Opacity of relativistically underdense plasmas for extremely intense laser pulses [[1]](#footnote-1)\*)

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Propagation of laser radiation through electron-ion plasmas have been studied for decades. It is generally believed that relativistically underdense plasmas ($n\_{e}<a\_{0}n\_{cr}$) is transparent for intense laser radiation ($a\_{0}>1$) [1]: in this case even plasmas more dense then critical can become transparent due to realtivistic mass increase of plasma electrons, which build so called relativistic self-induced transparency (RSIT). Here is the density of electron plasmas, is the plasmas critical density, and $a\_{0}={eE\_{0}}/{mc}ω$is the dimentionless laser field amplitude.

 However, particle-in-cell simulations with 3D code QUILL[2] reveal abnormal laser field absorption above the intensity threshold about W cm-2 for the wavelength of 1 μm. Above the threshold, the further increase of the laser intensity doesn’t lead to the increase of the propagation distance (estimated by losing 50% of the field energy).

The simulations take into account emission of hard photons and subsequent pair photoproduction in the laser field. These effects lead to onset of a self-sustained electromagnetic cascade[3] and to formation of dense electron-positron (e+e-) plasma right inside the laser field. The plasma absorbs the field efficiently, that ensures the plasma opacity. The role of a weak longitudinal electron-ion electric field in the cascade growth is discussed[4].

At the same time smulations without electron-positron pairs photoproduction demonstrate that plasmas still transparent for laser radiation, and laser propagation distance growth with approximately linear low by the laser field amplification.

Before this work laser field absorption were only discussed for complication fields and dense plasma targets.

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References

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