Reaching high laser intensity by a radiating electron

M. Jirka, et al, Phys. Rev. A 103, 053114
Notebook: Óscar Amaro, June 2021/Jan 2022 @ GoLP-EPP

Figure 1

Problem: what is the definition of T(τ)? By inspection it's possible to determine an approximate relation, though it does not seem to be explicit in the text.

In[787]:=
```
Clear[χe, εe, γe, Wγ, pc, tc, ω0, E0, εc, me, c, e, α, ħ, T, ES, λμm, τ]

χe = 2 γe E0 / ES;
γe = εe / (me c^2);
Wγ = 3^(2 / 3) × 28 Gamma[2 / 3] α me^2 c^4 χe^(2 / 3)  / (54 ħ εe) ;
pc = Wγ tc;
tc = τ / (2 Sqrt[2 Log[2]]);
ω0 = 2 π c / (λμm 10^-6);
E0 = 0.855 λμm Sqrt[I0 10^-18] me ω0 c / e;


εc = (1 - 16 / 63)^pc εe
(*Refine[//Simplify,{c>0,me>0,E0>0,ES>0,ħ>0,εe>0,τ>0}]//FullSimplify*)


me = 9.11 × 10^-31; (*[Kg]*)
c = 299 792 458; (*[m/s]*)
e = 1.602176634 × 10^-19; (*[C]*)
α = 1 / 137; (*[]*)
ħ = 1.054571817 × 10^-34; (*[J s]*)
T = 0.67 λμm 10^-6 / c;
ES = me^2 c^3 / (e ħ);(*[V/m]*)

LogLinearPlot[
 {((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ/(εe ħ)))
  //. {εe → 100 × 10^9 e, τ → T, λμm → 0.25},
```

```
((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 100 × 10^9 e, τ → T, λμm → 0.5},

((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 100 × 10^9 e, τ → T, λμm → 1},

((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 50 × 10^9 e, τ → T, λμm → 1},

((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 30 × 10^9 e, τ → T, λμm → 1},

((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 100 × 10^9 e, τ → 2 T, λμm → 1},

((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 50 × 10^9 e, τ → 2 T, λμm → 1},

((47/63)^(0.030199136711634034` c^4 me^2 (Sqrt[10] εe/(e ES))^(2/3) α τ)/(εe ħ)) //. {εe → 30 × 10^9 e, τ → 2 T, λμm → 1}},

{I0, 10^23, 10^25}, PlotRange → {{10^23, 10^25}, {0, 1}},
Frame → True, GridLines → Automatic]
```

Out[795]=
$$\left(\frac{47}{63}\right)^{\frac{3.01991\times10^{6}\, c^4\, me^2 \left(\frac{\varepsilon e}{e\, ES}\right)^{2/3} \alpha\, \tau}{\varepsilon e\, \hbar}} \varepsilon e$$

Out[798]=

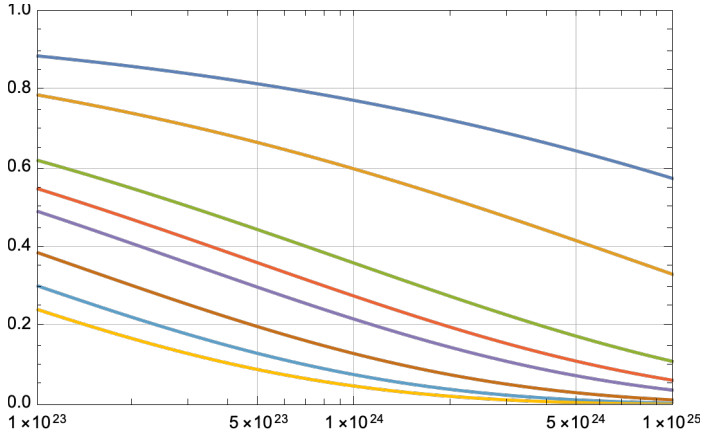

Figure 2

Confirm with figure

In[799]:=
```
Clear[χe, εe, γe, Wγ, pc, tc, tf, ω0, E0, εc, me, c, e, α, ħ, T, ES, λμm, τ]

χe = 2 γe E0 / ES;
γe = εe / (me c^2);
Wγ = 3^(2 / 3) × 28 Gamma[2 / 3] α me^2 c^4 χe^(2 / 3)  / (54 ħ εe) ;
tc = τ / (2 Sqrt[2 Log[2]]);
tf = τ / (Sqrt[2 Log[2]]);
pc = Wγ tc;
pf = Wγ tf;
ω0 = 2 π c / (λμm 10^-6);
E0 = 0.855 λμm Sqrt[I0 10^-18] me ω0 c / e;

me = 9.11 × 10^-31; (*[Kg]*)
c = 299 792 458; (*[m/s]*)
e = 1.602176634 × 10^-19; (*[C]*)
α = 1 / 137; (*[]*)
ħ = 1.054571817 × 10^-34; (*[J s]*)
T = 0.67 λμm 10^-6 / c;
ES = me^2 c^3 / (e ħ); (*[V/m]*)

I0 = 10^24;
εe = 50 × 10^9 e;
τ = T;
λμm = 1;

εc = (1 - 16 / 63)^pc εe;
γec = εc / (me c^2);
εf = (1 - 16 / 63)^pf εe;

εc / (10^9 e)
εf / (10^9 e)
χec = 2 γec E0 / ES
```

Out[817]= 13.7695

Out[818]= 3.79196

Out[819]= 111.784