# Abstract

Microring resonators (MRRs), the special case of micro-resonators, are the most sought-on-chip optical components after the optical waveguides due to versatile usages and functionalities whether in linear or nonlinear and quantum. A simple on-chip MRR geometry consists of one or two straight waveguides evanescently coupled to circular or bent waveguides. The strong confinement of energy in MRRs makes them ideal candidates for harnessing nonlinear and quantum properties. Temporal dissipative Kerr solitons (DKSs) and their frequency counterparts, Kerr frequency Combs generated from continuous wave or pulse-pumped MRRs have been vastly explored. Different forms of DKS pulses, including oscillatory Turing patterns, multi-DKSs, and dark and bright single DKSs, can be generated from MRRs. External pump power and the detuning between pump and resonance frequency are pivotal in determining the field dynamics inside the MRR. One may observe specific forms of DKSs at the output. This thesis explores innovative approaches to generate single bright stabilized DKSs and frequency combs in on-chip racetrack MRR and elliptical microresonator systems. The modal characteristics of the MRR geometries have been predominantly carried out by the Finite Difference Time Domain and Finite Element Method simulations. The DKS and frequency combs have been simulated and analyzed by the well-known Lugiato-Lefever Equation and Ikeda map approaches using the Split-Step Fourier methodology. The dynamics of frequency combs generated from single DKSs in the anomalous dispersion regime for a racetrack silicon nitride ($Si_3N_4$) based MRR at temperatures slightly lower than the room temperature has been investigated in detail. The maximum temperature rise due to the circulating DKS has also been studied through finite element simulations. Through homogeneous steady-state analysis, we have validated that the stability of a single DKS is enhanced at low temperatures. We have also demonstrated stable single DKSs in the same $Si_3N_4$ racetrack MRR with a built-in spectral filter in the normal dispersion regime.

The MRR was pumped by chirped super-gaussian pulses which aided in convenient trapping of the DKS to the centre of the driving pulse background. In rudimentary MRR geometries, the evanescent coupling of light from the straight to bent waveguides is crucially dependent on the coupling gap between them. To overcome the stringent requirement of coupling-gap, we have proposed an on-chip coupling-gap-free ellipsoid-shaped microresonator. The theoretical framework has been deduced to attain the proposed microresonator's modal properties, which shows good agreement with Finite Difference Time Domain simulations and experimental results. Further, the LLE simulations for the continuous wave pumped $Si_3N_4$ based ellipsoid resonator indicate the possibility of successfully generating single DKS and frequency combs with reasonably good nonlinear conversion efficiency.

**Keywords**: Dissipative Kerr Soliton, Kerr Frequency Comb, Lugiato Lefever Equation, Ikeda Map, Spectral filter, chirped super-Gaussian pump, ellipsoid microresonator.