**Linking entanglement detection and state tomography via quantum 2-designs**

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We present an experimentally feasible and efficient method for detecting entangled states with measurements that extend naturally to a tomographically complete set. Our detection criterion for bipartite systems with equal dimensions is based on measurements from subsets of a quantum 2-design, e.g. mutually unbiased bases or symmetric informationally complete states, and has several advantages over standard entanglement witnesses. First, as more detectors in the measurement are applied, there is a higher chance of witnessing a larger set of entangled states, in such a way that the measurement setting converges to a complete setup for quantum state tomography. Secondly, our method is twice as effective as standard witnesses in the sense that both upper and lower bounds can be derived. Thirdly, the scheme can be readily applied to measurement-device-independent scenarios.