

Stimulated Raman scattering

Dr Yoonchan Jeong

School of Electrical Engineering, Seoul National University

Tel: +82 (0)2 880 1623, Fax: +82 (0)2 873 9953

Email: yunchan@snu.ac.kr

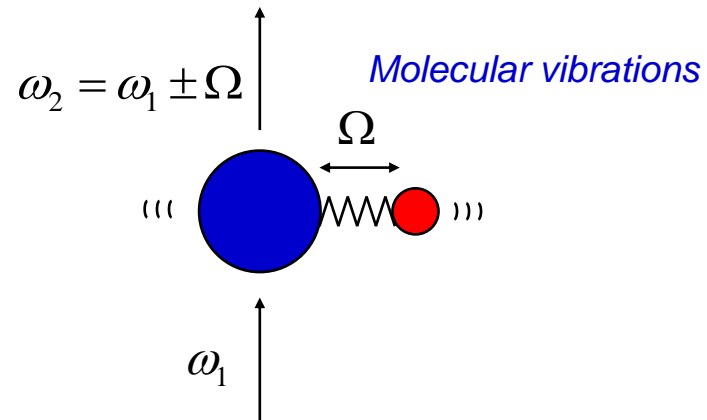
Raman scattering



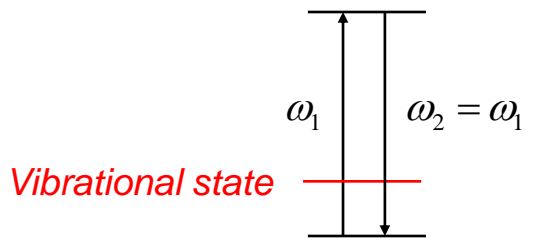
C. V. Raman
(Chandrasekara Venkataraman, 1888 -1970)

The Raman effect was discovered in 1928 by C. V. Raman.

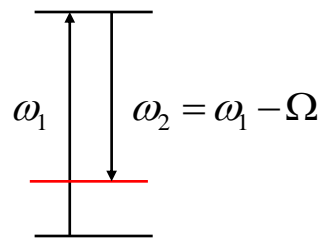
Inelastic scattering ← *molecular vibrations*



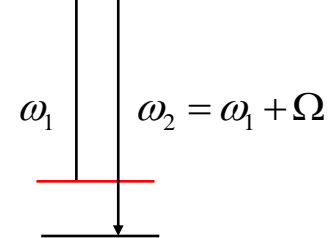
Does every kind of molecule vibrate?



