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Kinetic Inflation of Stimulated Raman Scattering Driven by a Broadband, Frequency-Modulated Laser Pulse

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The stimulated Raman scattering (SRS) instability can inhibit the performance of laser-driven inertial confinement fusion (ICF) implosions by scattering light into unwanted directions or by generating hot electrons that preheat the target fuel. In principle, ICF target designs can avoid parameter regimes conducive to large, linear SRS gains. In practice, kinetic inflation—the autoresonant enhancement of SRS due to electron trapping in the excited plasma wave—makes this difficult. Here we show that laser bandwidth in the form of frequency modulation can either decrease or increase the intensity threshold for kinetic inflation depending on the maximum chirp of the laser pulse. The threshold, mapped out by a series of particle-in-cell simulations, exhibits a minimum when the frequency change within the pulse cancels the spatial detuning due to density inhomogeneities along the trajectory of the scattered light. By tuning the chirp away from this minimum, the threshold can be larger than at zero bandwidth, providing a complementary approach to avoiding SRS. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0003856.