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Nonlinear generation and mixing of higher-order laser modes via Raman and Brillouin amplification

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Raman and Brillouin amplification in plasma have been promoted as a route to achieve strong compression of high-energy laser pulses to petawatt powers without the risk of damage to the gain medium [1,2]. However, thanks to their non-linear character, Raman and Brillouin amplification can also be used effectively to create and manipulate laser modes with exotic phase and polarisation topologies. In this paper, I will explore the varied landscape of Raman amplification with exotic laser modes. First, I will demonstrate the amplification of higher-order Laguerre-Gaussian (LG) and Hermite-Gaussian (HG) modes using basic Gaussian pump beams with lowest-order phase topology [3]. Second, I will show how the nonlinear character of Raman amplification can be used to create new LG or HG modes from existing modes, and to create laser modes with Orbital Angular Momentum (OAM) from beams without any initial OAM [3]. Third, I will show how Raman amplification can be used to drive cascades of LG modes with controllable OAM levels in the amplified seed pulse [4]. Finally I will demonstrate how Raman amplification can be used to amplify seed laser pulses with complex higher-order (Poincare) polarisation modes using pump beams with only basic linear or circular polarisation [5]. As an application, I will revisit the classic RFS / beat-wave scheme, and show how it can be used to drive plasma waves with OAM. This leads to the formation of a Megagauss axial magnetic field, which may find applications in charged beam collimation and microscale pinch [6].

References

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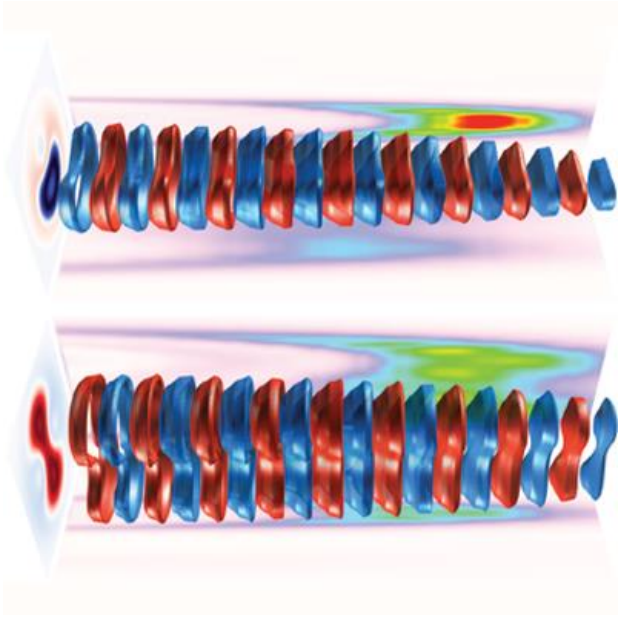

Figure 1: Simulation of seed electric field isosurfaces for pulses containing high orbital angular momentum harmonics driven by stimulated Raman backscattering in a plasma (plasma not shown). The pulses have 1 lobe (top) and 2 lobes (bottom). Image taken from Ref. [4].

Note: Abstract should be in (full) double-columned one page.