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Modelling seeded stimulated Brillouin scattering (SBS) and dispersion

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The dominant nonlinear effect within standard telecommunication fibers is stimulated Brillouin scattering (SBS). SBS can grow from a spontaneous process or it can be seeded for applications such as fiber amplifiers or fiber sensors. The spontaneous process occurs when a pump signal is scattered by thermal fluctuations within the fiber, resulting in a frequency downshifted Stokes signal. The seeded process involves injecting the counterpropagating pump and Stokes signals into their respective ends of the fiber and not relying on the random scattering from thermal noise for initiation. In applications that implement a seeded configuration, spontaneous generation is usually irrelevant and therefore SBS occurs primarily when the pump and Stokes overlap and drive stimulated scattering. Numerical models typically only incorporate attenuation and SBS within their equations while neglecting dispersion and other nonlinear effects. Under specific conditions it is possible for both pump and Stokes waves to travel significant distances, during which they may experience dispersion, before overlapping and interacting. We are presenting a hybrid numerical method that separates the propagation and interaction regimes within the fiber. The propagation of the pump and Stokes up to the interaction region is accomplished using a split step method which allows attenuation, dispersion, and nonlinear effects other than SBS to be included. Within the interaction region dispersion, SBS, and other nonlinear effects are evaluated through an implicit Runga-Kutta integration. This method is uniquely suited to evaluate situations with large propagations with relatively short interaction regions, allowing the pump and Stokes pulses to be altered by dispersive effects before coupling and transferring energy through SBS.

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