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Energy absorption, photon-photon scattering and channelling with ultra-intense laser pulses

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I will present an overview the research being undertaken in my group at the Clarendon Laboratory, University of Oxford and with colleagues at the Rutherford Appleton Laboratory. We are particularly interested in exploring how laser energy is absorbed in the laser-QED regime for the 10 PW laser pulses that will shortly be available with the ELI facilities. We have found that there is a regime change in the dependence of fast electron energy on incident laser energy that coincides with the onset of pair production via the Breit-Wheeler process. This prediction is numerically verified via an extensive campaign of QED-inclusive particle-in-cell simulations. The dramatic nature of the power law shift leads to the conclusion that this process is a candidate for an unambiguous signature that future experiments on multi-petawatt laser facilities have truly entered the QED regime [https://arxiv.org/abs/1901.08017]. We have also investigated the effect of orbital angular momentum on photon-photon scattering in vacuum and found that the generated beam also carries a unique orbital angular momentum signature, thereby greatly improving the signal to noise ratio This forms the basis for a future high-power laser experiment utilizing quantum optics techniques to filter the generated photons based on their orbital angular momentum states. [https://arxiv.org/abs/1902.05928]. Finally, I will review hole-boring and channelling simulations and experiments confirming that it is possible to overcome the hosing and filamentation instabilities to generate a straight channel in the coronal plasma of a fusion pellet. This provides a new route to augment the heating of the central hot spot for inertial fusion targets and allows the original fast ignition concept to be explored in detail.

Working group

Laser-driven electron acceleration

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