Abstract Submitted
for the DAMOP16 Meeting of
The American Physical Society

Hybrid ion chains inside an optical cavity ZICHAO ZHOU, Univ of Maryland-College Park, JAMES SIVERNS, Joint Quantum Institute, Univ. of MD, College Park, MD 20740, QUDSIA QURAISHI, Army Research Laboratory, 2800 Powder Mill Rd., Adelphi, MD 20783 — Trapped ions remain a leading candidate for the implementation of large-scale quantum networks. These networks require nodes that can store and process quantum information as well as communicate with each other though photonic flying qubits. We propose to use hybrid ion chains of barium, for communication, and ytterbium, for quantum information processing. We report on progress in setting up a hybrid ion chain in a versatile four-blade trap using high numerical aperture collection optics. Although the visible photons produced from barium ions are more favorable as they are not suitable for long distance fiber communication. With this in mind, we intend to implement frequency conversion to overcome this issue. Also, with the view toward increasing the flying-qubit production rate, we propose a cavity-based system to enhance interactions between the ions and photons. The cavity axis is to be placed along the axial direction of the trap allowing a chain of multiple ions to interact with the cavity at the same time. With this configuration the atom-photon coupling strength can be improved by sqrt(N), where N is the number of ions. Experiments will focus on exploring the dynamics of hybrid ion chain, dual species quantum information processing, two-colour entanglement and phase gates assisted by the ion-cavity coupling are to be explored.

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Date submitted: 30 Jan 2016 Electronic form version 1.4