Rajasthan Technical University, Kota
B.Tech. VI Semester ECE
Fiber Optics Communication

Unit 5: Lecture 03
Stimulated Raman Scattering (SRS)
Stimulated Brillouin Scattering (SBS)

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Contents

Introduction

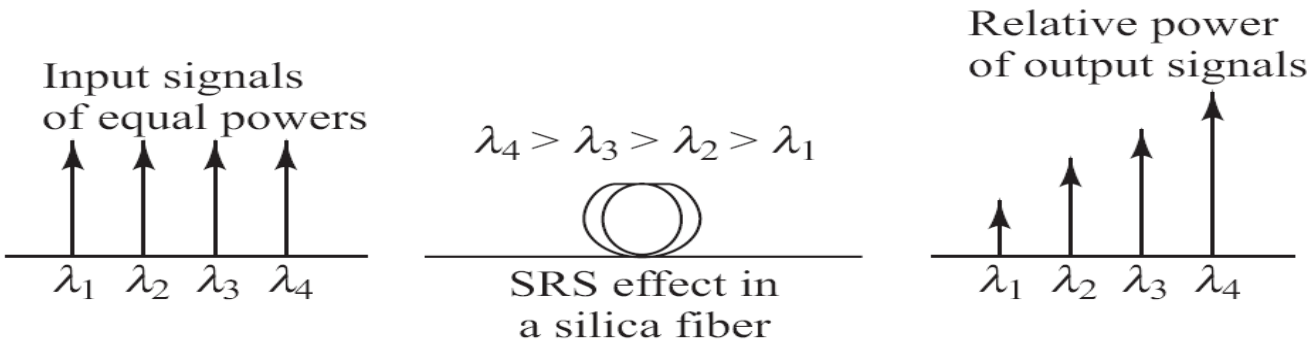
The origin of SRS and SBS lies in Ultrafast third-order susceptibility $\chi^{(3)}$.

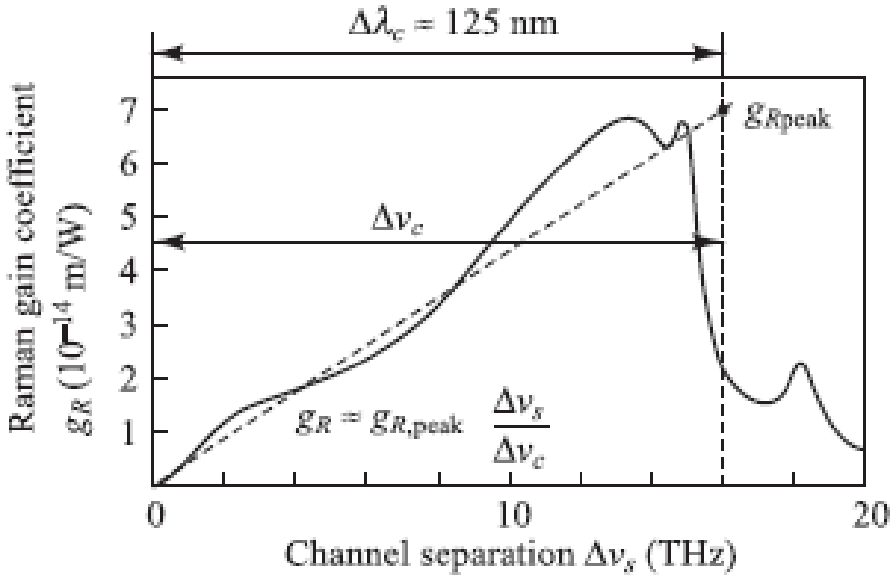
- Imaginary part leads to
  - Stimulated Brillouin Scattering(SBS)
  - Stimulated Raman Scattering (SRS)
- Non linearities due to Inelastic Scattering Process

Stimulated Raman Scattering

- SRS is interaction between lightwave and the vibrational modes of silica molecules.
- If a photon with energy hv_1 is incident on a molecule having vibrational frequency v_m, the molecule can absorb some energy from the photon.
- In this interaction, the photon is scattered thereby attaining a lower frequency v_2 (longer wavelength) and lower energy hv_2.
- The modified photon is called a stokes photon.
- Because the optical signal wave that is injected into a fiber is the source of the interacting photons, it is called the *pump wave* because it supplies power for the generated wave.
- This process generates scattered light at a wavelength longer than that of incident light.
- If another signal is already present at this longer wavelength then that signal is amplified.
- The power transferred to a higher-wavelength channel increases approximately linearly with channel spacing up to about 16 THz (or 125 nm at 1550-nm), and then drops off sharply for larger spacing.

