# ABUNDANCES OF C, N AND O IN PLANETARY NEBULAE

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ABSTRACT. The abundances of C, N and O in planetary nebulae must correspond to the evolutionary status of their progenitor red giant stars. The best spectral features for abundance determination of these elements are the recombination lines, which depend weakly on the variations of $T_e$ and $n_e$. The abundance ratio of the ions $A^+$ and $H^+$ can be given by [1-3].

$$\frac{N(A^+)}{N(H^+)} = \left\{\frac{A^+}{H^+}\right\} = \frac{\lambda_{ki}}{\lambda(H\beta)} \frac{\alpha^{eff}(H\beta)}{\alpha^{eff}_{ki}} \frac{F_{ki}}{F(H\beta)} = X(T_e) \frac{F_{ki}}{F(H\beta)}, \qquad (1)$$

where $F_{xi}$ is the observed flux in a spectral line ki of ion A, corrected for interstellar extinction and $F(H\beta)$ is the same quantity for a $H\beta$ line, the quantities $\alpha^{eff}_{xi}$ and $\alpha^{eff}(H\beta)$ are the corresponding effective recombination coefficients. we present some values of approximation coefficients for the quantity $X(T_e) = X_0(T_e/10^4K)^n$ as found in papers [1-3]. Considering the spectral line C III λ4650, the high-temperature dielectronic recombination (cf. [5]) in its modification described in [1] must be taken into account.

We estimated the total abundances of C, N and O using the following formulae obtained by L. Aller and S. Czyzak [9] for the models of highly excited planetary nebulae:

$$\{C/H\} = \{(C\,III + C\,IV + C\,V)/H^+\},$$
$$\{N/H\} = 1.7\,\{(N\,IV + N\,V)/H^+\} = 2.0\,\{N\,IV/H^+\}, \qquad (2)$$
$$\{O/H\} = K\{O\,IV + O\,V)/H^+\},\ K = 3.6,\ 2.4,\ 2.0$$
$$\text{for } E_w = 8,\ 9,\ 10.$$

The correction factors for nitrogen and oxygen show that the contribution of lower ionization stages even for high excitation planetary nebulae is essential, and thus (2) underestimates for low excited nebulae the abundances.

Using the observed fluxes in the spectral lines of C, N and O ions [7-9], we estimated the abundances of these elements in 40 planetary nebulae of high excitation.

The mean values of C, N and O in the high excitation planetary nebulae exceed the solar values ($\{C/H\} = 4.7\text{-}4$, $\{N/H\} = 9.8\text{-}5$, $\{O/H\} = 8.3\text{-}4$) by 2 - 3 or more times. This accords with the "two-wind" hypothesis of planetary nebulae formation. However, from Table 2 it appears that for N and O the abundances found from the fluxes in recombination lines, are essentially higher than the values found from the fluxes in ultraviolet or forbidden lines. The reason for that has been discussed [1,9], but it has remained rather obscure up to now.



*S. Torres-Peimbert (ed.), Planetary Nebulae, 218.*