THE GALACTIC BULGE: THE PROBLEM OF PLANETARY NEBULAE ABUNDANCES

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Abstract. Abundances in the galactic bulge can be obtained from giant stars or planetary nebulae (PN). Planetary nebulae concentrate their radiation in a few strong emission lines, so that they can be observed at large distances. We present a study of Galactic Bulge Planetary Nebulae, based on high quality spectroscopy. Abundances for a sample of 31 objects were derived, which are compared with the abundance patterns of the disk.

Instrumentation. The project requires spectrophotometric observations of emission lines in the optical range, including the [OII] 372.7, [OIII] 495.9, 500.7 nm, and Hα lines. Observations of lines in the near infrared, such as [SIII] 953.1 nm would be very helpful as well. Telescopes should be at least in the 2-4 m range, with typical resolutions of 2 to 5 A.

1. Introduction

The Galactic Bulge is one of the oldest components of the Galaxy, as can be seen from the colour-magnitude diagrams of stars in Baade's Window, or of bulge globular clusters. Abundances in the bulge are among the highest in the Galaxy, and can be as high as in the disk, or even higher. Such abundances can be obtained from giant stars or planetary nebulae. The latter concentrate their radiation in a few strong emission lines, such as [OIII] 494.9, 500.7, so that they can be observed at relatively large distances.

In this work, we present a study of Galactic Bulge Planetary Nebulae, for which we obtained high quality spectroscopy, and compare our derived abundances with disk objects. The project would benefit from the use of a bigger telescope, such as the SOAR/GEMINI projects, so that a larger and more accurately studied sample would be possible. The use of the near-IR capacities of these telescopes would be of great interest to assess the abundances of certain elements, such as sulphur and chlorine, through the observation of lines in this spectral range.

2. Observations

The observations of the sample of 31 planetary nebulae were secured at the ESO 1.52m telescope, using a B&C spectrograph with CCD FA#27 2040 × 2040 pixels. The sky aperture was 3 × 4 arcsec, and the spectral range from 400 to 740 nm. In order to get some weak lines such as [OIII] 436.3 and [NII] 575.5, which are essential for the plasma diagnostic, we made exposures of 45 min up to 1h30. In these spectra, the strongest lines ([OIII] 500.7 and Hα) are saturated. In order to get the intensities in these lines, shorter exposures were made afterwards. The spectra have been reduced in wavelength and flux with the MIDAS package. Line intensities have been measured with the IRAF package.

3. Results and discussion

We have used the plasma diagnosis code HOPPLA (Köppen et al. 1991) in order to determine the plasma diagnostics and elemental abundances. Temperatures were determined from the [OIII] $I_{436.3}/(I_{495.9} + I_{500.7})$ and [NII] $I_{575.5}/(I_{654.8} + I_{658.3})$ line ratios. Electron densities were determined from the [SII] $I_{671.7}/I_{673.0}$ line ratio. From the temperatures and densities, ionic abundances can be determined for ions having observed lines. Elemental abundances include Ionic Correction Factors (ICF) as given for example in Costa et al. (1996).

Some of the elements that can be observed in planetary nebulae are affected by the nucleosynthesis of the progenitor stars, such as He and N. The corresponding nucleosynthetic processes are related to the progenitor star mass, so that abundance patterns for these elements may carry and indication of the progenitor star age. On the other hand, elements such as O, S, Ar and Cl are not produced in the PN progenitor stars, so that their abundances are expected to be representative of the interstellar medium at the time when the progenitor star was born.

Figure 1a shows the O abundances of our sample, compared with the abundances of disk PN from Maciel and Köppen (1994). It can be seen that the O/H abundances, which trace the metallicity of the bulge, are statistically higher than in the disk. Figure 1b shows the N/O ratio of the PN in the bulge, again compared with the disk (Maciel and Köppen 1994, Maciel and Chiappini 1994). We see that in the bulge the PN with the highest N/O ratios are missing, which correspond to the objects with the youngest progenitors. Therefore, the progenitor stars of bulge PN are statistically older than in the disk. The He abundances of the bulge PN follow the same pattern, characterized by the absence in the bulge of the PN with the highest He abundances, although this feature is not as clear as in the previous case.

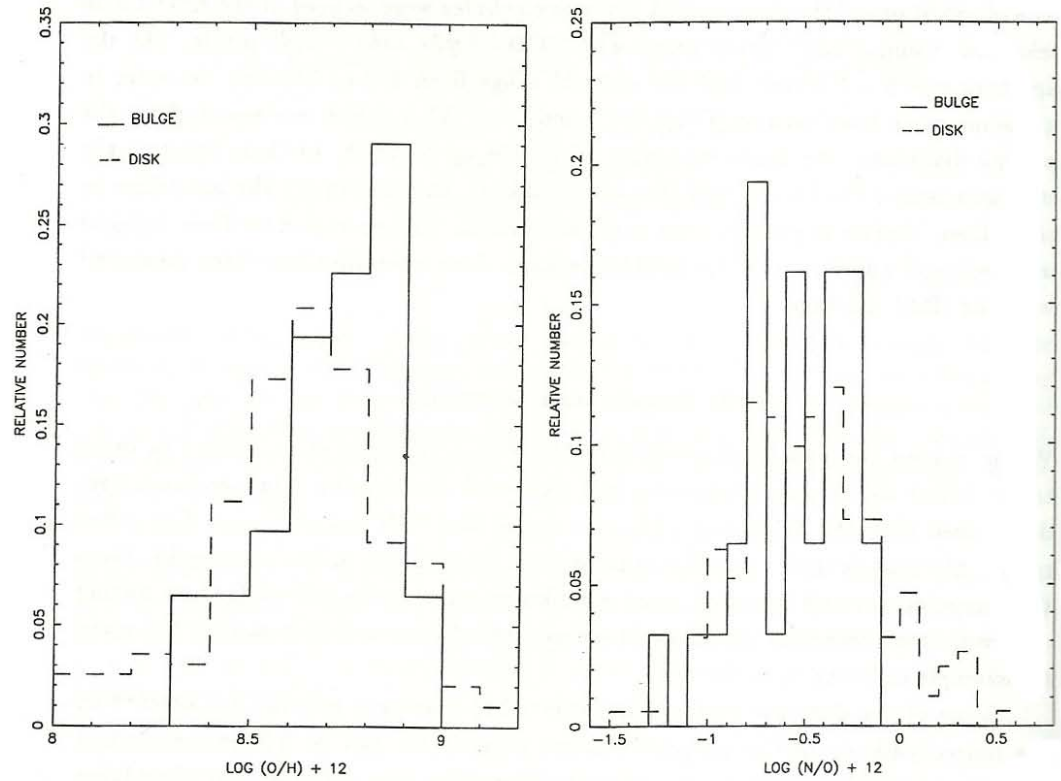

Figure 1. (a) O/H and (b) N/O abundances of bulge PN as compared with disk objects.

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