Single Qubit Quantum Ring Structures and Applications

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Quantum ring structures (QRS) are building blocks for applications such as qubit storage, sensing elements, and oscillators. QRS architectures are motivated by the need to retain or modify the state of a flying qubit such as a photon and incorporate a feedback path so that the state-carrying particle can be spatially localized for a brief period of time. In one configuration of these architectures, referred to as Quantum Ring Oscillators (QRO), the feedback qubit state alternates in binary basis states with a period proportional to the delay of the circuit elements. Because the feedback state is not superimposed, it can be measured to determine the internal state of the oscillator that is superimposed. Circuits for information carrier injection, state extraction, and features of QRS/QRO are described in this work. When the overall transfer function for the feed-forward stage in a QRS is equivalent to a Pauli-X rotation, a QRO results. The second application is the use of the structure as the basis for a qubit storage element. The inclusion of rotation and controlled-rotation operators into the structure allow for any arbitrary qubit to be "stored" in the structure. Storage is achieved through continuous regeneration of the qubit state rather than attempting to preserve the same qubit.