
Table 2A, T=1000K

Eqs (15) & (23) assuming a tenuous plasma

\[ \frac{d n(Z^+)}{d t} = -\alpha n(Z^+) n(e^-) \]
Radiative Recombination Only

\[ \frac{dn}{dt} = -\left( a_1 n + a_2 n^2 + a_3 n^3 \right) \]

\[ a_3 = 0 \Rightarrow \frac{1}{n} = \left( \frac{1}{n_0} + \frac{a_2}{a_1} \right) \exp(a_1 t) - \frac{a_2}{a_1} \]

\[ a_1 \approx \frac{1}{30 \mu s} \] constraint on fit for large t
Radiative Recombination Only

\[
\frac{1}{n} = \left( \frac{1}{n_0} + \frac{a_2}{a_1} \right) \exp(a_1 t) - \frac{a_2}{a_1}
\]

\[
G_0 = 290 \ GADC
\]

\[
a_2 = 3.58 \times 10^{-7} (GADC - ns)^{-1}
\]

\[
a_1 = 3.35 \times 10^{-5} \ ns
\]

Due to recombination alone at \( t=0 \)

\[
- \frac{1}{n_0} \frac{dn}{dt} \bigg|_{t=0} = a_2 G_0 = 1.04 \times 10^{-4} \ ns^{-1}
\]

Conclusion = Initial assumption that \( a_3 = 0 \) is not correct
Radiative & Collisional Recombination

\[
\frac{dn}{dt} = -\left( a_1 n + a_2 n^2 + a_3 n^3 \right)
\]

\[a_1 \equiv \frac{1}{30 \mu s}\] constraint on fit for large \(t\)

\[a_2 = 0 \Rightarrow \frac{1}{n^2} = \left( \frac{1}{n_0^2} + \frac{a_3}{a_1} \right) \exp(2a_1 t) - \frac{a_3}{a_1}\]

\(a_2 \& a_3 \neq 0\) is algebraically messy
Radiative & Collisional Recombination

\[ G_0 = 290 GADC \]
\[ a_2 = 4.80 \times 10^{-7} (GADC - ns)^{-1} \]
\[ a_3 = 6.38 \times 10^{-9} (GADC^2 - ns)^{-1} \]
\[ a_1 = 3.3 \times 10^{-5} \text{ ns}^{-1} \]

Due to recombination alone at \( t=0 \)

\[ \frac{1}{n_0} \frac{dn}{dt} \bigg|_{t=0} = a_2 G_0 + a_3 G_0^2 = 6.7 \times 10^{-4} \text{ ns}^{-1} \]

\[ n_0 = 4.8 \times 10^{13} \text{ cm}^{-3} \]

\[ \tau = \frac{1}{a_1} = 3 \times 10^4 \text{ ns} \]

Cubic term \( (a_3) \) dominates at E162 plasma density
Radiative & Collisional Recombination

\[ \frac{dn}{dt} = - \left( a_1 n + \alpha(n)n^2 \right) \]

\( \alpha \) can be fit with a polynomial

\[
\ln(\alpha) = 0.033146 \times \ln(n)^2 - 1.03288 \times \ln(n) - 39.1767
\]

Take plasma density to be proportional to the GADC

\[ n = CG \]

\[ \frac{dG}{dt} = -G(a_1 + \alpha(CG)CG) \]

Solve by Runge-Kutta integration with the initial value \( G = G_0 \) where \( G_0, a_1 \) and \( C \) are iterated.
Radiative & Collisional Recombination

\[ G_0 = 330.5 \]
\[ C = 7.46 \times 10^{10} \]
\[ a_1 = 5 \times 10^{-5} \text{ ns}^{-1} \]
\[ \tau = 20 \mu s \]

At \( t = 0 \), \( n = 2.47 \times 10^{13} \text{ cm}^{-3} \)

Fit with \( \tau = 30 \mu s \) was not good