COMMENTS

Comments are short papers which criticize or correct papers of other authors previously published in the **Physical Review.** *Each Comment should state clearly to which paper it refers and must be accompanied by a brief abstract. The same publication schedule as for regular articles is followed, and page proofs are sent to authors.*

Comment on ‘‘Model for transmission of ultrastrong laser pulses through thin foil targets’’

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By discussing the results of Yu *et al.* [Phys. Rev. E **59**, 3583 (1999)] on the near-total transmission of laser pulses through highly overdense plasma foils, we show that they actually cannot explain the experimental results of Giulietti *et al.* [Phys. Rev. Lett. **79**, 3194 (1997)]. Simple analytical calculations as well as particle-in-cell simulations support our assertion. [S1063-651X(99)04011-8]

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Recently, Yu *et al.* [1] reported a numerical and analytical study on the penetration of ultrashort, relativistically intense laser pulse through highly overdense thin foil targets. Using one-dimensional (1D) PIC simulations they find near 100% transmission for a *p*-polarized pulse with dimensionless amplitude $q=3$, with $q=0.85[I\lambda^2/(10^{18}\ \mathrm{W\ cm^{-2}}\mu\mathrm{m}^2)]$, an ion density $n_i=50n_c$, with $n_c=(1.1\times10^{21}\ \mathrm{cm}^{-3}\ \mu\mathrm{m}^2)/\lambda^2$ as the critical density, and a ‘‘foil thickness 0.1 times the wavelength.’’ The onset of near-total transmission is due to the compression of electrons by light pressure, which reduces the ‘‘effective’’ target width. Thus, this mechanism seemed to account at least partially for the experimental results of Giulietti *et al.* [2], who observed near-total transparency of thin foil plastic targets at $q=1.2$.

It is the aim of this Comment to point out that the effect observed by Yu *et al.* actually holds only for much thinner targets than those used in the experiment. In fact, it is apparent that the target thickness used in the simulations of Yu *et al.* is $d=0.1\zeta_e$, with $\zeta_e=c/\omega$, and therefore $d=0.1\lambda/2\pi$ and *not* 0.1λ (as one reads in the Introduction of the paper), which would be close to the experimental value $d\simeq0.1\ \mu$m for $\lambda=0.815\mu$m. In the case $d=0.1\lambda$ one finds that the light pressure is too weak to push electrons against the ultrastrong recoil force of ions. In fact, a displacement δ of the electrons induces a backholding electric field $E_e=en_i\delta/\epsilon_o$ which corresponds to an electrostatic pressure $p_e=en_iE_e=(en_i\delta)^2/\epsilon_o$. For $\lambda=0.815\ \mu$m and $n_i=50n_c\simeq8\times10^{22}\ \mathrm{cm}^{-3}$ one finds $p_e\simeq(2\times10^{19}\ \mathrm{N\ m^{-2}})\delta^2$ with δ measured in μm. The light pressure for $q=3$ is $p_L\leqslant 2I/c\simeq1.33\times10^{15}\ \mathrm{N\ m^{-2}}$. Therefore, $p_e\simeq p_L$ if $\delta\simeq8\times10^{-3}\ \mu$m as in the case actually studied by Yu *et al.*, but $p_e\simeq64p_L$ if $\delta\simeq0.04\ \mu$m, as would be the case in order to induce transparency in a 0.1λ thick target; therefore, in the latter case no large charge separation might be built up.

To prove our assertions, we have performed 1D PIC simulations for the same parameters of Yu *et al.* and for both cases $d=0.1\lambda$ and $d=0.1\lambda/2\pi$. The results are shown in Fig. 1. In the first case the ratio between the transmitted and the incident pulse is only of the order of 10^{-2}; charge separation is found only in a very thin surface layer as expected. In the second case, we basically recover the results of Yu

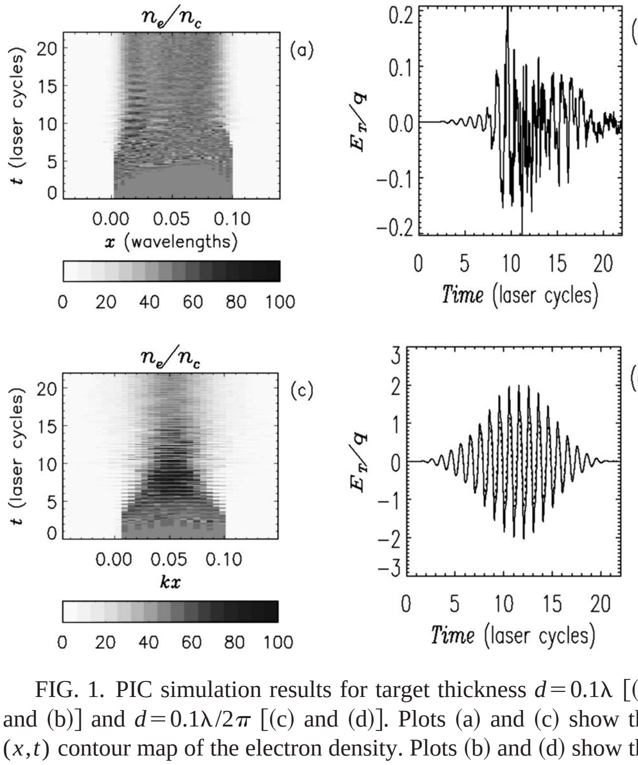

FIG. 1. PIC simulation results for target thickness $d=0.1\lambda$ [(a) and (b)] and $d=0.1\lambda/2\pi$ [(c) and (d)]. Plots (a) and (c) show the (x,t) contour map of the electron density. Plots (b) and (d) show the transmitted electric field vs time. The dashed line in plot (d) corresponds to the case of the inclusion of the Liénard-Wiechert correction in the calculation [3]. Notice the different length scales between (a) and (c).

et al.. It is, however, interesting to notice that, in this case, the Liénard-Wiechert correction as discussed in [3] is quite significant; for instance, when included in the simulations for the $d = 0.1\lambda/2\pi$ case it leads to a decrease in transmission of the order of $\simeq 50\%$ [Fig. 1(b)].

In conclusion, our calculations confirm the onset of high laser transmission for target thicknesses $\simeq 0.1\lambda/2\pi$ and other parameters equal to the case studied by Yu *et al*. [1]. Such ultrathin targets may be produced by appropriate manufacturing techniques and thus the effect may be used for shaping of ultraintense pulses as suggested by Yu *et al*. For target thicknesses $\simeq 0.1\lambda$, however, the transmission results are very small; therefore, the effect cannot account for the experimental results of Giulietti *et al*. [2].

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[1] W. Yu *et al.*, Phys. Rev. E **59**, 3583 (1999).
[2] D. Giulietti *et al.*, Phys. Rev. Lett. **79**, 3194 (1997).
[3] L. Plaja and E. Conejero Jarque, Phys. Rev. E **58**, 3977 (1998).