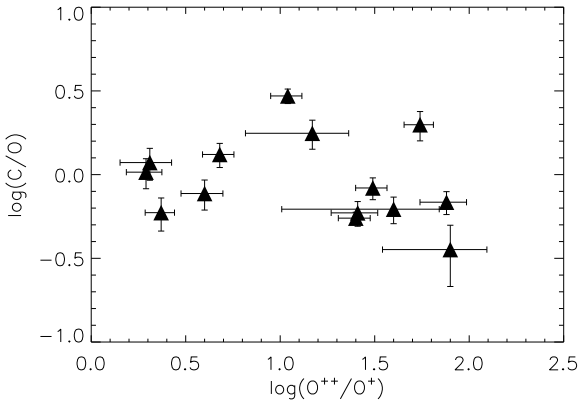

Fig. 1. C/O ratio *vs.* ionization degree.

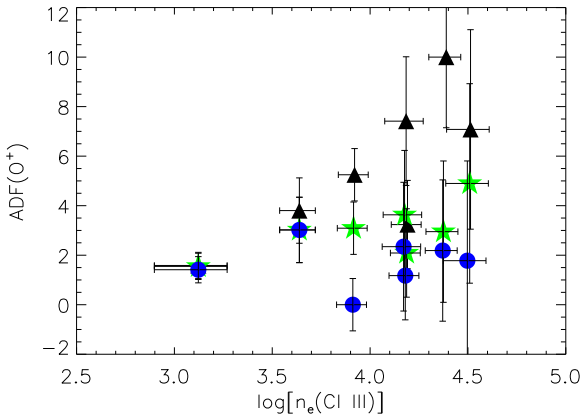

Fig. 2. ADF(O^+) computed by assuming n_e([O II]) (black triangles), n_e([S II]) (green stars) or n_e([Cl III]) (blue circles.

were measured by integrating all the flux between two given limits over a local continuum. In some blends, we applied multiple Gaussian profile fits, and in some particular cases, lines were so severely blended that we adopted the flux as the sum of all the lines. All the measurements were made using the SPLOT routine of IRAF[5]. More details of the analysis process are explained in García-Rojas et al. (2009), where we have published the complete study for the objects PB 8 and NGC 2867.

We computed physical conditions, T_e and n_e using several diagnostic ratios. In general, we adopted T_e([N II]) for the low ionization zone and T_e([O III]) for the medium-high ionization zone. In the most ionized objects, we also used T_e([Ar IV]) for the highest ionization zone. Regarding the density, we have obtained several values from different diagnostic ratios, i.e., [S II] and [O II] ratios for the low ionization zone, [Cl III] ratio for the medium-high ionization zone and [Ar IV] ratio for the highest ionization ions. Taking into account that the first two ratios saturate at densities $>10^4$ cm^{-3}, we adopted n_e([Cl III]) as more representative of the low to intermediate ionization zones of nebulae for those PNe with higher densities (see below). We then computed ionic abundances for a large number of ions from CELs and total abundances by using ionization correction factors from the literature.

We derived C^{++}/H^+ and O^{++}/H^+ ratios from pure C II and O II RLs for all the objects in the sample. Moreover, for some objects we could also derive C^{+3}/H^+ ratios from RLs. The very high spectral resolution and depth of our spectra allowed us to measure with a proper deblending of telluric lines, the very faint O I multiplet 1 RLs and hence, to derive the O^+/H^+ ratios for 7 objects using pure RLs. This is the largest sample of objects with derived O^+ abundance from RLs in the literature. With all these data, we have been able to compute C/O ratios for our sample from optical RLs. In Figure 1 we can see that there are 6 objects with C/O > 1, which indicates that about 43% of the sample are C-rich. This fraction is very similar to the one derived from the C III] λ 1909)/[O III] λ5007 line ratios for a large sample of PNe by Rola & Stasińska (1994).

We computed the abundance discrepancy factor (ADF, following the definition in Liu et al. 2000) for O^{++} for all our objects. The values obtained for the ADF(O^{++}) range from 1.4 to 3.9 and are moderate and similar to the typical value obtained in PNe.

We could also derive the ADF(O^+) for seven objects of our sample. Given the low critical densities of the [S II] and [O II] lines used to compute densities, we have to manage with caution with the densities obtained from these ratios, especially when computing abundances from density-sensitive collisionally excited lines, such as [O II] $\lambda\lambda$3726+29. In Figure 2 we show the dependence of the ADF with the assumed density for the O^+ zone. This strong dependence is due to O^+/H^+ computed from [O II] CELs is extremely dependent of the assumed density, whether the same abundance ratio obtained from pure RLs is almost independent on the electron density.

[5]IRAF is distributed by the NOAO, which is operated by AURA, Inc., under contract to the National Science Foundation.

REFERENCES

García-Rojas, J., & Esteban, C. 2007, ApJ, 670, 457
García-Rojas, J., et al. 2009, A&A, 496, 139
Liu, X.-W., et al. 2000, MNRAS, 312, 585
Rola, C., & Stasińska, G. 1994, A&A, 282, 199