Bound State in the Continuum by Tunable Q-factors on Photonic Circuit

Eduardo C. Lima[1,2], Matteo Galli[3], Daniele Bajoni[2], Marco Liscidini[3], Massimo Borghi[3]

[1]*Centro de Ciências Naturais e Humanas, Universidade Federal do ABC, 09210-580, Santo André, Brazil*

[2] *Dipartimento di Ingegneria Industriale e dell'Informazione, Università di Pavia, 27100 Pavia, Italy*

[3] *Dipartimento di Fisica "Alessandro Volta", Università di Pavia, 27100 Pavia, Italy*

Bound States in the Continuum (BIC) are solutions of particular quantum systems that emerge as discrete eigenstates within a continuous spectrum of radiation modes [1]. While a BIC is spatially decoupled from the continuum modes and thus inaccessible via linear coupling, its existence may be verified through nonlinear processes. We demonstrate the creation of a BIC in a photonic circuit, illustrated in Figure 1(a) [2], which allows one to tune the coupling rate between a silicon nitride microresonator (Main) and a bus waveguide (continuum of modes) for selected resonances using an auxiliary (Aux) resonator. Figure 1(b) shows the transmission spectra of the Main ring around three different resonance orders, labelled as Idler, Pump and Signal, a said "normal" configuration, while Figure 1(c) displays the idler resonance totally decoupled from the bus waveguide, resulting in a BIC. Figures 1(d-f) detail the light paths, showing the possible outcomes for the normal and BIC configurations, and where the top-imaging are done at the wavelength of the idler mode. In normal configuration, Figure 1(d), the light path travels through the main resonator and the bus waveguide. Figure 1(e) shows that in the BIC configuration the light cannot enter the resonator by outside and instead bypasses it through the bus, characterizing the continuum of modes. To reveal the BIC, we performed Stimulated Four-Wave Mixing by coupling a pump and a signal laser to the Main ring, stimulating the generation of the Idler mode. We proved that the nonlinearly excited BIC is linearly decoupled from the continuum of modes by measuring a leaked idler intensity into the bus waveguide which is three orders of magnitude lower than that in the normal configuration. We further explore the role of the BIC in various applications, which include the increase of the photon-pair generation rate, the control of coherence time and the reduction of Optical Parametric Oscillation threshold.

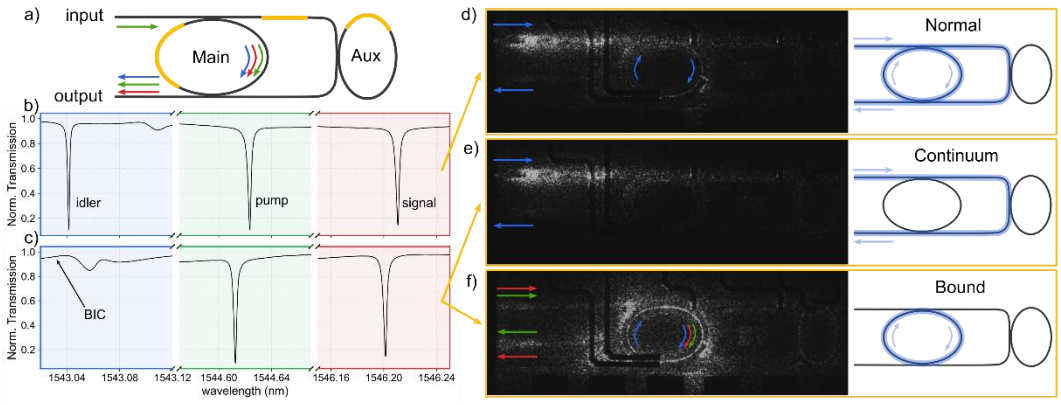

Fig. 1: *(a) Circuit design. (b,c) Normal and BIC configuration respectively. (d) Light path for normal configuration. (d,f) Continuum and Bound states light path for BIC configuration.*

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References

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