Stimulated Brillouin scattering

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Brillouin scattering

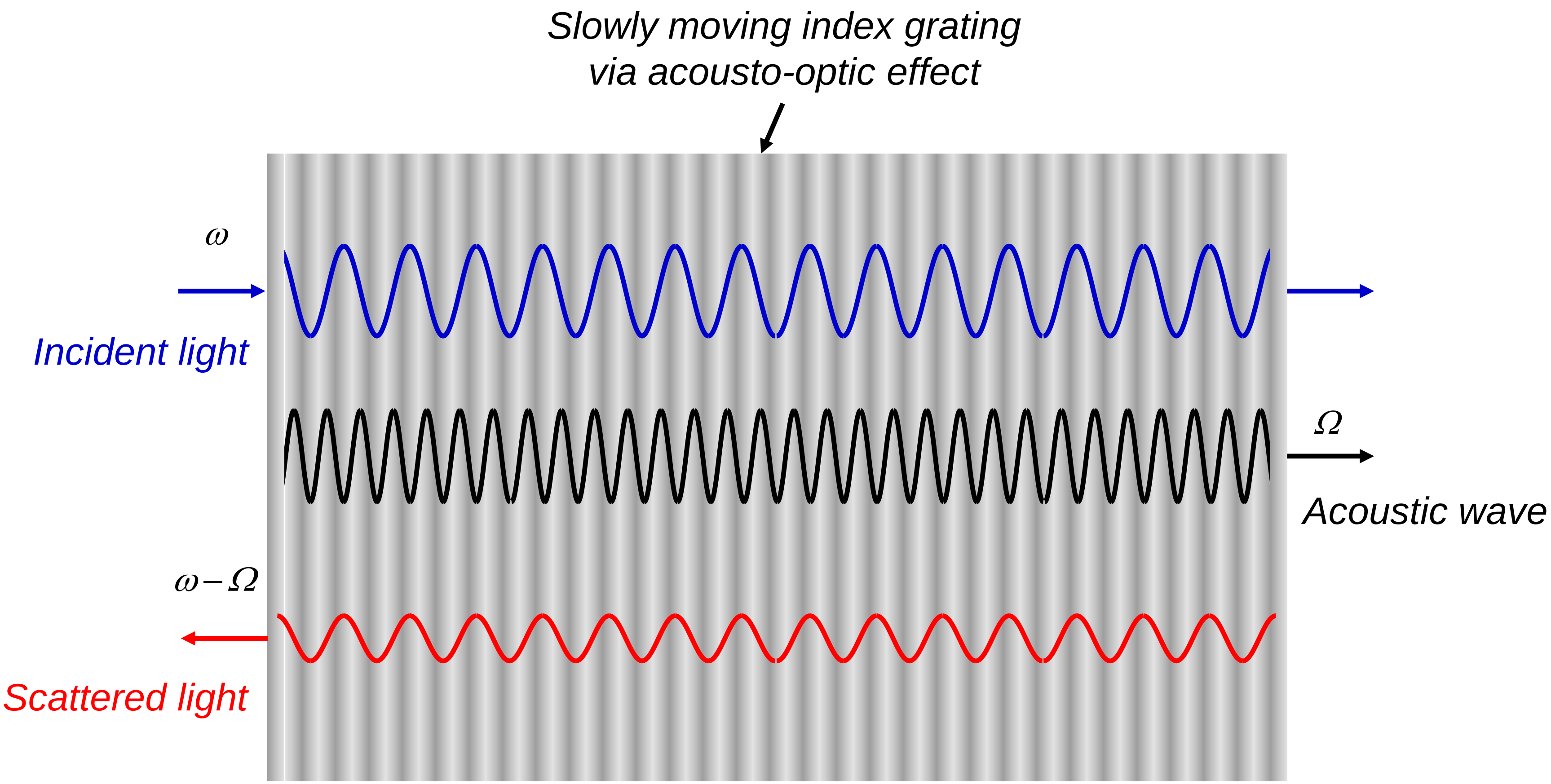
Predicted by Brillouin in 1922

The process of stimulated Brillouin scattering (SBS) was first observed by Chiao *et al.* in 1964.

Also related with inelastic scattering:
Frequency shift the order of 1 ~ 10 GHz

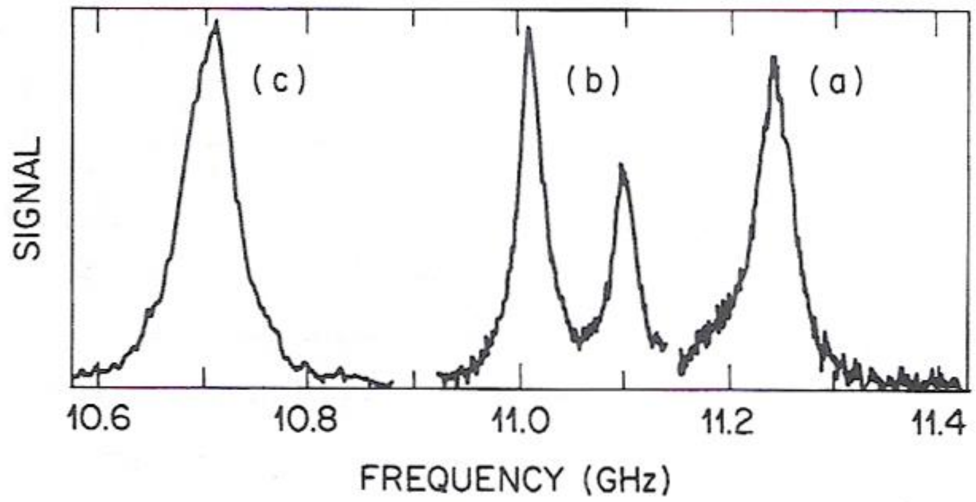
Nonlinear interaction between optical waves travelling in the opposite directions via acousto-optic effect

