Calculation of Te/Ti equilibration in SSX

The idea here is that we measure Te to be pretty constant in time (about 10 eV), while Ti starts high (about 25 eV) then cools. Let's see if Te/Ti equilibration could be the culprit. The equilibration rate is called *v*ie, the Coulomb logarithm is called Λ, the masses are scaled to the proton mass, I'll set Z=1 for both species. The first calculation uses the full formula from the NRL formulary (the NRL formula uses Mp and me in cgs units, I did that to get the formula below). The second one, using the constant collision frequency, is almost exactly the same (Ti/1836 is a tiny correction). At our densities (5×10^{15}, and Te=8 eV), equilibration is very fast.

In[51]:= `Mi = 1`

Out[51]= `1`

In[52]:= `Me = 1/1836`

Out[52]= $\frac{1}{1836}$

In[53]:= `Λ = 8.4`

Out[53]= `8.4`

In[54]:= `Ze = 1`

Out[54]= `1`

In[55]:= `Zi = 1`

Out[55]= `1`

In[56]:= `vie[n_, Te_, Ti_] :=` $3.24\times10^{-9}\,\frac{Zi^2\,Ze^2\,n\,\Lambda}{(Mi\,Te + Me\,Ti)^{3/2}}$

In[57]:= `vie[`10^{15}`, 10, 10]`

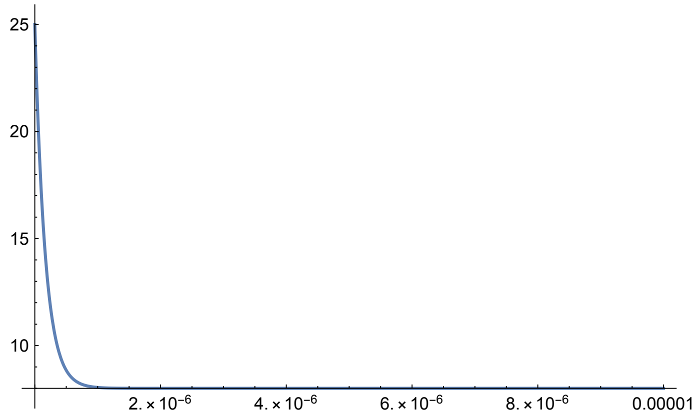
Out[57]= `859 943.`

In[58]:= `s = NDSolve[{Ti'[t] == vie[`5×10^{15}`, 8, Ti[t]] (8 - Ti[t]), Ti[0] == 25}, Ti, {t, 0, 0.001}]`

Out[58]= `{{Ti → InterpolatingFunction[` Domain: {{0., 0.001}} Output: scalar `]}}`

In[59]:= `Plot[Evaluate[Ti[t] /. s], {t, 0, 0.00001}, PlotRange → All]`

Out[59]=



In[60]:= vieSimple[n_, Te_] := $3.2 \times 10^{-9} \frac{Zi^2\ n\ \Lambda}{Te^{3/2}}$

In[61]:= vieSimple[10^{15}, 10]

Out[61]= 850020.

In[62]:= s = NDSolve[{Ti'[t] == vieSimple[5×10^{15}, 10] (8 - Ti[t]), Ti[0] == 25}, Ti, {t, 0, 0.001}]

Out[62]= {{Ti → InterpolatingFunction[Domain: {{0., 0.001}} Output: scalar]}}

In[63]:= `Plot[Evaluate[Ti[t] /. s], {t, 0, 0.00001}, PlotRange → All]`

Out[63]=