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Optics Laboratories to Teach Quantum Mechanics[1]

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Quantum optics laboratories based on entangled photon pairs produced by parametric down-conversion provide a curriculum of laboratories that illustrate by experimentation the fundamental principles of quantum mechanics. Experiments focus on fundamental issues, such as superposition, entanglement, realism and nonlocality. They encourage students to think deeply about quantum physics, with topics such as quantum erasure, delayed choice, measurement and wave-particle complementarity issues. The laboratories also serve as a platform to exercise quantum bra-ket algebra, with optical elements acting as operators on the states of the light. Under development are new labs to illustrate the quantum mechanical wave-function in the harmonic oscillator via non-diffracting light beams. The labs can be used in the advanced physics laboratory course, or as we do, in a dedicated lab for the upper-level quantum mechanics course.

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