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Planetary Nebulae and the bulge-disk interface of the Galaxy

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1 Introduction

- The bulge and the disk have different evolution histories, as for example the disk inside out formation model (Chiappini et al. 2001) or the bulge multiple infalls scenario (Costa et al. 2008).
- We expect that there is a galactocentric distance which better separates the two populations from the point of view of chemical abundances.
- The main goal of this work is to determine the galactocentric distance where, according to intermediate mass population, bulge and disk properties separate. New chemical abundances of a PNe sample located towards the Galactic Bulge were also derived.

2 Selecting the Sample

- Spectrophotometry observations in the optical domain for a sample of 56 planetary nebulae located in the direction of the Galactic Bulge with the 1.6m Brazilian telescope (LNA).
- Three selection criteria were adopted, which lead to the rejection of about 90–95% of foreground PNe:

$$\begin{aligned} |\ell| &\leq 25^\circ \\ |b| &\leq 10^\circ \end{aligned}$$

$$\begin{aligned} F(5\text{GHz}) &\leq 100\text{mJy} \\ \theta &\leq 12'' \end{aligned}$$

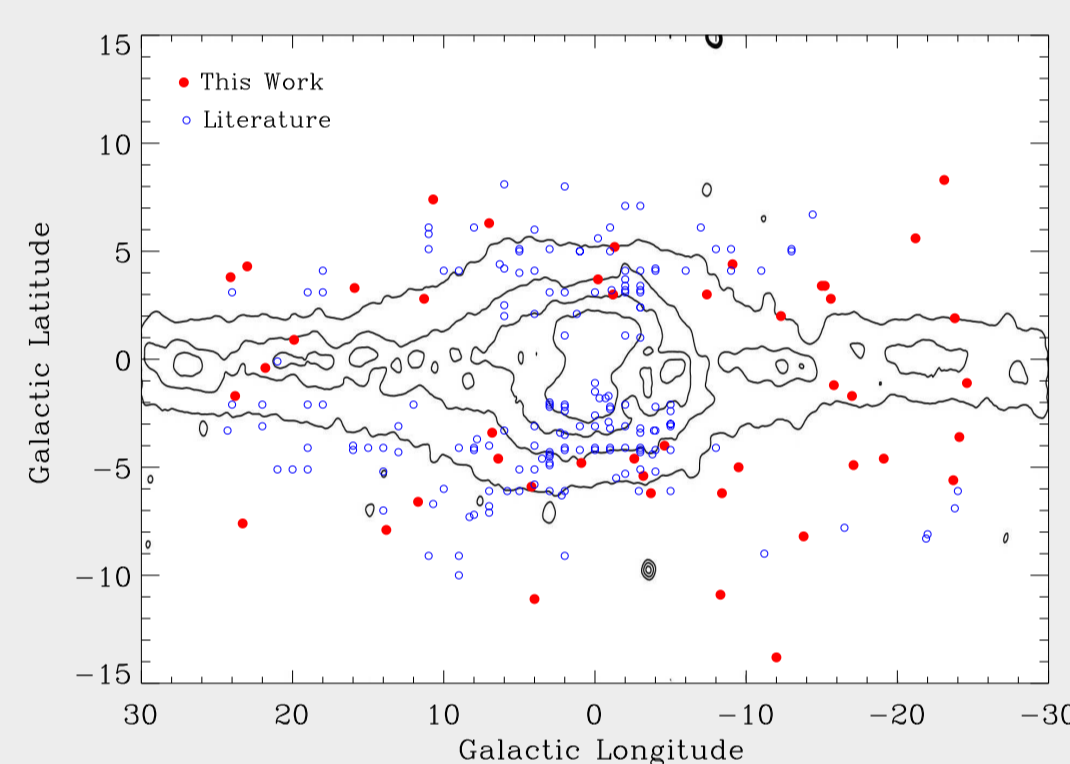


Fig. 1: PNe distribution with respect to the galactic bulge for this work (filled circles) and data from the literature (open circles).