Elastic scattering:
Rayleigh scattering



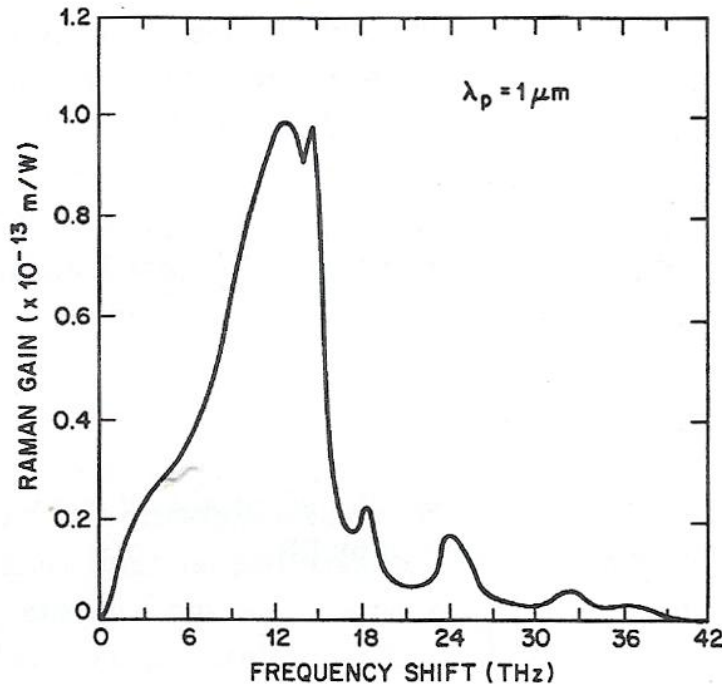
Inelastic scattering:
Stokes scattering



Inelastic scattering:
Anti-Stokes scattering

Raman gain

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



Source: *Optical Waves in Crystals*, A. Yariv and P. Yeh

$$\frac{dI_s}{dz} = g_R I_p I_s - \alpha_s I_s,$$

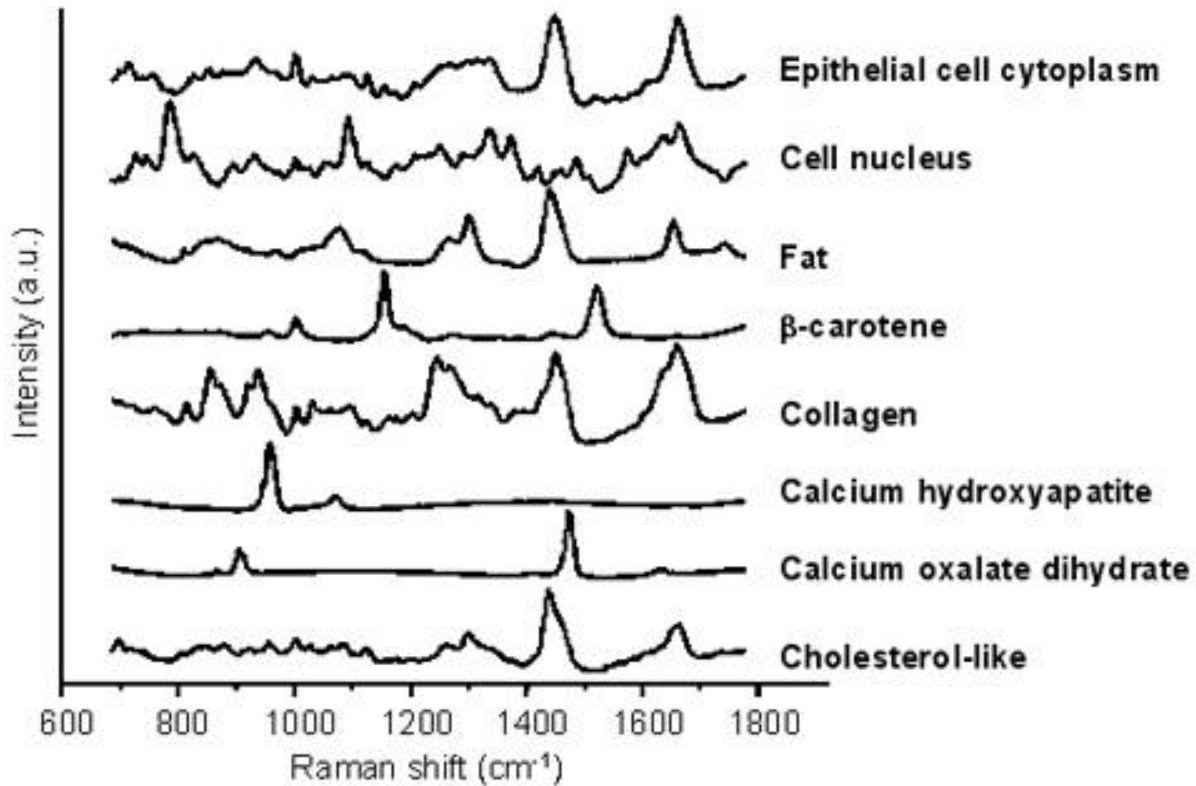
$$\frac{dI_p}{dz} = -\frac{\omega_p}{\omega_s} g_R I_p I_s - \alpha_p I_p.$$

