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*Positive Operator Valued Measures and a Quantum Bayes' Rule*

A positive operator valued probability measure (POVPM) is a function on a sigma-algebra of subsets of a (locally compact and Hausdorff) sample space that satisfies the formal requirements for a probability, but where its values are positive operators acting on a complex Hilbert space, and a quantum random variable is a measurable operator valued function. Although quantum probability measures and random variables are used extensively in quantum mechanics, some of the fundamental probabilistic features of these structures remain to be determined. In this talk we discuss quantum analogues of the expected value of a random variable and the Radon-Nikodym derivative. This enables us to develop quantum analogues of Bayes' rule and a martingale convergence theorem. This research is based on joint work with Doug Farenick, Sarah Plosker, Kyler Johnson, and Mahbuba Rahman.