3 Chemical Abundances

- Physical parameters: $n_e([SII])$, $T_e([OIII])$, and $T_e([NII])$.
- Ionic abundances were calculated from Alexander & Balick (1997).
- Elemental abundances calculated by means of ICFs.
- 35 PNe have their abundances derived for the first time.
- More details will be available in Cavichia et al. (2009).

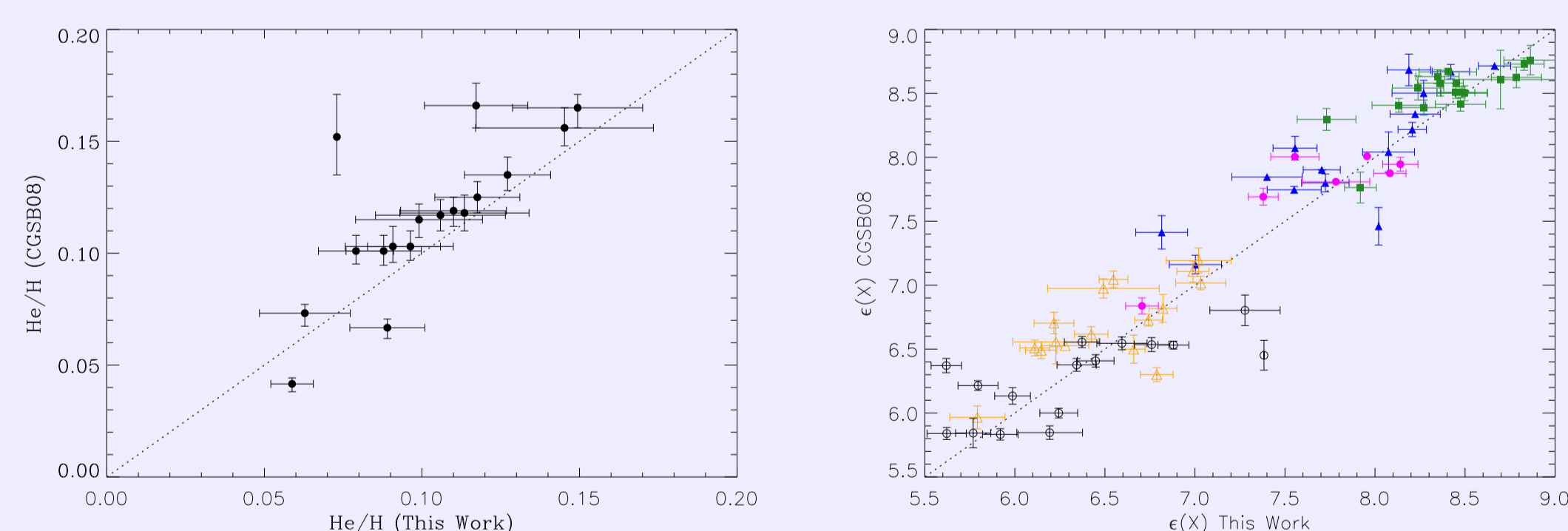


Fig. 2: Comparison between abundances from this work and Chiappini et al. (2009) for helium (left) and for other elements (right). For the later the abundances are in units of $\log(X/H)$ where X stands for nitrogen (filled triangles), oxygen (filled squares), neon (filled circles), sulfur (open triangles), argon (open circles).

References

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- Zhang, C. Y., A statistical distance scale for galactic planetary nebulae, *ApJS*, 1995, 98, 659 (Z95)

4 Method and Results

- A galactocentric distance (R) defines a limit for the sample.
- The sample is divided in: **group I** $d \leq R$ and **group II** $d > R$.
- The distance (R) is varied from 0.1 to 3.6 kpc, in 0.7 kpc steps.
- Average abundances were calculated for each step.
- A Kolmogorov-Smirnov test was performed for each step, in order to check which R separates more clearly the groups.