$$g_R \sim 10^{-13} \text{ m/W}, \Omega_R \sim 13.2 \text{ THz}$$

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

Raman spectroscopy

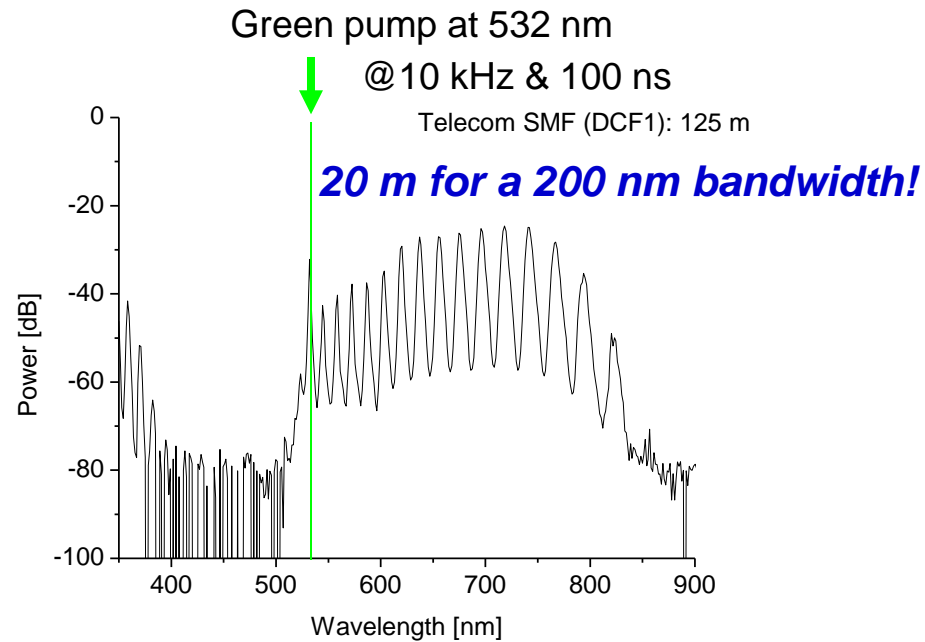
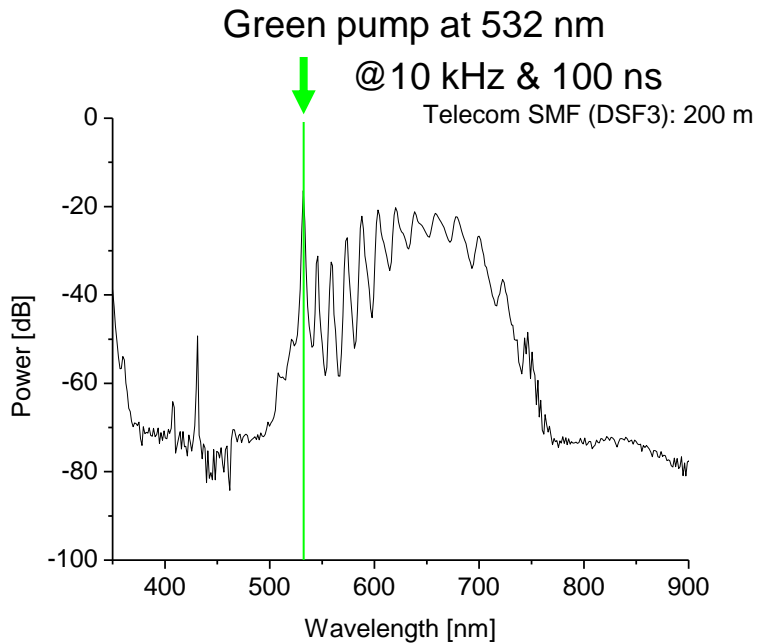
Raman spectra vary with materials:



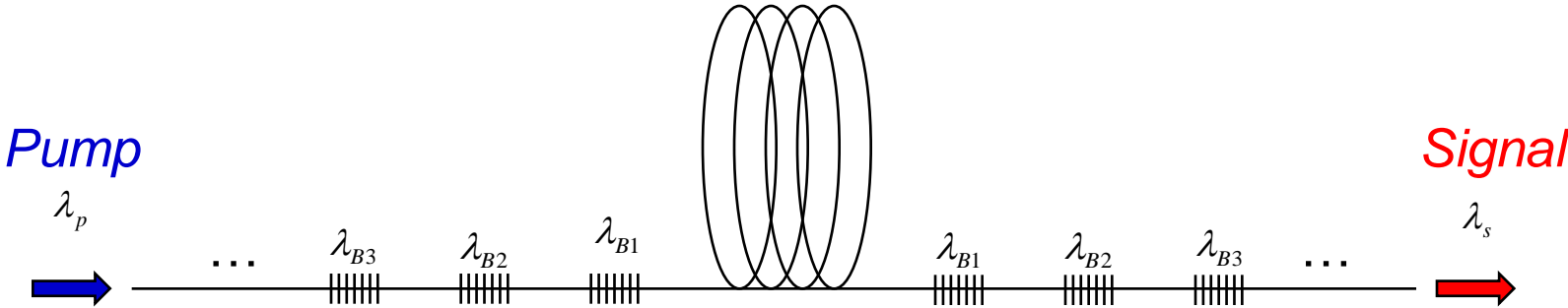
Source: http://web.mit.edu/spectroscopy/research/biomedresearch/Raman_breast.html

Raman conversion

Raman scattering readily converts higher energy photons to lower energy photons (down-shift)

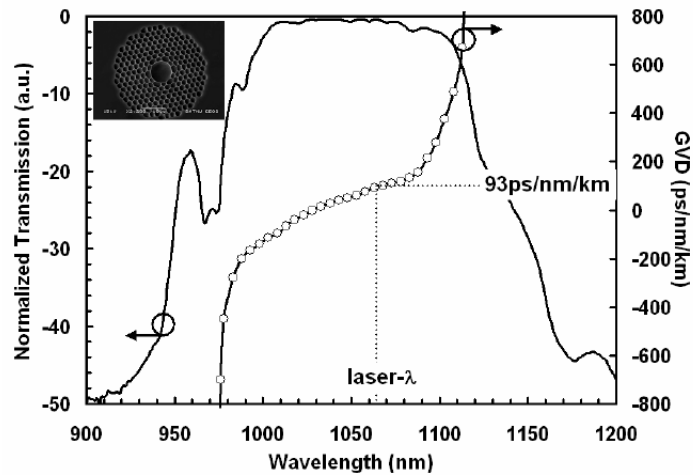


Cascaded Raman fibre lasers



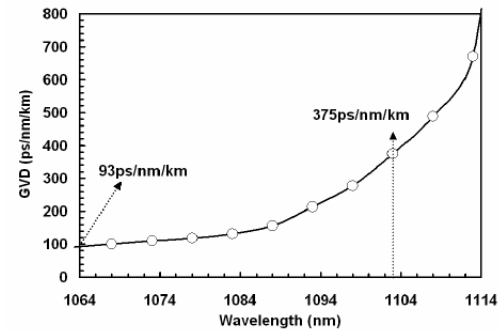
Wide-range wavelength access!

