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Ultra-intense high orbital angular momentum harmonic generation in plasmas JORGE VIEIRA, GoLP/Instituto de Plasmas e Fuso Nuclear, Instituto Superior Tcnico, Universidade de Lisboa, Lisbon, Portugal, R. TRINES, Rutherford Appleton Laboratory, E. P. ALVES, J. T. MENDONCA, GoLP/IPFN - IST, R.A. FONSECA, ISCTE-IUL, Lisboa, Portugal, P. NORREYS, University of Oxford, R. BIGHAM, Rutherford Appleton Laboratory, L. O. SILVA, GoLP/IPFN - IST — As an independent degree of freedom, it is in principle possible to manipulate the orbital angular momentum (OAM) independently of any other laser property. The OAM therefore stands in equal foot to any other fundamental property of light, such as its frequency. There are, however, many open questions regarding the ability to control the OAM as an independent degree of freedom. A striking example is high harmonic generation, for which there is no OAM counterpart. Here we investigate a high OAM harmonics technique to generate and amplify high OAM harmonics while preserving the laser frequency. The scheme, based on simulated Raman backscattering [J. Vieira et al Nat. Comms. 7, 10371 (2016)], employs a linearly polarised long pump containing more than one OAM level, and a counter-propagating linearly polarised signal beam. The high OAM harmonics result from angular momentum cascading from modes with lower OAM to the modes with higher OAM. The OAM harmonics spectrum can be tailored according to the OAM contents of the pump. We illustrate the scheme with the generation of prime OAM harmonics, an all-optical realisation of the Green-Tao theorem. We support our theoretical findings with 3D particle-in-cell (PIC) simulations using Osiris [R.A. Fonseca et al, PPCF, 55 124011 (2013)].

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