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Optical Emulation of Rabi coupling for Sensing Applications

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Optical systems are at the forefront of modern technologies, from telecommunications to quantum computing, offering unparalleled speed and efficiency in data processing and transmission. To develop and optimize these systems, engineers and scientists rely on tools like optical emulators. These tools play a critical role in modeling, testing, and refining optical networks, devices, and phenomena before real-world implementation. Optical emulators are light-based systems that mimic the behavior of physical devices and networks, providing an efficient way to test and optimize performance in real-time scenarios. This presentation explores the phenomenon of Rabi-like splitting based on mode-mode coupling and self-referenced refractive index sensing using an open-access microcavity setup. Here, we investigate the coupling between cavity photon modes and optical Bragg modes arising from distributed Bragg reflectors (DBRs). By tuning the cavity length, cavity photon modes can be detuned to hybridize with Bragg modes, resulting in observable anticrossing at distinct Bragg mode positions, validating the strong coupling between the modes and producing tunable Rabi-like splitting energies. This coupling strength can be adjusted by depositing an active absorber layer on one of the cavity mirrors, with further control achieved by optimizing the thickness of the absorber material and fine-tuning the cavity length. The strong coupling and mode hybridization were experimentally observed and corroborated through numerical modeling using finite element methods (FEM). These hybrid modes provide a novel mechanism for designing self-referenced refractive index sensors, capable of detecting various analytes with high sensitivity. The open-access nature of this cavity configuration allows for seamless integration in applications ranging from biological sensing to quantum measurements, positioning it as a versatile tool for future sensing technologies.

Type of presence

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