Stimulated Raman Scattering



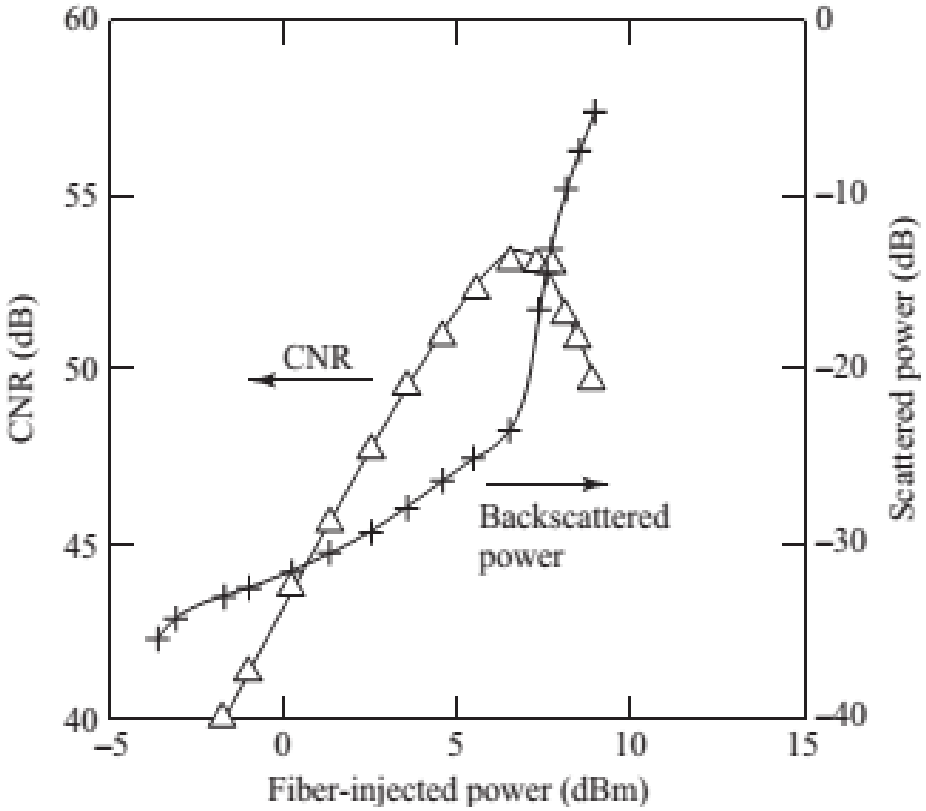


Stimulated Brillouin Scattering

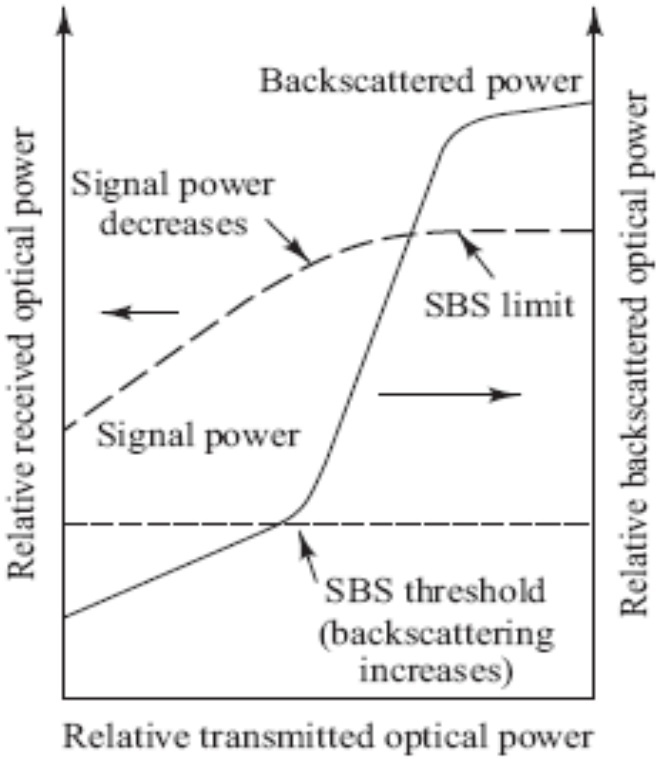
- In *stimulated Brillouin scattering (SBS)* a strong optical signal generates an acoustic wave that *produces variations in the refractive index*.
- The index variations *cause lightwaves to scatter in the backward direction towards the transmitter*.
- The backscattered light *experiences gain from the forward-propagating signals*, which leads to depletion of the signal power.
- Frequency of scattered light experiences a doppler shift:

$$\nu_B = 2nV_s/\lambda$$ n= referactive index; Vs= Velocity of sound in material

- Below a signal level called the *SBS threshold*, the transmitted power increases linearly with the input level and SBS is negligible.
- *Beyond the SBS threshold*, the % increase in signal depletion grows with signal strength
- Beyond the *SBS limit* any additional launched optical power is scattered backward in the fiber.
- SBS affects the power in same channel only.



The SBS impairment on the CNR of an AM-VSB signal. The triangles are the CNR and the crosses represent the backscattered power. (Adapted with permission from Mao, Bodeep, Tkach, Chraplyvy, Darcie, and Dorosier,[11] © IEEE, 1992)



The effect of SBS on signal power in an optical fiber

References

- Optical Fiber Communication, 5 e TMH by Gerd Keiser
- Optical Fiber Communications, 2 e Pearson Education by John M. Senior
- www.google.com

- Note: Author do not claim the originality of contents. The texts referred above have been used for preparation of this lecture for instructional purpose only.

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