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Ultra-gentle measurements and the information-damage trade-off in quantum metrology

Quantum-enhanced measurement strategies are being applied in fields from gravitational-wave detection to optical magnetometry to biological microscopy. These applications have in common a trade-off between information gained and damage caused to the system under study. We argue that this trade-off, rather than traditional quantum resources (e.g. particle number), is the relevant quantum limit in many practical applications. Using two-photon "NooN" states to probe an ensemble of rubidium atoms, we show that the information-damage trade-off can be improved using quantum entanglement.