TEMPERATURE FLUCTUATIONS IN PN

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For planetary nebulae, empirical abundances can be obtained from the observed emission-lines as long as the electron density, the electron temperature, and the ionization corrections factor are determined. However, due to temperature fluctuations in the emitting gas, the evaluation of the temperature from the observational data is strongly dependent on the method used. The temperature fluctuation is usually characterized by the mean square temperature fluctuation, t^2 (Peimbert and Costero, 1969 - PC).

Theoretical t^2 values have been discussed in detail for H II regions (Gruenwald and Viegas, 1992 - GV). These results show that t^2 decreases with the gas density. The stellar temperature is also an important parameter, but the t^2 dependence is not monotonic. Although planetary nebulae are denser, the stellar temperature can be higher than that of the H II region ionizing star. The temperature fluctuation could then still be important.

Theoretical t^2 values are obtained for typical PN conditions ($n_H = 10^2$-$10^6 \mathrm{cm}^{-3}$; T_*=30000-300000K; L_*=300-20000$L_\odot$; [Z]= Stasinska and Tylenda,1986) using the photoionization code Aangaba (GV). The main conclusions are the following: a) t^2 generally increases with stellar temperature, and can be high even at high densities; b) t^2 is higher for S ions; c) $t^2(\mathrm{H}^+)$ is not negligible, and increases very much with stellar temperature and luminosity, and also with the gas density; d) the effect of density is also important for N^+ ions; e) $t^2(\mathrm{O}^{++})$ is small, but $t^2(\mathrm{Ne}^{++})$ can be important at high stellar temperatures.

Since temperature fluctuations are more important for planetary nebulae with high stellar temperatures, the effect of t^2 on ionic abundance determinations in such nebulae is analyzed. The abundances of N^+, O^+, O^{++}, Ne^{++}, S^+, and S^{++} ions relative to H^+ are obtained for 47 high central stellar temperature PNe ($T_* \geq 10^5$K). Two cases are considered: a)no temperature fluctuation, considering $T_{[NII]}$ for the region where low ionization lines are formed, and $T_{[OIII]}$ where high ionization lines and Hβ are produced; b)the line temperature (PC) is obtained for each line from $T_{[NII]}$ (low ionization lines) or $T_{[OIII]}$ (high ionization lines and Hβ) and t^2 for the corresponding ion (from the models) . Data for T_*, L_*, n_e, $T_{[NII]}$, and $T_{[OIII]}$ for each nebulae are obtained from the literature. The calculations show that the ionic relative abundances are higher in case *b*, but, due to the combined effect of T_*, L_*, and gas density, t^2 of the analyzed objects are not high. Consequently, the differences in the ionic abundance determinations by the two methods are less than 20%, except for S^+ ions, which deviation can reach 48%.

References

Gruenwald, R.B. and Viegas, S.M. (1992), Ap.J.Suppl.Ser. 78, 153
Peimbert, M. and Costero, R. (1969), Bol.Obs.Ton.Tac. 6,29
Stasinska, G. and Tylenda, R. (1986) A.&A. 155,137