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I4.204 Novel regimes of high-intensity laser-plasma interactions enabled by extreme magnetic fields

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Newly constructed laser facilities such as ELI NP and ELI Beamlines are expected to deliver unprecedented laser intensities, making it possible to probe new regimes of light-matter interactions in laboratory conditions. One such regime is where a laser-irradiated solid material becomes relativistically transparent and enables laser propagation though an otherwise prohibitively dense electron population. We found that a collective electron response to the laser pulse results in a MA-level current that sustains previously inaccessible quasi-static magnetic fields with a strength reaching a MT [1, 2]. This magnetic field qualitatively alters the electron dynamics in the propagating laser pulse, making it possible to
- Accelerate electrons to GeV energies over just tens of laser wavelengths [3];
- Induce efficient and directed -ray emission at intensities as low as 5 x 10^22 W/cm^2, with over 10^12 multi-MeV photons in a 30 fs bunch [1];
- Produce proton accelerating structures that generate dense mono-energetic beams with 200 MeV in energy and tens of nC of charge [4].

Using 3D kinetic simulations, we found that structured targets with a pre-filled lower density channel are essential for generating the magnetic fields in a controlled way. These targets mitigate plasma cavitation, thus extending the volumetric laser-plasma interaction for longer laser beams (e.g. 150 fs long L4 beam at ELI Beamlines). We also found that structured targets can aid the detection of the extreme magnetic fields using XFEL beams by reducing the effect of the relativistic transparency for the probing x-ray photons [5].
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References

[1] D. Stark, T. Toncian, and A. Arefiev, Phys. Rev. Lett. 116, 185003 (2016)
[2] O. Jansen, T. Wang, D. Stark, E. d'Humieres, T. Toncian, and A. Arefiev, PPCF 60, 054006 (2018)
[3] Z. Gong, F. Mackenroth, T. Wang, X. Q. Yan, T. Toncian, and A. Arefiev, arXiv:1811.00425 (2018)
[4] A. Arefiev, Z. Gong, T. Toncian, and S. S. Bulanov, arXiv:1807.07629 (2018)
[5] T. Wang, T. Toncian, M. S. Wei, and A. Arefiev, Phys. Plasmas 26, 013105 (2019)

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