ABSTRACT

The concept of Airy function was first introduced as a unique undistorted accelerating solution to the time dependent Schrödingers equation. The realization of the Airy function in optical domain was introduced much later exploiting the isomorphism between the Schrödingers equation and linear diffraction equation. After this discovery the self-healing and self-accelerating dynamics of the Airy function in optical domain has been studied extensively. In the temporal optical domain, the unique properties of the finite energy Airy pulse (FEAP) has been explored in both linear and nonlinear optical mediums where the pulse dynamics is governed by nonlinear Schrödingers equation (NLSE). It has been shown that the Airy pulse loose its characteristics and sheds optical soliton in nonlinear mediums which is undesirable in the context of the FEAP dynamics. In our thesis we explore the self-healing and bending properties of the FEAP in linear optical domain. Near the zero dispersion wavelength where the effect of third order dispersion (TOD) is dominant FEAP faces a temporal flipping at a particular distance and beyond that spatial position the pulse propagates with opposite acceleration. In our study we have concentrated to explore this unique property of FEAP in presence of TOD. Throughout our study we have used Si-based optical waveguides which are suitabely designed using COMSOL commercial software. We have provided adequate details about the designing of the waveguide as per our convenience throughout the thesis. In the first part of our thesis we have highlighted that a suitable cubic phase modulation(CPM) can enhance the healing effect of the FEAP by counterbalancing the temporal reversal due to dominant TOD hence it can preserve the pulse shape for a longer distance. On the other hand, a suitable quadratic phase modulation (QPM) parameter can temporally squeeze a FEAP

to absolute limit and leads to the formation of an amplified chirp-free Gaussian pulse useful for remote energy transfer. To further explore the rich dynamics of the trajectory of the pulse we have shown that under the influence of a linear temporal potential the trajectory of the pulse can be delicately engineered and there is a monotonous spectral shift which may lead to dominant TOD. We establish the general solution of the pulse for nonvanishing TOD in presence of linear optical potential. It is shown for positive TOD, the pulse can be absolutely focused for a particular value of the potential strength. Basically, in these works we have shown that the trajectory and properties of the FEAP can be altered without disturbing the optical medium of pulse propagation which is very important for application purpose.Although in the later part of our thesis we have shown that the properties of FEAP can be considerably altered by efficient dispersion modulation of the optical medium.We have designed two distinct type waveguides whose dispersion profiles change linearly and periodically with distance.We find that a linear spatial variation of GVD may lead to a quasi-linear trajectory of the accelerating FEAP with modulated peak power.For the periodic case we have analytically shown that selective temporal focusing can be achieved by suitable designing of the waveguide. The above mentioned observations of the properties of FEAP are done in linear optical medium. But,we have also shown that the collision of the FEAP and an optical soliton inside a Kerr medium can initiate very strong radiation in presence of TOD. The spectral position of te radiation is found analytically for both positive and negative TOD. All the results throughout the study are derived analytically and they are verified numerically with satisfactory agreement.