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Shedding Light Through Chaos: Microlasers as Quantum Billiards

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In 1917 Einstein pointed out that physicists knew of no way to connect classical and quantum mechanics for generic systems in which the dynamics is partially chaotic. Only in the last few decades of the 20th century did we begin to solve this problem through the study of the quantum manifestations of chaos. Recently it has been shown that a class of systems of technological interest, dielectric microcavities and microlasers, are equivalent to chaotic "quantum billiards" and may be designed and understood using the insights of quantum chaos theory. In particular if the shape of the dielectric resonator is deformed from the conventional spherical or cylindrical design a variety of novel and even counter-intuitive optical properties are observed. These properties can all be understood by looking at the dynamics of light rays in the phase space defined by the resonator boundary. There is a realistic chance that these wave-chaotic resonators will find use in integrated optical technology, demonstrating again the wonderful manner in which pure research can lead to unanticipated applications of value to society.

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