Planetary Nebulae in our Galaxy and Beyond
Proceedings IAU Symposium No. 234, 2006
M. J. Barlow & R. H. Méndez, eds.

doi:10.1017/S1743921306004133

Chemical composition of the Galactic bulge from deep spectroscopy of planetary nebulae

W. Wang & X.-W. Liu

Department of Astronomy, Peking University, Beijing 100871, China
email: bwaw@bac.pku.edu.cn, liuxw@bac.pku.edu.cn

Abstract. Previous abundance analyses for the Galactic bulge using giant stars, RR Lyrae variables and PNe (based on the traditional method by means of collisionally excited lines – CELs) as tracers yielded different results (c.f. the review by McWilliam (1997, ARAA, 35, 503 and references therein). We have obtained deep long-slit medium resolution spectra for a sample of 25 Galactic bulge PNe (GBPNe) and 6 Galactic disk PNe (GDPNe) with which we have carried out detailed extinction analyses, plasma diagnostics and elemental abundance determinations, using both CELs and optical recombinations lines (ORLs) from heavy elemental ions. Here we report the preliminary results and compare them with earlier work for both bulge and disk PNe.

Keywords. Galaxy: abundances; planetary nebulae: general, abundances

---

Fig. 1 compares (a) $(C/H)_{CELs}$; (b) $(O/H)_{CELs}$; (c) $(C/H)_{ORLs}$ and (d) $(O/H)_{ORLs}$ for bulge and disk PNe. The bulge sample is from our current work and that of disk PNe is mainly from three recent surveys (Liu et al. 2004, MNRAS, 353, 1251; Tsamis et al. 2004, MNRAS, 353, 953; Wesson *et al.* 2005, MNRAS, 362, 424). In Panel (b) we also show a distribution of $(O/H)_{CELs}$ for bulge PNe with data collected from the literature, which show good agreement with our results. Fig. 1 shows that from both CELs and ORLs GBPNe have higher metallicities compared to GDPNe, by a modest 0.10 dex for O/H [c.f. Fig. 1(b) and (d)]. The enhancement is similar for other heavy elements analyzed, including N, Ne and Ar.

The whole data set has also been used to determine abundance gradients across the Galaxy. The gradient deduced from the ORL abundances of O and Ne is about −0.016 dex kpc^{-1}, while that derived from the CEL abundances of O, Ne, S and Ar is approximately −0.028 dex kpc^{-1}. The latter value is about half of that obtained by Maciel & Quireza (1999, A&A, 345, 629). Part of the difference may also arise due to different treatment of extinction – they used the standard Galactic reddening law. But more importantly, there was a lack of PNe near the GC in the sample of Maciel & Quireza. Thus the discrepancy may in fact indicate a flattening of the abundance gradient towards the inner part of the Galaxy.

By resort to the relatively strong C II λ4267 ORL, we have been able to obtain reliable abundances of the key element carbon for the first time for a significant sample of GBPNe. We find that GBPNe have C/O ratios about 0.2 dex lower than disk PNe, suggesting that the progenitor stars of GBPNe tend to be more massive and consequently a larger amount of carbon is converted into nitrogen compared to progenitor stars of GDPNe (albeit a selection effect can not be ruled out – less massive PNe are less bright and consequently harder to observe in the bulge). Alternatively, it may indicate that the 3rd dredge-up process is less efficient for metal-rich GBPNe than for GDPNe.

In addition, in 7 out of the total 31 objects, we have detected the Mg II 3d-4f λ4481 ORL, allowing determinations of the magnesium abundance. The results seem to indicate

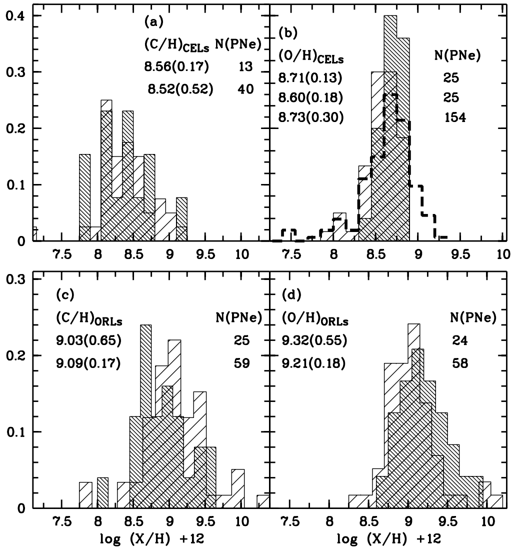

Figure 1. Comparison of heavy elemental abundances and their ratios for bulge (right-hatched histograms) and disk (left-hatched histograms) PNe as deduced from CELs and from ORLs. In (b), data compiled from the literature for a sample of GBPNe are also shown for comparison (dashed histogram). The average value and its standard deviation are labelled, along with the number of PNe in each sample.

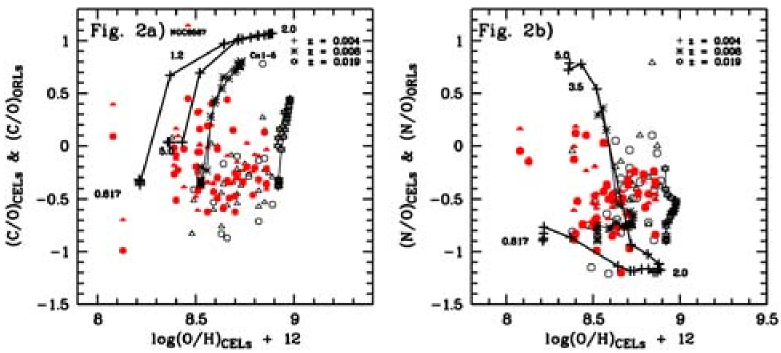

Figure 2. a) C/O and b) N/O ratios for GBPNe (filled symbols) and GDPNe (open ones), deduced from CELs (circles) and from ORLs (triangles), plotted against $(O/H)_{CELs}$. Also shown are theoretical predictions from Marigo (2001) for different values of the initial metallicity Z. The curves are labelled with the initial mass of the progenitor stars in units of the solar mass.

that GBPNe have an average Mg/H about 0.15 dex higher than that of GDPNe; the latter is almost identical to the solar value of 7.55 (Lodders, 2003, ApJ, 591, 1220).

Fig. 2 compares C/O and N/O ratios deduced for GBPNe and GDPNe with the theoretical predictions of Marigo (2001, A&A, 370, 194), calculated for different initial metallicities Z. Panel a) shows that GBPNe seem to have evolved from stars of a higher Z, about 0.013, compared to GDPNe which are best described by an initial Z of 0.008. Fig. 2 thus seem to suggest that a larger fraction of GBPNe descend from more massive stars compared to GDPNe.