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New effective recombination coefficients for nebular N II lines⋆ *(Corrigendum)*

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1. Effective recombination coefficients

Errors in the computed effective recombination coefficients for nebular N II lines in an earlier publication (Fang et al. 2011) have been discovered and are here corrected. Those errors were not due to the basic atomic physics (i.e. creation of the N^{2+} target and the target wave functions, and calculations of bound-state energies, oscillator strengths and photoionization cross-sections for the N II states) but due to mislabeling of five N II bound-state energy levels. The $2p3p\,^3P^e_1$ level was originally labeled as $2p3p\,^3S^e_1$, the $2p3p\,^3S^e_1$ level was labeled as $2p3p\,^1P^e_1$, and the $2p3p\,^1P^e_1$ level was labeled as $2p3p\,^3P^e_1$; labels of the $2p3d\,^3D^o_2$ and $2p3d\,^1D^o_2$ levels were swapped. As a consequence, the effective recombination coefficients for the N II lines that are directly related to the above five states were incorrect. We have corrected the labeling of the N II energy levels and re-calculated the effective recombination coefficients for the N II lines at the same electron temperature and density ranges as in Fang et al. (2011). The newly calculated effective recombination coefficients are given in Tables 3–6.

2. Effective recombination coefficient fits

Analytical fits to the effective recombination coefficients as a function of electron temperature were carried out for the 55 strongest transitions of N II in the optical (Tables 7–14 in Fang et al. 2011), using a non-linear least-squares algorithm. Two temperature regimes were defined, the low-temperature regime (T_e < 10 000 K) and the high-temperature regime (10 000 ≤ T_e ≤ 20 000 K), and different fit equations were used for the two regimes (Eqs. (3) and (4) in Fang et al. 2011). However, the fit equation for the high-temperature regime (Eq. (4)) was not ideal. In the current corrigendum, we present new analytical fits for the 55 lines of N II, using the single equation, valid for 125 K ≤ T_e ≤ 20 000 K,

$$\alpha = a + b\,t + c\,t^2 + (d + e\,t + f\,t^2)\log_{10} t + g\,(\log_{10} t)^2 + h/t, \quad (1)$$

where $\alpha = \log_{10}\alpha_{\rm eff} + 15$ and $t = T_e\,[{\rm K}]/10^4$, and $\alpha_{\rm eff}$ is the effective recombination coefficient of an N II line as defined by Eq. (2) in Fang et al. (2011). a, b, c, d, e, f, g and h are fit parameters as given in Tables 7–10 (for Case B recombination) and Tables 11–14 (for Case A recombination). The fit equation Eq. (1) has taken into account the behaviour of the contribution from radiative recombination (RR), which has an approximately power-law dependence on electron temperature ($\alpha_{\rm RR} \propto T_e^{-a}$, $a \sim 1$), and a possible contribution from dielectronic recombination (DR), which has an exponential dependence on temperature ($\alpha_{\rm DR} \propto T_e^{-3/2}\exp(-E_{\rm ex}/kT_e)$, where $E_{\rm ex}$ is the excitation energy of an autoionization state, to which an electron is captured.

At all densities and temperatures considered, the maximum fitting errors (the last column in Tables 7–14) of the effective recombination coefficients for the 55 transitions of N II are no more than 0.86 per cent, except for the lines of the M5 ($3p\,^3P - 3s\,^3P^o$) multiplet at the density of 10^5 cm^{-3} and for T_e ≤ 250 K in case A, where the maximum fitting error is 1.45 per cent (Table 14). The average fitting errors (the penultimate column in Tables 7–14) are all less than 0.21 per cent, and less than 0.1 per cent for most of the transitions, except for the M5 lines at the density of 10^5 cm^{-3} in case A, where the average fitting errors are 0.26–0.33 per cent (Table 14). Figure 1 visually demonstrates the accuracy of the new analytical fits to the M3 λ5679.56 ($2p3p\,^3D_3 - 2p3s\,^3P^o_2$) line, which is the strongest line of N II detected in the spectra of emission line nebulae.

3. Total recombination coefficients

Table 15 is a comparison of our revised direct recombination coefficients to states of N^+ with those of Kisielius & Storey (2002) and Nahar (1995).

⋆ Corrected Tables 3–15 are all available at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/viz-bin/qcat?J/A+A/530/A18. Effective recombination coefficients at an extended temperature and density range are available from the authors.

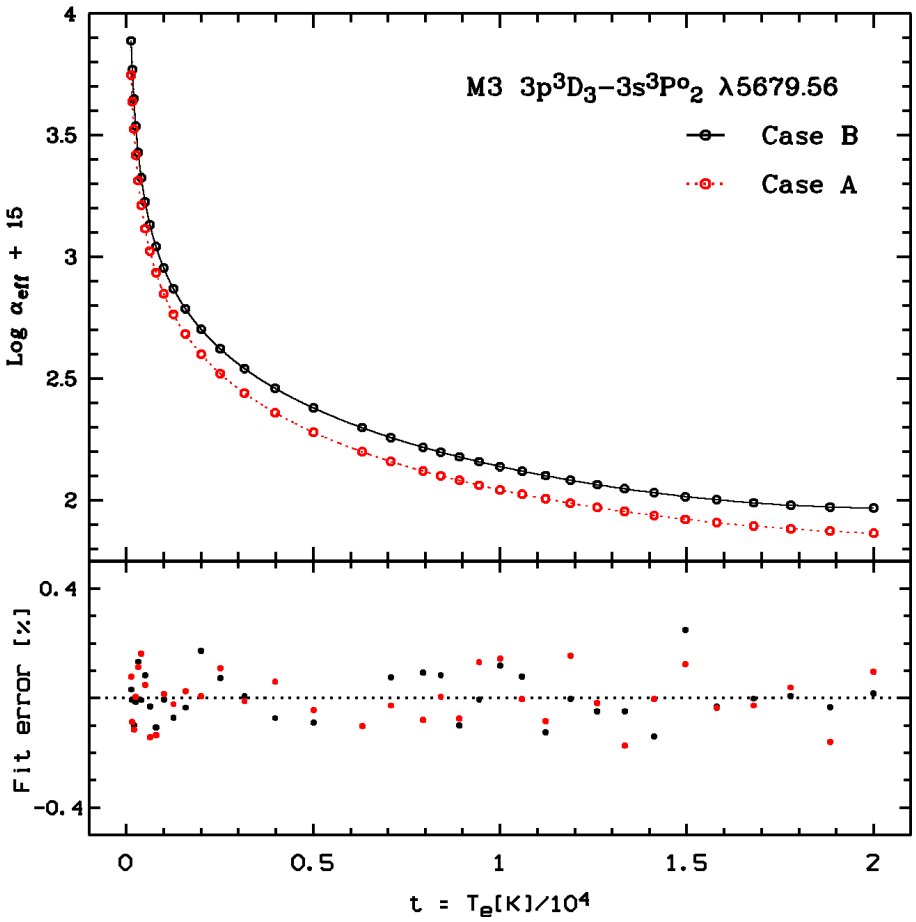

Fig. 1. Analytical fits to the Case A (the red circles) and Case B (the black circles) effective recombination coefficients for the N II M3 λ5679.56 ($2p3p\ ^3D_3 - 2p3s\ ^3P^o_2$) line, at an electron density of 10^4 cm^{-3}. *Upper panel*: the red dotted and the black solid curves are the analytical fits (Eq. (1)) to the Case A and Case B effective recombination coefficients, respectively. *Lower panel*: fitting errors (in percentage) of the Case A (the red dots) and Case B (the black dots) data.

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