Self-frequency shifted solitons in photonic crystal fibers: coherent and temporal properties

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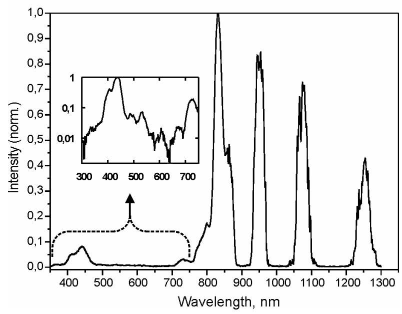
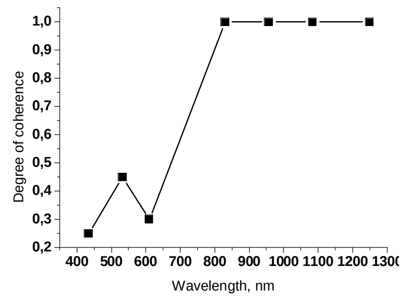
During the past few years, the effect of soliton self-frequency shift was reported in various microstructure/tapered fibers [1]. The achieved relatively high spectral density of the soliton radiation power suggests a number of interesting applications of this effect, in particular when developing optical comb generators that utilise one of the soliton radiation frequencies together with a frequency of short-wavelength non-soliton radiation spaced exactly one octave from it. However, until very lately the question whether or not the phases of radiation frequencies from self-frequency shifted (SFS) solitons are coherent remained open.

In the present work, coherent properties and temporal parameters of solitons generated in photonic crystal fibers (PCF) pumped with femtosecond pulses was explored for the first time both experimentally and theoretically. The experimental studies were conducted by means of registering the interference between two successive soliton pulses inside an asymmetric Michelson interferometer. The coherence degree of the SFS solitons was measured from the visibility of the interference pattern recorded by a CCD camera within a certain wavelength ranges. The 30-cm-long PCF with core diameter of ~2 µm was pumped at 835 nm with ~50-fs long pulses, the repetition rate being 100 MHz and the average output power of 300 mW.



In the figures are shown: the spectrum and degrees of coherence within different spectrum ranges of radiation at the exit of PCF. The degree of coherence in the SFS solitons at wavelengths around 955, 1085 and 1250 nm turns out to be close to unity (as it is for the pump radiation at 835 nm). The degree of stability of phase in short-wavelength non-soliton radiation was considerably less than unity and amounted to 0.25–0.45. These experimental results are in agreement with our numerical simulations based on generalised Schrödinger equation and quantum noise model.



[1] *D.V.Skryabin, F.Luan, J.C.Knight, P.St.J.Russell. Science, 2003, v. 301, N 9, pp. 1705-1708.*