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Recent progress in trapped-ion quantum information processing[1]

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Trapped strings of cold ions provide an ideal system for quantum information processing. The quantum information can be stored in individual ions and these qubits can be individually prepared, the corresponding quantum states can be manipulated and measured with nearly 100% detection efficiency. With a small ion-trap quantum computer based on two and three trapped Ca+ ions as qubits we have generated in a pre-programmed way genuine quantum states. These states are of particular interest for the implementation of an ion quantum register: we have demonstrated selective read-out of single qubits and manipulation of single qubits of the register conditioned on the read-out results. Moreover, entangled states of up to eight particles were generated using an algorithmic procedure and the resulting states were analyzed using state tomography proving genuine multi-partite entanglement. With a new cavity QED setup we create an ion-qubit to photon-qubit interface for interconnecting ion-trap based quantum computers. With this device a source of deterministically generated single photons can be built and atom-photon entanglement can be investigated.

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