Contribution ID: **65** Type: **Poster (participant)**

Computational modelling of the semi-classical quantum vacuum in 3D

Tuesday, 15 April 2025 17:10 (1h 30m)

The commissioning of multi-Petawatt laser systems is gathering pace around the world, promising unparalleled access to ultra-high electromagnetic fields for fundamental Physics studies. Here, we present the first real-time three-dimensional simulation results of two quantum vacuum effects using a semi-classical numerical solver for the Heisenberg-Euler Lagrangian. The simulation model is benchmarked against vacuum birefringence analytical results using counter-propagating probe and pump pulses. Simulations of both plane-wave and Gaussian pulses show results consistent with theoretical predictions. The solver is then applied to four-wave mixing using three Gaussian pulses with real-time information on the output pulse for the first time. Results of the polarisation and power of the output pulse and the number of photons obtained from the interaction are obtained and compared with analytical theory based on the plane-wave model. The solver delivers key quantities such as asymmetry in the signal and near-focus field strengths that analytical predictions are unable to resolve. The output power and polarisation dependence on input polarisation is also investigated, and found to be consistent with the theoretical predictions.

Primary author: Ms ZHANG, Zixin (University of Oxford)

Co-authors: Ms JAMES, Abigail (University of Oxford); Mr DENIS, Elliott (University of Oxford); Mr OUATU, Iustin (University of Oxford); Prof. SILVA, Luis (Universidade de Lisboa); Dr VON DER LEYEN, Marko (University of Oxofrd); Prof. NORREYS, Peter (University of Oxford); Dr ABOUSHELBAYA, Ramy (University of Oxford); Dr TIMMIS, Robin (University of Oxford); Dr TORRES, Rui (Universidade de Lisboa); Dr GRISMAYER, Thomas (Universidade de Lisboa)

Presenter: Ms ZHANG, Zixin (University of Oxford)

Session Classification: Poster Session

Track Classification: Theory and simulations