Circular Wiggler: A Novel Contacted Microcavity with Suppressed Radiation Loss Based on Imaginary Frequency Splitting

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Microring cavities with mechanical support spokes are of interest in optomechanical systems that make use of suspended optical resonators with motional degrees of freedom. We propose here circular wiggler-mode resonators, a novel type of ring-based structures where the supporting spokes act to couple two degenerate eigenmodes with different (first and second order, respectively) transverse field patterns to produce a low radiation loss wiggler mode that avoids the contacts of the spokes. This coupling, in contrast to conventional frequency splitting, is due to an unusual imaginary frequency splitting, whose physical origin is far field destructive interference rather than power exchange.

A high Q circular wiggler resonator is designed by first aligning the resonance frequencies of the two eigenmodes with different transverse spatial patterns of the uncontacted, circularly symmetric cavity through choosing appropriate waveguide width and ring radius. The addition of spokes perturbs the system and couples the two modes, splitting them in imaginary frequency into two supermodes a high loss mode, and a low loss wiggler mode where the optical field wiggles to avoid the contacts.

Using a 2D eigenmode modesolver, air suspended silicon ($n_{\text{core}} = 3.5$) circular wiggler designs with theoretical Q values as high as 3×10^5 have been found (e.g. Figure 1, waveguide width = 740nm, outer ring radius = 3.95μm, inner spoke width = 200nm, outer spoke width = 100nm). This novel resonator design will enable a number of unique photonic functions, including not only high-Q suspended cavities, but also efficient thermal or electrical contact to the optical resonator body without the substantial degradation of the cavity loss Q, e.g. for tuner and modulator design.

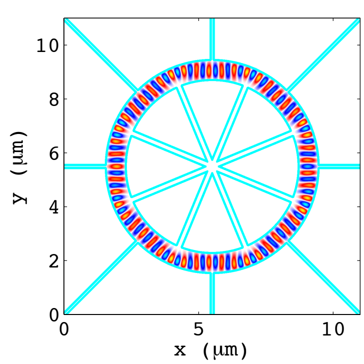

Figure 1. Circular wiggler resonator with wiggler mode simulated using 2D eigenmode solver.