

Stars and Planetary Nebulae in the Galactic Bulge

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1. Introduction

Planetary Nebulae are interesting objects for the study of the Galactic Bulge because they concentrate the energy of their central stars in the emission lines of their spectra, and can therefore be observed relatively easily at this distance. Furthermore the masses of their progenitor stars varying from 0.8 to $8M_{\odot}$, their ages span from 50 Myr to 25 Gyr, covering more than 95% of the possible ages in the Universe, and of course in the Bulge.

The only stars with a similar ages range, that are reasonably observable in the Bulge, are the Red Giants. They are actually the direct precursors of the Planetary Nebulae. Some elements have their abundances unmodified by the stellar evolution in Red Giants as well as in Planetary Nebulae. These elements keep the fingerprints of the chemical composition of the ISM when the progenitor star was born, and because of the span of their ages, they allow to follow its evolution over a very wide time range.

One particular point of interest are the relative abundances of elements produced in type II and in type Ia supernovae. Type II supernovae explode very rapidly, after some Myr, e.g. quasi instantaneously on the Bulge evolution timescale, whereas type Ia supernovae explode after a period of the order of one Gyr. The relative abundances of type II and type Ia supernovae should thus allow to measure the timescale of the Bulge formation.

On the other hand, elements produced during the lifetimes of the progenitor stars should allow to determine their ages - at least statistically. In Planetary Nebulae, nitrogen is very easily detectable, and has its abundance modified in high mass progenitors, that are short lived. Nitrogen abundances in Planetary Nebulae should thus help to identify recent star formation.

2. Abundances in Stars and in Planetary Nebulae

We derived abundances for a sample of 30 PN, that we observed with high quality spectroscopy (Cuisinier et al. 2000). These abundances being of really

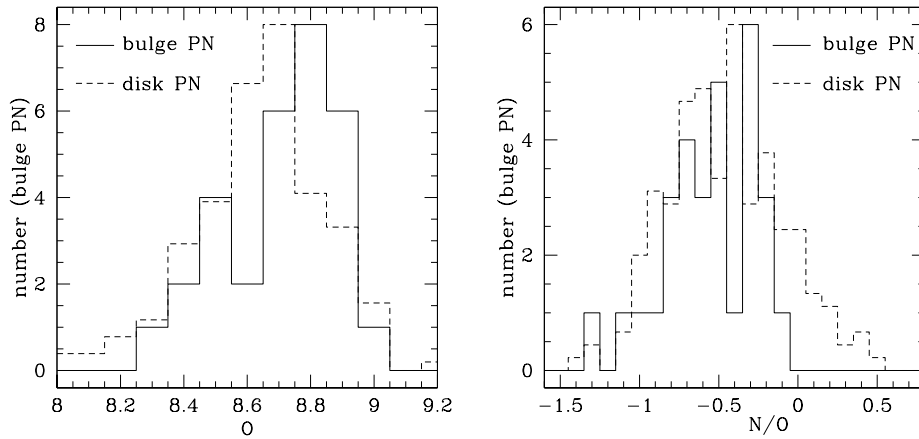


Figure 1. Left: O abundances in PN. Right: N/O ratios in PN

better quality than others available in the literature, we will only consider these ones here.

Abundances for individual elements in stars are up to now only available for a sample of 11 red giants, from McWilliam & Rich (1994).

Unfortunately, a direct comparison of abundances is not possible, the elements detectable in stars with a good confidence being different from those detectable in Planetary Nebulae.

We compared therefore the distributions of O, S and Ar in Planetary Nebulae in the Bulge and in the Disk, these elements representing the pristine abundances of the ISM (Figure 1, left panel, for O). We found the abundances distributions to be quite similar, like the Fe abundances in the stars (Mc William & Rich 1994).

On the other hand, the N/O ratios comparison in the Bulge and the Disk (figure 1, left panel) show that the young progenitor, N-rich Planetary Nebulae, that are present in the Disk, are lacking in the Bulge. From the Planetary Nebulae, the Bulge does not seem to have formed stars recently.

If the Red Giant and the Planetary Nebulae populations in the Bulge seem to be quite similar in the light of our study, the picture that arises from a comparison of the various elements originating from type II and type Ia supernovae that are detected in Planetary Nebulae and in Red Giants remains very puzzling: Mg and Ti, that are enhanced over Fe, seem to favor a quick evolution, whereas He, O, Si, S, Ar and Ca show normal abundances patterns, and favor a much slower evolution.

References

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 McWilliam, A., Rich, R.M., 1994, *ApJS*, 91, 749