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An optical approach to quantum education

Quantum mechanics is an inherently challenging subject to learn and is sometimes counterintuitive. For example, concepts like entanglement, and the wave-particle duality theory oppose classical physics. However, conceptual parallels between quantum systems and classical systems can be exploited to bring intuition and advance the learning process. Classical light fields are one such states that can exhibit properties that are analogous to some properties of quantum states, for example, they also satisfy the wave-particle duality theory. Vector fields are a form of classical light whose spatial mode is coupled to its polarisation state and are said to be non-separable. Mathematically, they are similar to quantum entangled states, that is when two spatially separated particles are correlated, thus, performing a measurement on one particle will affect the outcome of a measurement on the other particle. In this work, the use of quantum tools, like quantum state tomography and Bell-type measurements, is demonstrated on simple classical experiments to draw an intuition of quantum entangled states. We present a low-cost, easily replicable experiment, based on spatial light modulator technology, for laboratories to assist in the study of quantum mechanics.

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