Measuring a photonic qubit without destroying it

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abstract Measuring the polarisation of a single photon typically results in its destruction. We propose, demonstrate, and completely characterise a quantum non-demolition (QND) scheme for realising such a measurement non-destructively. This scheme uses only linear optics and photo-detection of ancillary modes to induce a strong non-linearity at the single photon level, non-deterministically. We vary this QND measurement continuously into the weak regime, and use it to perform a non-destructive test of complementarity in quantum mechanics. Our scheme realises the most advanced general measurement of a qubit: it is non-destructive, can be made in any basis, and with arbitrary strength.