Abstract

In this thesis, we have studied intermodal nonlinear interaction between femtosecond optical pulses propagating in a triple-clad silica fiber (TCSF). The first part of the thesis addresses the nonlinear interaction between a dispersive pulse propagating in the fundamental mode of the TCSF and a soliton propagating in the LP_{02} mode of the fiber. Both the soliton and dispersive pulse are launched at the same wavelength in the TCSF and the fiber parameters are chosen in such a way that the intermodal walk-off length between the soliton and the dispersive pulse is in the order of a few centimeters. Such interaction lengths make it possible to achieve sufficient intermodal interaction between femtosecond optical pulses propagating in the LP_{01} and the LP_{02} modes of the TCSF. The cross-phase modulation (XPM) led intermodal interaction between the soliton and the dispersive pulse causes the temporal reflection of the dispersive pulse by the soliton. The temporal reflection leads to either a red-shift or a blue-shift in the spectrum of the dispersive pulse depending upon whether the dispersive pulse is launched before or after the soliton, which in turn is determined by the fact whether the dispersive pulse propagates at a slower or faster group speed than the soliton. The phase-matching conditions (PMCs) are derived for the generation of the new radiation in the LP_{01} mode and the PMC solutions agree with the numerical results. This phenomenon is next exploited to achieve an efficient control of the soliton by a comparatively weak dispersive pulse by using single wavelength pump source. In the single-mode case already studied in the literature, two different wavelength sources are required for the same purpose. In the second part of the thesis, we have studied the nonlinear interaction between the orthogonal components of a vector-soliton propagating in a birefringent fiber under the combined effect of Raman induced frequency shift (RIFS), the XPM, the group-velocity difference and the negative third-order dispersion. The interplay between RIFS and the XPM leads to different evolution behaviour in both the polarizations of the vector-soliton. This type of dynamics can be realized in the LP_{02} mode of proposed TCSF, if a structural birefringence is introduced in the TCSF design.

Keywords: Soliton, Dispersive pulse, Cross-phase modulation, Phase-matching condition, Raman induced frequency-shift, Temporal reflection, Vector-soliton.