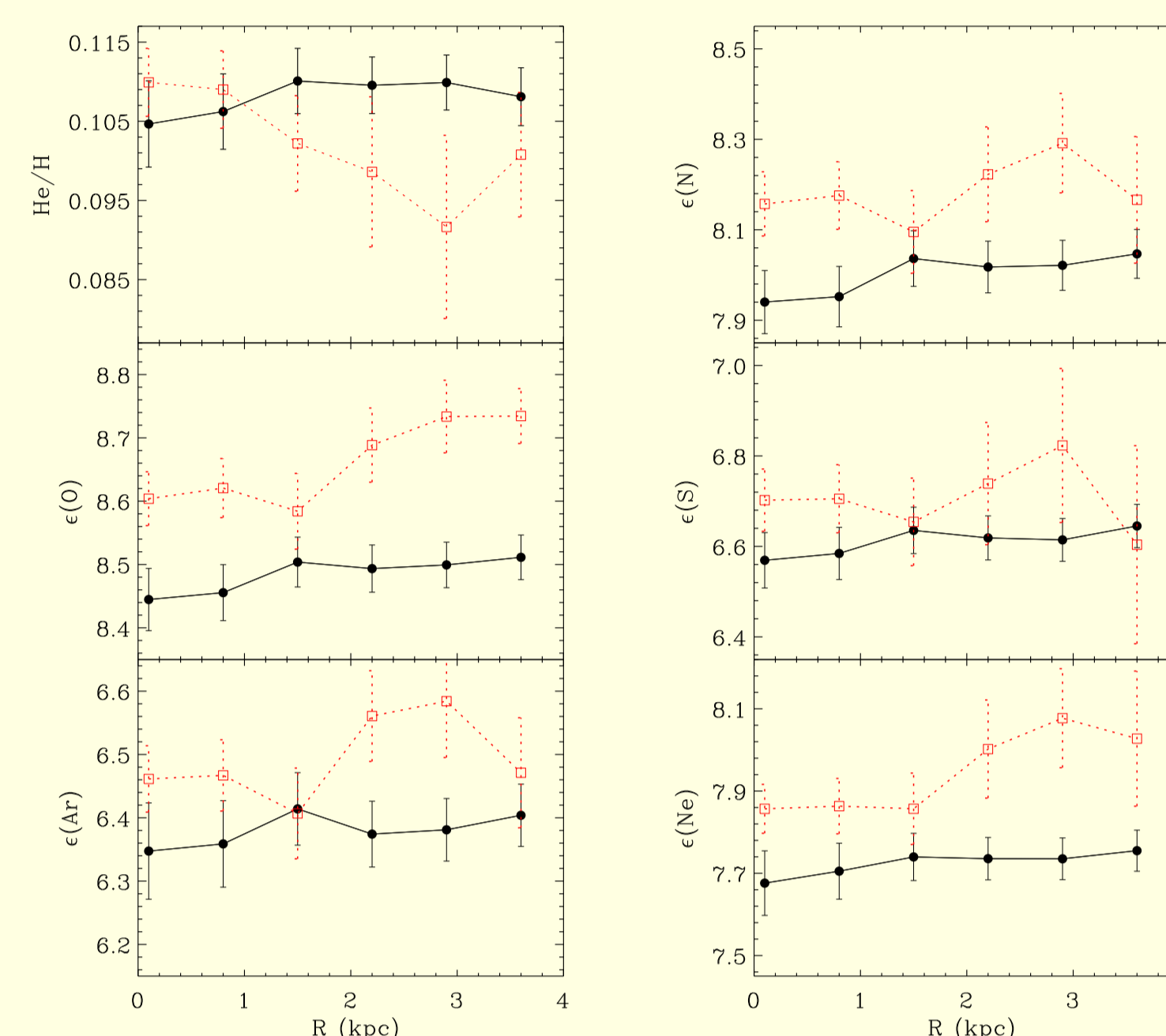


Fig. 3: Average radial distribution of chemical abundances for PNe based on Stanghellini et al. (2008) (SSV08) distance scale. Circles represent group I while squares represent group II PNe.

