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Accidental bound state in the continuum in a chain of dielectric disks

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Dielectric resonators are open systems whose eigenmodes couple to the radiation continuum resulting in nonzero radiation losses. For a long time, it was believed that only guided modes with frequencies below the light line were decoupled from the radiation continuum [1]. In the early 2000's, several counterexamples of perfectly localized states – i.e. totally decoupled from the radiation continuum – at frequencies above the light line were proposed in dielectric gratings and photonic crystal waveguides [2]. Such states are known as *bound states in the continuum (BIC)*.

In this work, we report the first experimental observation of an accidental electromagnetic BIC with zero orbital angular momentum in a one-dimensional periodic chain of coaxial ceramic disks. While the in-Γ (symmetry protected) BICs are insensitive to variation of the system's parameters, the experimental detection of an accidental BIC is more challenging, since it requires fine adjustment of the system's parameters. In the experiment, we selectively excite a magnetic octupole mode with zero orbital angular momentum and measured the transmission spectrum using the coaxially placed loop antennas, see inset in Fig. 1(a). The accidental BIC manifests itself as a narrow peak which width indicates the Q factor of BIC. Figure 1(b) shows the Q-factor of 38-disks chain both extracted from the experimental data and obtained from numerical simulation. The accidental quasi-BIC is observed at the frequency about 2.95 GHz.

We demonstrate a linear growth of the radiative quality factor of the BICs with the number of disks that is well-described with a tight-binding model. With both numerical simulation and experiment, we estimate the number of the disks when the radiation losses become negligible in comparison to material absorption and, therefore, the chain can be considered practically as infinite.

The obtained results provide useful guidelines for practical implementations of structures with BICs opening new horizons for the development of radio-frequency and optical metadevices.

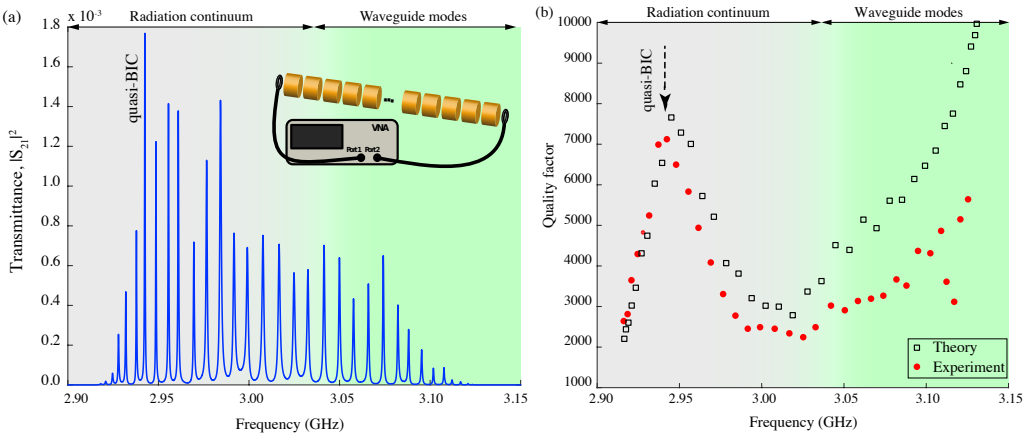

Fig. 1 Bound state in the continuum in the chain of ceramic disks with period $L = 28$ mm, radius $R = 15$ mm, height $h = 20$ mm and permittivity $\varepsilon = 44$ – (a) Transmission spectrum of the 38-disk chain. The magnetic octupole (TE) mode with $m = 0$ was excited with an electric dipole antenna. The green color shaded area represents the frequency domain of waveguide modes, while the grey shaded area the radiation continuum. The inset depicts the experimental setup for transmission spectrum measurement. (b) The Q-factor of the resonant states extracted from experiment, and simulation.

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