Are we ready to transfer optical light to gamma-rays?

M. Vranic, T. Grismayer, S. Meuren, R. A. Fonseca, and L. O. Silva, Phys. Plasmas **26**, 053103 (2019)
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Introduction

In this notebook we reproduce some results from the paper.

Figure 2

In[403]:=
```
Clear[γF, σF, a0, θF, I22, I, γ0, k, θ];

(* eq 2: CRR final "average" electron energy *)
γF = γ0 / (1 + k γ0);

(* eq 3: CRR factor *)
k = 3.2 × 10^-5 I22 τ0 (1 - Cos[θ])^2;

(* eq 6: estimated final electron energy spread *)
σF = ( 1.5 × 10^-4 I22^1/2 γ0^3 / (1 + 6.1 × 10^-5 γ0 I22 τ0)^3 )^1/2;

(* eq7: estimated final electron angular spread, see [Vranic2016NJP]*)
θF = Sqrt[2/π] a0/γF^2 σF;

(* conversion between intensity and a0 *)
I22 = I 10^-22;
I = 10^+18 ( a0 / (0.855/√2) )^2;

(* parameters *)
θ = π;(*[] collision angle, counter-propagating *)
γ0 = 0.85/(0.511 × 10^-3);(*[] initial electron energy *)
a0 = 27;(*[] laser a0 *)

Plot[10^3 θF, {τ0, 0, 200}, Frame → True,
 FrameLabel → {"Pulse duration [fs]", "Angle [mrad]"},
 PlotRange → {0, 30}, PlotStyle → {{Blue, Dashed}}]
```

Out[413]=

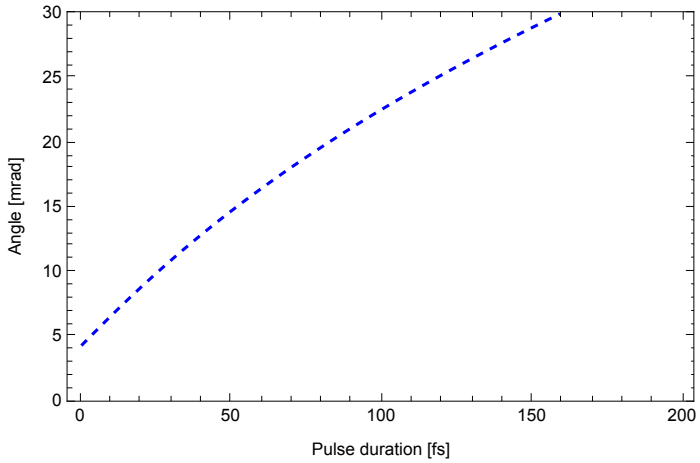


Figure 3

In[414]:=
```
Clear[a0, Δγ]
Δγ = 9 × 10^-4 a0^2 + 0.2 a0;
Plot[Δγ, {a0, 0, 2000}, FrameLabel → {"a0", "Δϵ per particle [mc^2]"},
 Frame → True, PlotStyle → {Red}, PlotLegends → {"Eq. (9)"}]
```

Out[416]=

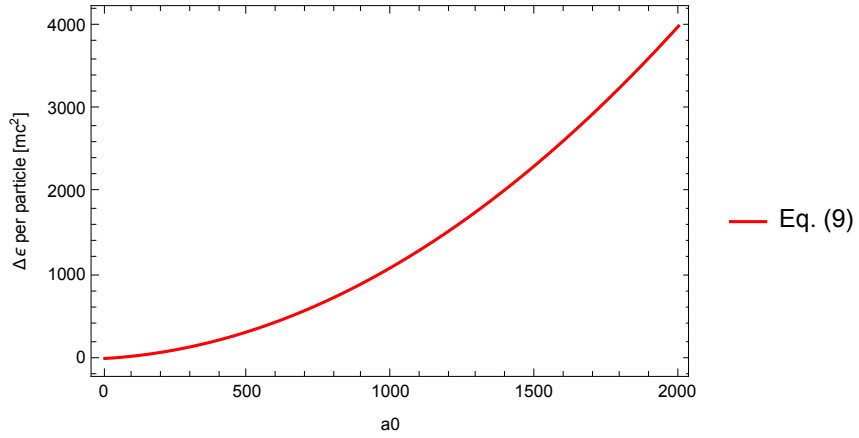
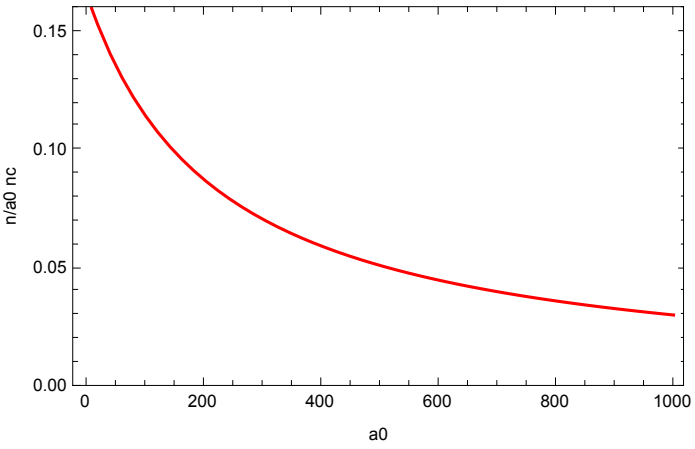


