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Exotic and intense lasers with orbital angular momentum for laser plasma interactions JORGE VIEIRA, Instituto Superior Tecnico (IST), RAOUL TRINES, Rutherford Appleton Laboratory (RAL), EDUARDO ALVES, IST, RICARDO FONSECA, DCTI/ISCTE Lisbon University Institute, JOSE T. MENDONCA, IST, PETER NORREYS, University of Oxford, ROBERT BINGHAM, RAL, LUIS SILVA, IST — Ultra-intense lasers have a multitude of applications in astrophysics, particle acceleration and radiation generation. Most advances were reached by exploiting a narrow set of fundamental laser properties, such as intensity and duration. The orbital angular momentum (OAM) is a new fundamental degree of freedom that can be exploited to reach new laser-plasma interactions regimes. Here, we explore the interaction between exotic laser pulses with orbital angular momentum, and plasmas resorting to theory and three-dimensional particle-in-cell OSIRIS [1] simulations. We will then explore Raman scattering processes in plasmas, and show that these process can amplify OAM lasers to intensities beyond the PW, similarly to the case of a Gaussian laser. We also show a new set of selection rules for the creation of new, initially absent laser modes with well defined OAM. We show that these intense OAM laser pulses could then be used to drive strongly non-linear plasma waves in the doughnut blowout regime [2]. We then show that the doughnut blowout regime can accelerate ring shaped electron and positron bunches.

[1] R.A. Fonseca et al, PPCF, 55 124011 (2013);
[2] J.Vieira et al, PRL 112, 215001 (2014).

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