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ON THE ABUNDANCE GRADIENT OF THE GALACTIC DISK

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Our goal is to analyze the systematic errors in the determination of the chemical abundances in planetary nebulae introduced by a possible overestimation of the temperature, and its efect on the abundance gradient of the Galaxy. The gradient value provides constraints on chemical evolution models.

The empirical method used to determine the chemical abundances (Peimbert & Costero 1969) requires the temperature and density of the gas, which are obtained, respectively, from the observed the [O III] and [N II] line ratios,and from the [S II] line ratio (McCall 1984). Estimates of the [O III] temperature in planetary nebulae (PN) usually indicate values higher than the temperature obtained from the Balmer discontinuity (Liu & Danziger 1995). The difference could be due to temperature fluctuations (Peimbert 1971) or density fluctuations (Viegas & Clegg 1994).

The oxygen, nitrogen, sulfur and neon gradients were calculated using the optical emission-lines of type II planetary nebulae.

When some of the lines used in determining the physical conditions are not observed, usually, in the literature, the authors adopt a value for the density or for the temperature. Since we are searching for systematical errors, such an approach must be avoided, reducing the data sample. In order to increase the number of objects in our sample, a relation between T[O III] and T[N II] was found, using the excitation classes of the PN in the sample. The classes were defined following Ratag et al. (1997) suggestion based on the He II/He I and the [O III]/[O II] line ratios. Because the number of objects in each class was not enough to weel define a relation, photoionization models were used. The observational points agreed with the models for the low and intermediate excitation classes. For high excitation classes this method is not reliable.

In order to estimate the systematic error due to an overestimation of the temperature, it is assumed that T[O III] is overestimated by ΔT, for each PN. The value, ranging from zero to $\Delta T_{\rm max}$, is chosen following a probability $P(\Delta T)$ (constant, linearly increasing or linearly decreasing). Once the type of probability and $\Delta T_{\rm max}$ are chosen, the chemical abundances are recalculated for each PN in the sample, using $T = T[\rm O\,III] - \Delta T$ for the high ionization zone. A new value of the elemental abundance gradient, α, is then obtained by linear fit, for each chemical element, as well as the difference $\Delta\alpha = \alpha - \alpha_0$, where α_0 is the value before the temperature correction. The procedure is repeated 15 000 times and the $\Delta\alpha$ average value gives the estimate of the systematic error in the gradient due to an overestimation of the gas temperature.

TABLE 1

RESULTS OF THE HISTOGRAMS TO $\Delta T_{\rm max} = 4000$ K

	$\Delta\alpha$		
	P constant	P increasing	P decreasing
O	0.058 ± 0.028	0.086 ± 0.027	0.030 ± 0.019
N	0.058 ± 0.030	0.086 ± 0.029	0.030 ± 0.020
S	0.054 ± 0.036	0.083 ± 0.036	0.024 ± 0.022
Ne	0.052 ± 0.031	0.074 ± 0.027	0.030 ± 0.023

The results of Monte Carlo simulations are shown in Table 1 for $\Delta T_{\rm max}$ equal to 4000 K. The results obtained with a lower T[O III] steepen the gradient. The implications of this result are directly related to chemical evolution models, which adopt the radial abundance gradients as a constraint, and try to reproduce them.

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