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Analytical Models for Crossing-Beam Backward Stimulated Brillouin Scattering Amplifiers

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Backward Stimulated Brillouin Scattering (SBS) in gases offers a promising means to amplify short laser pulses to high energies while avoiding damage to the gain medium that solid state amplifiers experience. To optimize the yield of such amplifiers, modeling codes are required. In the high-pressure regime hydrodynamic theory using the Navier-Stokes model has been shown to agree with experimental results [1] while at lower pressures the behaviour of SBS can be predicted with kinetic theories using the Boltzmann-BGK model [2]. While these models can predict ideal gain coefficients, a more complete numerical calculation is required to include the effects of spatial and temporal non-uniformities in the beams. Additionally, in non-colinear SBS amplification systems, the pump/probe beams must pass through each other at small angles which these models do not consider. To verify the accuracy of any numerical calculations, a number of exact analytic cases are needed for comparison. We have developed several simple analytical models of SBS amplification for pulses with flat top and linear gradient spatial profiles at small crossing angles in the absence of pump depletion. These models have been extended to include pump depletion by incorporating the Frantz-Nodvik saturated gain equations [3]. These models are compatible with both the high and low pressure SBS regimes. The analytic models were then used to verify the results of a full numerical simulation in the low-pressure regime, which in turn was used to calculate the gain coefficients from experimental measurements. Further details of these models and examples of their application will be presented.

[1] E. E. Hagenlocker et al., Appl. Phys. Lett. Vol. 7, No. 9, pp. 236-238 (1965)
[2] V. S. Averbakh et al., Sov. J. Quant. Electron. Vol. 5, No. 10, pp. 1201-1206 (1975)
[3] L.M. Frantz et al., J. Appl. Phys. 24, 2346 (1963)

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Keyword-2

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