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A Study on Super Continuum Generation in Exponential type Saturable Nonlinearity

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1. Introduction

The Supercontinuum generation (SCG) using photonic crystal fiber (PCF) is the technology of choice for the next generation of ultrabroadband sources of coherent light. SCG is a process which dramatically broadens the spectral shape from the narrow initial spectrum, mainly induced by soliton fission and pulse breaking arising due to higher order effects of soliton related dynamics such as higher order linear dispersion terms, Raman soliton self-frequency shift, and spectral recoil. At higher peak power, Kerr nonlinear response is insufficient to predict the nonlinear response of the medium rather require saturable nonlinear response to figure out the overall nonlinear response of the medium [1,2].

We have analyzed the impact of MI-SCG under the so called conventional saturable nonlinearity (CSN). However, our intensive literature survey brings us the evidence of the existence of other type of saturable nonlinearities called as exponential saturable nonlinear response (ESN) [3].

2. Supercontinuum with ESN

The propagation of ultrashort pulse in the presence of exponential saturable nonlinear response in LCPCF is given by the modified nonlinear Schrodinger equation (MNLSE)

$$\frac{\partial U}{\partial z}+\sum_{n=2}^{3}\beta_n \frac{i^{n-1}}{n!}\frac{\partial^n U}{\partial t^n}=i\gamma\frac{(1-\exp-\Gamma|U|^2)}{\Gamma} \quad (1)$$

Where β_n is the nth order dispersion coefficient, γ and Γ are Kerr and saturable nonlinearity.

2.1 Numerical analysis

To investigate SCG in LCPCF, we numerically solved Eq. (1) using split step Fourier method with initial envelope of the soliton at z=0 given by U (0, T) =$\sqrt{P_0}$ sech (T). The fiber parameters are calculated using scalar effective index method. From the numerical simulation it is observed that the exponential saturable nonlinear response suppress the SCG like the case of conventional saturable nonlinear response. But the inclusion of ESN enables to achieve the broadband spectrum at relatively short distance of propagation owing to the ability to achieve the required phase matching for the nonlinear effects. **Fig.1** describes the spectral broadening in LCPCF with the influence of exponential saturable nonlinearity of CS_2 liquid.

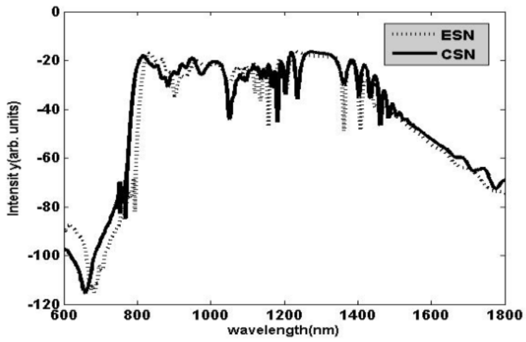

Fig.1 SCG of conventional and exponential type saturable nonlinear responses

From the **Fig.1**, it is evident that the broadband spectrum obtained through ESN and CSN are approximately the same for the given length. But the coherence obtained through the shot to shot noise analysis gives us the incorporation of ESN instead of CSN increases the coherence of the spectrum slightly.

3. Conclusion

We conclude that the use of exponential nonlinearity like the most cases of saturable nonlinearity suppress the supercontinuum spectrum, but slightly increases the coherence of the SCG.

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