~ -0.5) is lower than the value for Galactic Bulge stars ([Fe/H]~ -0.25) (McWilliam & Rich 1994).

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