Figure 5

In[417]:=
```
Clear[Δϵϵ, a0, n, nc]
(*n=160nc;*)

(* eq 11 *)
Δϵϵ = 3 × (9 × 10^-4 a0 + 0.2) / a0 (n / nc);
(* 10% absorption *)
sol = Solve[Δϵϵ == 0.1, n][[1, 1, 2]]

Plot[{sol / a0 /. {nc → 1, n → 160}}, {a0, 0, 1000},
 Frame → True, FrameLabel → {"a0", "n/a0 nc"}, PlotStyle → Red,
 ImageSize → Medium, PlotLegends → Automatic, PlotRange → {0, 0.16}]

Plot[{sol /. {nc → 1, n → 160}}, {a0, 0, 1000},
 Frame → True, FrameLabel → {"a0", "n/nc"}, PlotStyle → Blue,
 ImageSize → Medium, PlotLegends → Automatic, PlotRange → {0, 32}]
```

Out[419]=
$$\frac{0.0333333\ a0\ nc}{0.2 + 0.0009\ a0}$$

Out[420]=



Out[421]=

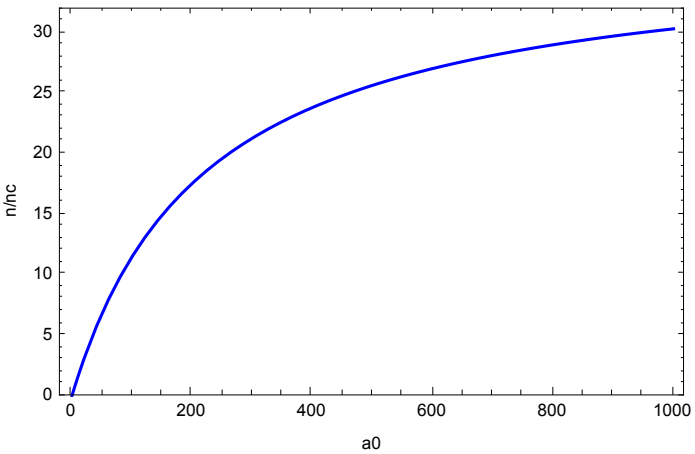


Figure 6

```
Clear[a0, ΓCP, ΓLPp, ΓLpm, ω0, aS, λ]

(* eq 12 *)
ΓCP = ω0 2.6 × 10^-3 a0 Exp[-2 aS / (3 a0^2)];

(* eq 13 *)
ΓLPp = ω0 1.8 × 10^-3 a0 Exp[-4 aS / (3 a0^2)];

(* eq 14 *)
ΓLPm = ω0 1.3 × 10^-3 a0 Exp[-8 aS / (3 a0^2)];

ω0 = 1;(*[ω0] for plotting purposes*)
λ = 1;(*[μm]*)
aS = 4.12 × 10^5 λ;(*[]*)

LogPlot[{ΓCP, ΓLPp, ΓLPm}, {a0, 100, 500}, PlotRange → {10^-6, 10^0}, Frame → True,
 FrameLabel → {"a0", "Γ/ω0"}, PlotLegends → {"ΓCP", "ΓLP+", "ΓLP-"},
 PlotStyle → {Red, {Blue}, {Blue, Dashed}}, Filling → {2 → {3}}]
```

Out[429]=