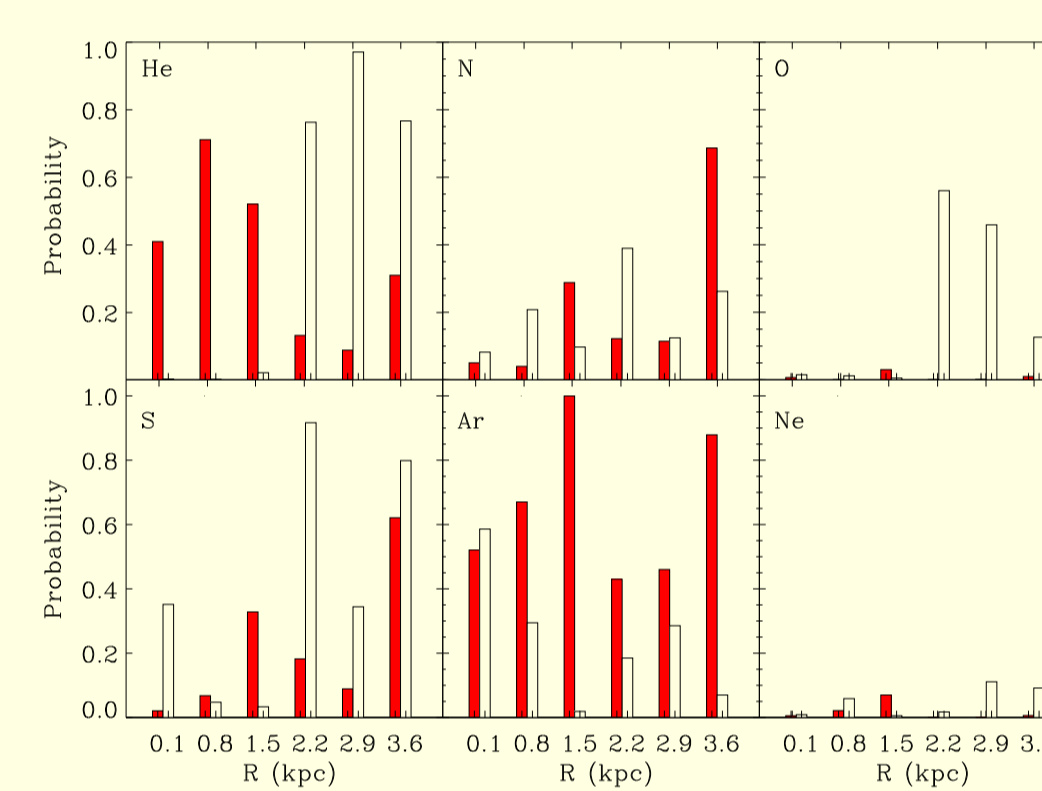


Fig. 4: Kolmogorov-Smirnov probability bar plot for each element as a function of the separation radius of groups I and II. Left bars correspond to SSV08 scale and right bars to Zhang (1995) (Z95) scale.

