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Erratum

Semi-classical collisional functions in a strongly correlated plasma

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Abstract. An unfortunate error has been found in the expression (Eq. (31)) of the ion sphere potential in Ben Chaouacha et al. (2004, A&A, 419, 771). Corrected expressions are given and the associated collisional functions are replotted.

Key words. atomic processes – errata, addenda

Due to an unfortunate error, a factor 1/2 is missing in Eq. (31) in Ben Chaouacha et al. (2004). That equation is consequently wrong. The correct expression of the Ion Sphere Potential model is as follows:

$$\begin{cases} V_{\rm IS}(t) = \dfrac{1}{r_{ip}}\left(1 - \dfrac{3}{2}\dfrac{r_{\rm p}}{R_{\rm c}} + \dfrac{1}{2}\dfrac{r_{\rm p}^3}{R_{\rm c}^3}\right);\ r \le R_{\rm c} \\ V_{\rm IS}(t) = 0;\ r > R_{\rm c}. \end{cases} \quad (1)$$

Thus, the $J_{1\mu}$ functions in Eq. (38) is changed by:

$$J_{1\mu}^{\rm IS} = \int_{-\infty}^{+\infty} {\rm e}^{i\omega_{ij}t}\left[\frac{Y_{1\mu}\left(\widehat{r_{\rm p}}\right)}{r_{\rm p}^2} - \frac{3}{2}\frac{Y_{1\mu}\left(\widehat{r_{\rm p}}\right)}{R_{\rm c}r_{\rm p}} + \frac{1}{2}\frac{r_{\rm p}Y_{1\mu}\left(\widehat{r_{\rm p}}\right)}{R_{\rm c}^3}\right]{\rm d}t. \quad (2)$$

Consequently, the collision functions for the transition probability $A_0^{\rm IS}(z)$ in Eq. (40) and $A_\pm^{\rm IS}(z)$ in Eq. (41) are written as follows:

$$A_0^{\rm IS}(z) = \left[zK_0(z) - \left(\frac{3}{2}\right)\frac{\pi z}{2z_{\rm c}}{\rm e}^{-z} + \left(\frac{1}{2}\right)\left(\frac{z}{z_{\rm c}}\right)^3\left(\frac{\sin(x_{\rm c}z)}{z^2} - \frac{x_{\rm c}\cos(x_{\rm c}z)}{z}\right)\right]^2 \quad (3)$$

$$A_\pm^{\rm IS}(z) = \frac{1}{2}\left[zK_1(z) - \left(\frac{3}{2}\right)\frac{\pi z}{2z_{\rm c}}{\rm e}^{-z} + \left(\frac{1}{2}\right)\frac{z^2}{z_{\rm c}^3}\sin(x_{\rm c}z)\right]^2. \quad (4)$$

The functions $\alpha_2(z)$, $\alpha_3(z)$ and $\alpha_4(z)$ of Eqs. (46)–(48) are rectified as follows:

$$\alpha_2(z) = -\frac{z^2}{16z_{\rm c}^6}\left\{1 + \frac{x_{\rm c}z^2}{2}\right\} + \frac{z}{8x_{\rm c}z_{\rm c}^6}\left\{\frac{11}{4} - \frac{z^2x_{\rm c}^2}{2}\right\}\sin(2x_{\rm c}z) + \frac{1}{8x_{\rm c}z_{\rm c}^6}\left\{\frac{11}{8x_{\rm c}} - \frac{7z^2x_{\rm c}}{4}\right\}\cos(2x_{\rm c}z) \quad (5)$$

$$\alpha_3(z) = \left\{\frac{z^2}{5}K_3(z) - \frac{4z}{3}K_2(z) + K_0(z) + K_1(z)\right\}\frac{z\sin(x_{\rm c}z)}{z_{\rm c}^3} - \left\{\left(\frac{7}{3}+\frac{2z}{3}\right)K_1(z) + \left(\frac{z^2}{5} - \frac{2z}{3}\right)K_2(z)\right\}\frac{zx_{\rm c}\cos(x_{\rm c}z)}{z_{\rm c}^3} \quad (6)$$

$$\begin{aligned}\alpha_4(z) = & -\frac{3\pi}{4z_{\rm c}^4}\frac{z{\rm e}^{-z}}{1+x_{\rm c}^2}\left\{\left(1 + zx_{\rm c}^2\right)\sin(x_{\rm c}z) + x_{\rm c}(1-z)\cos(x_{\rm c}z)\right\} - \frac{3\pi}{4z_{\rm c}^4}\frac{{\rm e}^{-z}}{\left(1+x_{\rm c}^2\right)^2} \\ & \times\left\{\left(1 + x_{\rm c}^2(4z-1)\right)\sin(x_{\rm c}z) + 2x_{\rm c}\left(1 - z\left(1 - x_{\rm c}^2\right)\right)\cos(x_{\rm c}z)\right\} + \frac{3\pi}{4z_{\rm c}^4}\frac{x_{\rm c}{\rm e}^{-z}}{\left(1+x_{\rm c}^2\right)^3} \\ & \times\left\{2x_{\rm c}\left(x_{\rm c}^2 - 3\right)\sin(x_{\rm c}z) + 2\left(1 - 3x_{\rm c}^2\right)\cos(x_{\rm c}z)\right\}. \end{aligned} \quad (7)$$

