# Abstract

Multimode fibers, overlooked for past many years, are gaining resurgence of interest due to its high data transmission capacity and high power handling capabilities. Complex spatiotemporal dynamics in multimode system can be exploited to explore several new physics. In this thesis, intermodal interaction based nonlinear phenomena in few-mode fiber for long pulse regime has been studied both experimentally and theoretically.

The work reported in this thesis has been largely divided into two parts. The first part of the thesis deals with the scenario where sub-nanosecond pump pulses are launched to excite single-mode of a few-mode fiber. Wideband spectrum has been generated owing to the combined effect of cascaded stimulated Raman scattering and complex intermodal four-wave mixing processes. Detailed theoretical description has been provided to explore the origin of multiple peaks.

In the second part, sub-nanosecond pump pulses are launched to excite dual modes with equal power in each mode. This gives rise to two complex nonlinear phenomena. Firstly, the excitation of proper mode combination is employed to achieve parametric frequency conversion via noise-seeded intermodal modulation instability (IM-MI). Multiple spectral peaks are generated along with the Raman peaks. The effect of modal group velocity mismatch on the modulation instability gain is investigated in details. Experimental results are well supported by the theoretical analysis based on bimodal-MI model. Secondly, the formation of optical induced transient Kerr grating is demonstrated where the interference of the modes lead to periodic variation of intensity pattern which in turn produce periodic refractive index distribution via optical Kerr effect. Furthermore, the application of the transient grating as an all-optical mode converter and temperature sensor are presented.

**Keywords**: Multimode fiber, Supercontinuum generation, Intermodal Four-wave mixing, Stimulated Raman scattering, Intermodal modulation instability, Transient Kerr grating, sensor.