Stimulated Brillouin scattering



Brillouin gain

Raman-gain spectrum for fused silica at a pump wavelength $\lambda_p = 1\ \mu m$



Source: Nonlinear Fiber Optics, G. P. Agrawal

$$\frac{dI_p}{dz} = -g_B I_p I_s - \alpha I_p,$$

$$\frac{dI_s}{dz} = -g_B I_p I_s + \alpha I_s.$$

$$\frac{d}{dz}\left(I_p - I_s\right) = 0 \text{ for lossless media}$$

$g_B \sim 5\times10^{-11}$ m/W for silica glass

$\nu_B \sim 11.25$ GHz, $\Delta\nu_B \sim 17$ MHz

$$g_B(\Omega) = g_p \frac{(\Gamma_B/2)^2}{(\Omega-\Omega_B)^2 + (\Gamma_B/2)^2}, \quad \leftarrow \exp(-\Gamma_B t)$$

$$g_p = g_B(\Omega_B) = \frac{2\pi^2 n^7 p_{12}^2}{c\lambda_p^2 \rho_0 v_A \Gamma_B}.$$

Lorentzian spectrum: phonon lifetime, i.e. ~10 ns for silica glass

ν_B varies with the incident light frequency as well as material properties (density, strain & temperature)

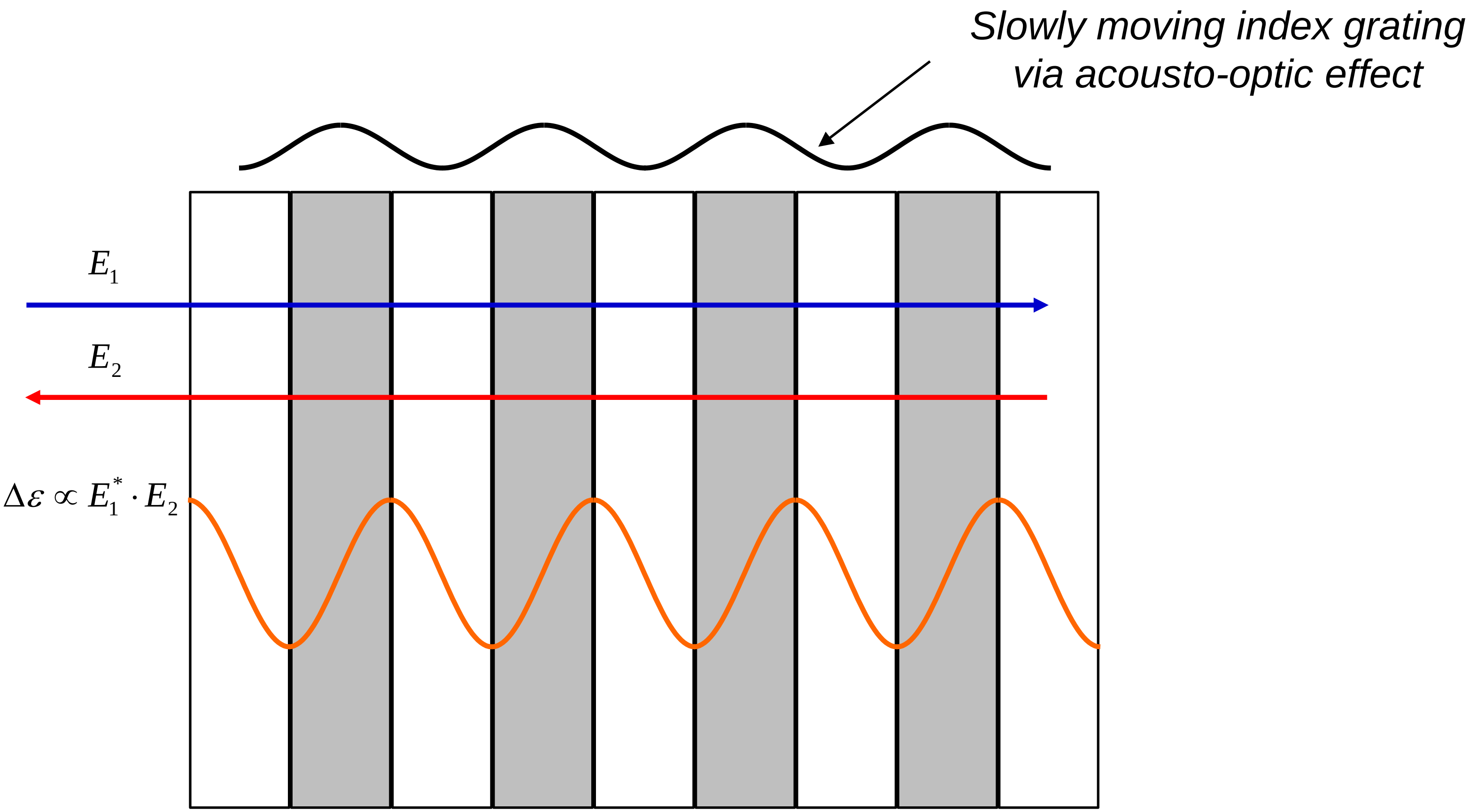
Brillouin spectroscopy

Nature Photonics, Volume 2, Issue 1, pp. 39-43 (2008).

Brillouin OTDA

J. Lightwave Technol. 7, 1170 (1989).

Phase conjugation mirror via SBS



Back reflection with phase-conjugation of the incident light!