Direct Observation of the Kirkwood-Dirac distribution

Jeff S Lundeen
Physics Dept., Nexus for Quantum Technologies
University of Ottawa
Ottawa, Canada
jlundeen@uOttawa.ca

Quantum Tomography is indirect in the sense that it infers the quantum state from a disparate set of measurements, e.g., in multiple bases. Using weak measurement, one can observe quantum states in a more direct way, that is, by the joint measurement of complementary observables, such as position X and momentum P. The complex amplitude of the quantum state appears directly in shifts of the pointer of the measurement apparatus. Scanning X and P measurements, the shifts are proportional to the Kirkwood-Dirac distribution, a quasi-probability distribution that is rigorously equivalent to the density matrix. I will outline the range of approaches we have devised and experimentally realized to perform joint weak measurements on photons, highlighting our efforts to make them increasingly simple and practical.