The functions $\beta_2(z)$, $\beta_3(z)$ and $\beta_4(z)$ of Eqs. (51)–(53) are rectified as follows:

$$\beta_2(z) = \frac{1}{16z_{\rm c}^6}\left\{\frac{z^4}{2} - \frac{z}{x_{\rm c}}\left(z^2 - \frac{3}{2x_{\rm c}^2}\right)z\sin(2x_{\rm c}z) - \frac{3}{2x_{\rm c}^2}\left(z^2 - \frac{1}{2x_{\rm c}^2}\right)\cos(2x_{\rm c}z)\right\} \quad (8)$$

$$\beta_3(z) = \frac{z^2}{z_{\rm c}^3}\left\{\left(K_2(z) - \frac{z}{5}K_3(z)\right)\sin(x_{\rm c}z) - \frac{x_{\rm c}z}{5}K_2(z)\cos(x_{\rm c}z)\right\} \quad (9)$$

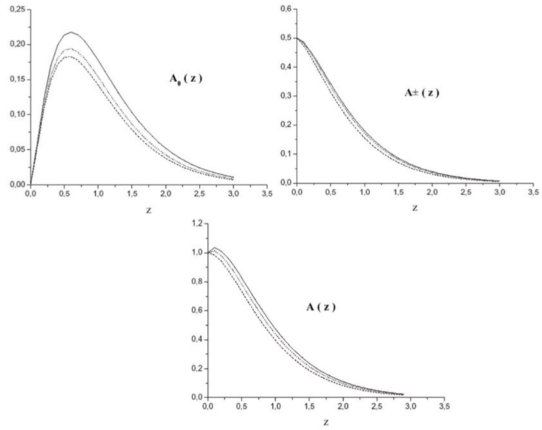

Fig. 1. Collision functions for the transition probability. Full lines: non-correlated functions $A_0(z)$, $A_\pm(z)$ and $A(z)$. Dotted lines: correlated functions $A_0^c(z)$, $A_\pm^c(z)$ and $A^c(z)$. Dashed lines: corrected strongly correlated functions $A_0^{IS}(z)$, $A_\pm^{IS}(z)$ and $A^{IS}(z)$ for $z_c = 20$.

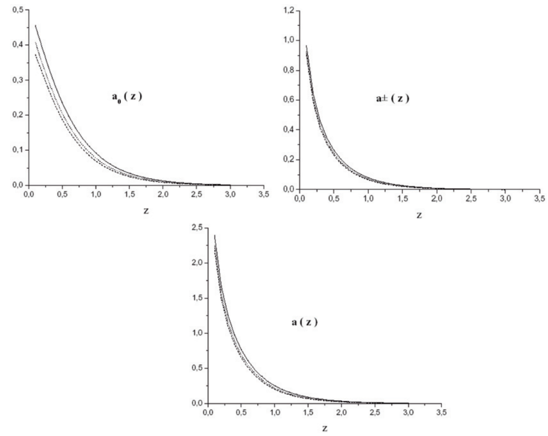

Fig. 2. Collision functions for the cross section. Full lines: non-correlated functions $a_0(z)$, $a_\pm(z)$ and $a(z)$. Dotted lines: correlated functions $a_0^c(z)$, $a_\pm^c(z)$ and $a^c(z)$. Dashed lines: corrected strongly correlated functions $a_0^{IS}(z)$, $a_\pm^{IS}(z)$ and $a^{IS}(z)$ for $z_c = 20$.

$$\begin{aligned}\beta_4(z) = & -\frac{3\pi}{4z_c^4}\frac{z^2 e^{-z}}{1+x_c^2}\left\{\sin(x_c z) + x_c\cos(x_c z)\right\} \\ & -\frac{3\pi}{2z_c^4}\frac{z e^{-z}}{\left(1+x_c^2\right)^2}\left\{\left(1-x_c^2\right)\sin(x_c z) + 2x_c\cos(x_c z)\right\} \\ & +\frac{3\pi}{2z_c^4}\frac{e^{-z}}{\left(1+x_c^2\right)^3}\left\{\left(3x_c^2-1\right)\sin(x_c z)\right. \\ & \left. + x_c\left(3-x_c^2\right)\cos(x_c z)\right\}. \end{aligned} \quad (10)$$

These new expressions do not alter the behavior of the collision functions relative to the Ion Sphere model for the transition probability and the cross section. In fact the collision functions plotted in Figs. 1 and 2 differ by less than 10% from the ones plotted in Ben Chaouacha et al. (2004) for the chosen value $z_c = 20$.

References

Ben Chaouacha, H., Ben Nessib, N., & Sahal-Bréchot, S. 2004, A&A, 419, 771