# Slow light in room-temperature optical waveguides

***Daniel Gauthier***
*Duke University, Department of Physics, Box 90305, Durham, NC, 27708, USA*

Over the last decade, there has been great progress in devising methods for tailoring the dispersion of optical materials, such as electromagnetically induced transparency, photonic crystals, and nano-optic resonators [1]. By tailoring the dispersion using all-optical methods, it is possible to adjust the group velocity $\upsilon_g$ of a pulse. Large normal dispersion, where the refractive index of the material increases with frequency over some range, results in slow light, where the group index $n_g$ is greater than one and $\upsilon_g$ is less than the speed of light in vacuum. Slow light has potential applications for optical buffering, data synchronization, optical memories, and optical signal processing.

Most slow light techniques rely on resonant effects that cause large normal dispersion in a narrow spectral region (approximately equal to the resonance width), as shown in Fig. 1. Much of the early slow-light research was conducted with near an atomic resonance in a gas of atoms, where large changes in $n_g$ where obtained by creating large optical coherence in the gas. More recently, it has been shown that simulated scattering process (such as stimulated Brillouin scattering [2, 3]) in laser-pumped optical waveguides gives rise to slow light at any wavelength where the material is transparent. This research has attracted considerable interest due to the inherent advantages with optical waveguides, such as compatibility with fiber-optic communication systems, room temperature operation, and the potential for large bandwidths [4].

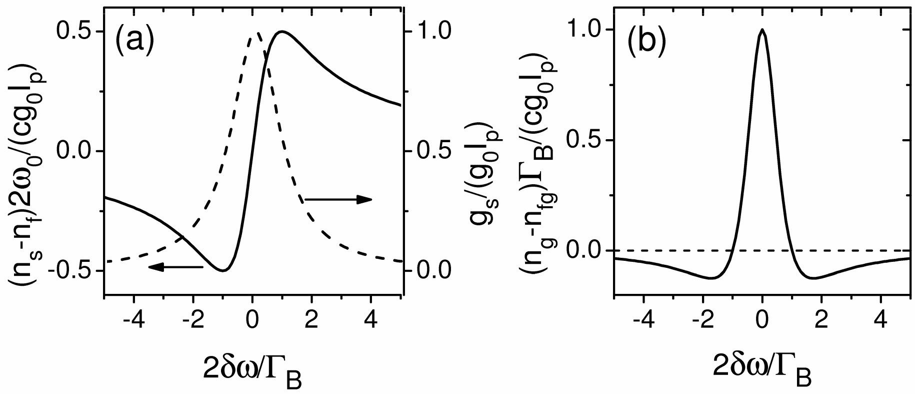


**Fig. 1** Slow light in an optical fiber due to stimulated Brillouin scattering. (a) The Stokes amplification resonance of width $2\Gamma_B$ (dashed line) and the associated change in refractive index (solid line). (b) Large normal dispersion near the center of the line shown in panel (a) gives rise to a positive group index (slow light) at line center.

Over the past year, researchers studying slow light via stimulated Brillouin scattering have demonstrated that it is possible to minimize pulse distortion by tailoring the higher-order dispersion of the material, operate at data rates over 10 Gb/s using broad-band pump light, obtain controllable delays exceeding one pulse width, and delaying pulses with minimal change in the pulse amplitude. Spurred by this work, there is active research in obtaining slow light in optical wave guides by stimulated Raman scattering and by the four-wave mixing process. Also, researchers are moving into the nonlinear regime to study slow-light with optical solitons. Simultaneously, results from the basic science laboratories are transitioning to applications-oriented laboratories who are integrating slow-light sub-assemblies into functions telecommunication components.

**References**

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