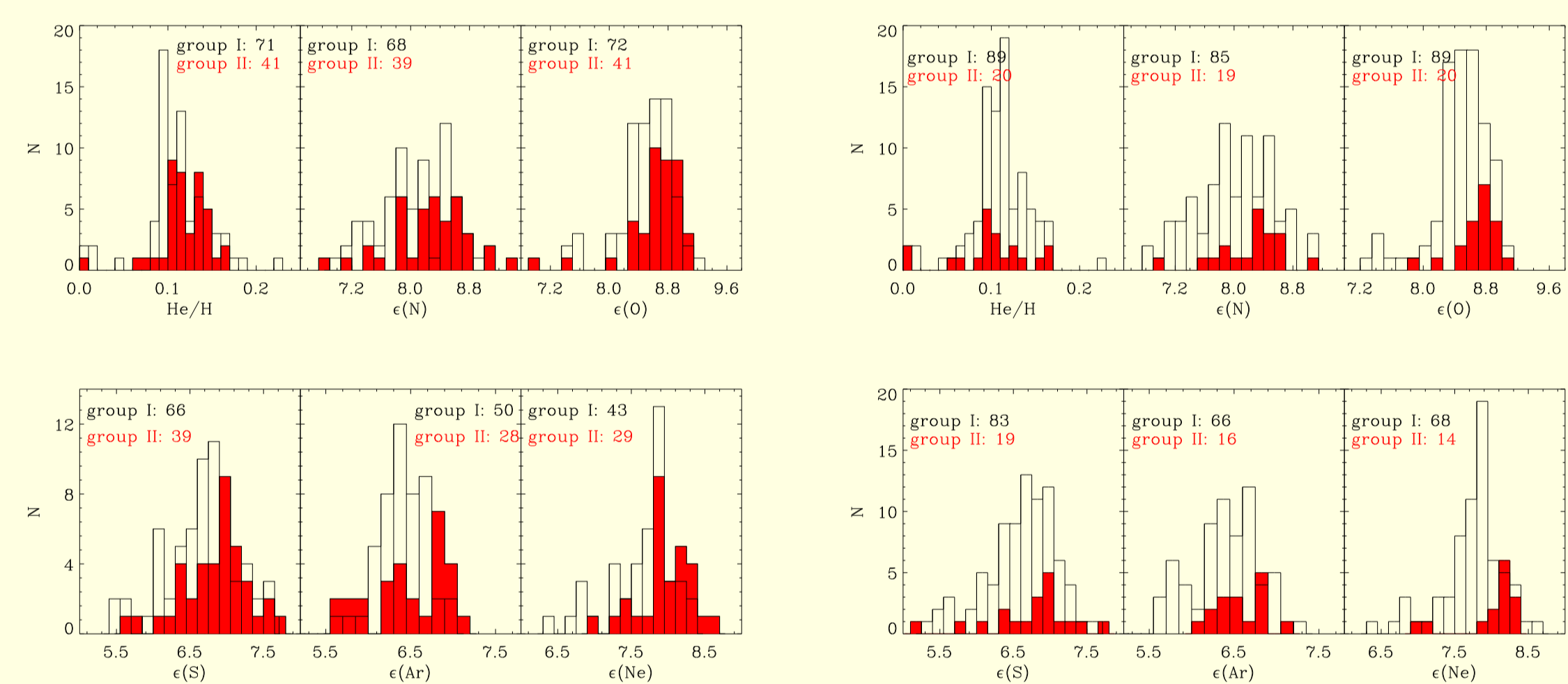


Fig. 5: Abundance distributions for groups I and II using the Z95 scale (left, $R = 1.5\text{kpc}$) and SSV08 scale (right, $R = 2.2\text{kpc}$). Unfilled histograms represent group I objects and filled histograms are for group II. The number of objects in each distribution is shown in the top.

5 Conclusions and perspectives for the Gaia era

- We presented here an analysis of chemical abundances for a PNe sample located towards the galactic bulge, trying to establish the galactocentric distance where bulge and disk characteristics intersect.
- The analysis was based on statistical distances derived for a sample of 56 objects. A Kolmogorov-Smirnov test resulted in a galactocentric distance of **1.5 kpc** or **2.2 kpc** for two different scales, respectively Z95 and SSV08. Results also show that, on the average, bulge PNe abundances are slightly *lower* compared to those from the inner-disk.
- The same kind of analysis could be performed using the **Gaia** results. From the parallax of central stars down to $V \sim 20$, reliable individual distances for a large sample of PNe will be finally available. They will allow the derivation of the interface between the inner-disk and the central region (bulge+bar), which is a key constraint to chemical/dynamical evolution models for the Galaxy.