# Effect of Nonlinear Dispersion Fiber Length and Input Power on Raman Scattering

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**Abstract**

The increasing demand for information transmission makes the problem of establishing a laser system is operating in C-band (1530-1565*nm*) wavelength region is a significant task, which attracts a lot of researchers' attention lately. In this paper, the ability to produce signals of multi wavelengths using a single light source was adopted to employ the Raman scattering effect for establishing Raman shift configuration-based multi-wavelength fiber lasers, which is not currently addressed in available schemes. This is what prompted to simulate the performance of C-band multi-wavelength produced by Raman fiber laser that utilizing fiber Bragg grating (FBG) to amplify pumped power and also utilizing the single-mode fiber (SMF) as the nonlinear gain medium. The proposed laser system is designed by OptiSystem software. The resulted maximum output power was 22.07*dB* at Wavelength Division Multiplexing (WDM) of 23.01*dB* input power. The achieved multi-wavelength that generated by Bragg grating and SMF was containing six Stokes and anti-Stokes, they are: 1548.51*nm*, 1549, 31*nm*, 1550.116*nm*, 1550.91*nm*, 1551.72*nm*, and 1552.52*nm*, in which the resulted computed efficiency of the system was raised up to 80.23% at input power 20 *dB* and dispersion fiber length of 0.2 *km*.



**Key Words:** Raman Scattering, Fiber Optics, Single Mode Fiber, Fiber Bragg Grating, Nonlinear Dispersion Length.

**DOI Number: 10.14704/nq.2021.19.11.NQ21175** **NeuroQuantology 2021; 19(11):47-65**

## Introduction

The light interaction with the molecule's vibrational modes makes the matrix material causes Raman scattering. Firstly, a photon of $\hbar\omega_o$ energy is exciting the system from $E_1$=$\hbar\omega$o vibronic state into $E_3$= $\hbar\omega_S$ virtual state. Secondly, a photon of $\hbar\omega$S energy is emitted by an excited molecule and it is de-exciting from $E_3$ virtual state into $E2=\hbar(\omega_o\text{-}\omega_S)$ final vibronic state when $E_2$ is identical to $E_1$, then the resultant photon have a frequency is identical to that of the incident radiation, this phenomenon is called Rayleigh scattering. On another side, when the $E_2$ is different from $E_1$, the occurred scattering will be inelastic and this phenomenon is called Raman scattering. When there is a spontaneous scattering, the energy of the scattered wave differ from those of the excitation source ($\hbar\omega_o$) for each vibration of molecular, which causes Stokes ($\hbar\omega_S$) and anti-Stokes ($\hbar\omega_{AS}$) lines as shown in Figure (1) (Chiara, 2016).

The nonlinear optical phenomena that occur inside optical fibers are the topic of nonlinear fiber optics. Despite the fact that nonlinear optics was founded in 1961 when the second-harmonic radiation inside a crystal was initially generated by a ruby laser, the fiber losses were lowered to less than 20dB/km after 1970, where optical fibers are used as a nonlinear media (Jun et al. 2021).

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**Relevant conflicts of interest/financial disclosures:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Received:** 30 August 2021 **Accepted:** 07 October 2021