Photonic transitions in nanophotonics: optical isolation and completely controllable single-pole optical resonance

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Abstract:

When subject to temporally harmonic refractive index modulation, photonic states in nanophotonic structures can go through photonic transition [1], in a manner similar to electronic transitions in semiconductors. In this talk, we show that such transition can be used to create new optical functionalities. In particular, in a periodic system described by a photonic band structure, the use of a modulation can impart both a frequency and a wavevector shift in the photon transition process, creating an indirect inter-band photonic transition. We show that such an inter-band transition can be used to break time-reversal symmetry and create complete and linear optical isolation [2][3], without the use of magneto-optical effect. As such the fundamental difficulty for achieving on-chip optical isolation in standard optoelectronics can be overcome. In addition, we show that photonic transition can be created between a state that is completely localized, and a propagating continuum of states. This process achieves a single-pole optical resonance in which both the resonant frequency and the quality factor is entirely specified by dynamics [4], leading to greater flexibilities and accuracies in controlling optical resonance.

References:

1. J. N. Winn, S. Fan, J. D. Joannopoulos and E. Ippen, Phys. Rev. B 59, 1551 (1999).
2. Z. Yu and S. Fan, Nature Photonics 3, 91 (2009).
3. Z. Yu and S. Fan, Appl. Phys. Lett. 94, 171116 (2009).
4. Z. Yu and S. Fan, Appl. Phys. Lett. 96, 011108 (2010).