Raman solitons



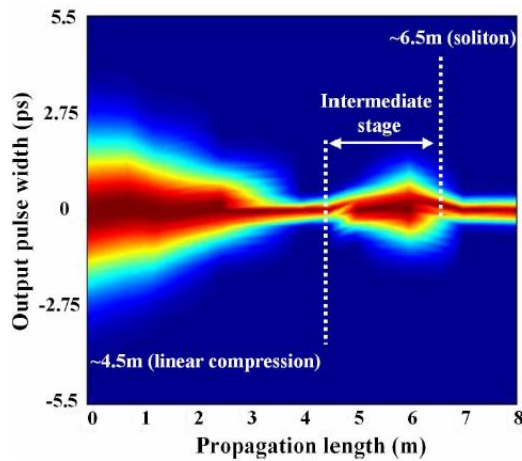
(a)

Optics Express, Vol. 16 Issue 4, pp.2381-2386 (2008)

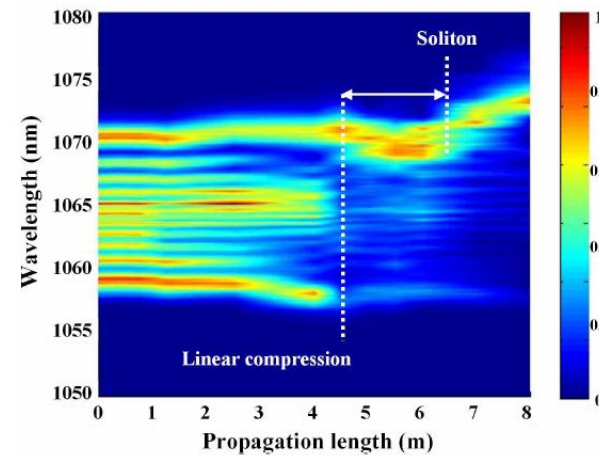


(b)

Fig. 1. (a). Normalized transmission (solid curve) and GVD (circle points) versus the wavelength. Fiber cross-section used in the following experiments is shown in the inset.: (b) GVD zoom between 1064nm and 1114nm.



(a)



(b)

Fig. 3. (a). Normalized experimental output pulse width and (b) spectrum as a function of the fiber propagation for 320nJ laser pulse energy. (Linear interpolation is used for the plot)

Double-clad Raman fibre lasers

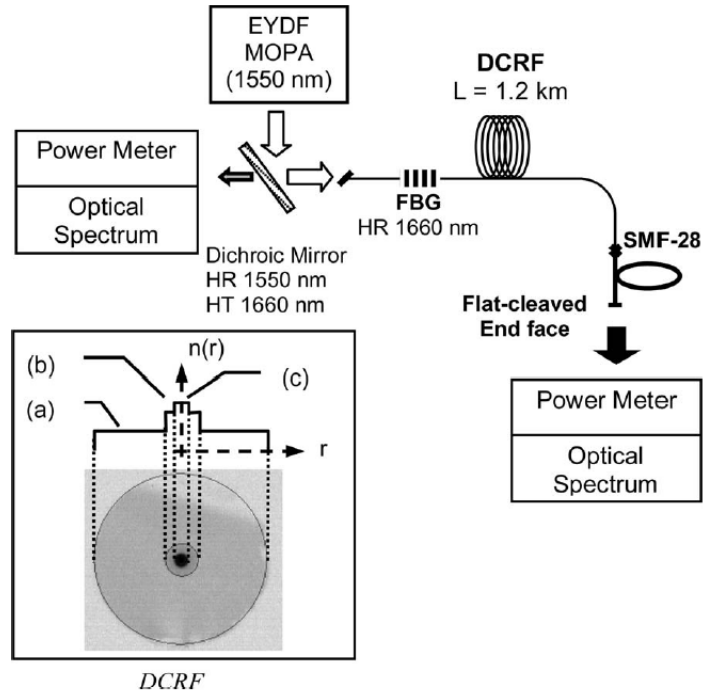


Fig. 1. Experimental setup of the high-power cladding-pumped Raman fiber laser. Inset, double-clad Raman fiber idealized refractive index profile and cross section: (a) outer silica cladding; (b) germanium-doped inner cladding; (c) core.

Optics Letters, Vol. 31 No. 15, pp. 2290-2292 (2006)

