Highly Directional Emission from Inhomogeneous Dielectric Microcavities

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We propose a novel method of extracting light beams from 2D microcavities. The concept is
based on inhomogeneous dielectric cavities (IDC) where the inhomogeneities arise from a
space-dependent refractive index whose variations may be continuous (e.g. a localized
induced gaussian profile of the index) or discontinuous (e.g. holes or refractive steps in the
cavity material). Instead of the so-called asymmetric resonant cavities (ARC), which are
smooth deformations of a circular cavity and produce directional output while sacrificing the
quality factor Q, we intend to operate with an integrable geometry (a disk) and induce
directionality through the (possibly reconfigurable) medium while preserving a high Q. The
systems are interesting on two counts. Firstly, as classical objects, the IDC are equivalent to
dielectric billiards (i.e. photonic escape is possible) where the broken symmetry of the
material can induce a transition from regular to chaotic dynamics: chaos in an integrable
billiard geometry, an almost unique combination. Secondly, guided by the classical phase
space information, the wave dynamics can be “engineered” to produce highly directional
emission with tailored optical properties, the grail of microcavity research. We have studied a
number of configurations and will present results on their respective performances.

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