Analytical modelling of the spray amplification of a spatially smoothed laser beam

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Spatial amplification of the near-forward Brillouin scattering (FSBS) produced by a laser beam smoothed with a random phase plate (RPP) is considered by using a novel technique of evaluation of the scattered light amplification based on the central limit theorem [C. Ruyer et. al., Phys. Rev. E 107, 035208 (2023)]. It is demonstrated that FSBS amplification of an intense RPP beam proceeds over a length much larger than the longitudinal speckle correlation length and, under certain conditions, scales as a square of the average gain coefficient. Analytical expressions for the spatial gain are successfully compared with paraxial electromagnetic simulations, demonstrating that the beamlet correlation dominates the spatial growth for intense enough beams. The scattered wave aperture increases with the gain and can go beyond the small angle scattering limit. These results are in agreement with the recent experimental results and open the way for developing reduced modelling of beam spray amplification in radiation hydrodynamics codes.