Abstract Submitted
for the DAMOP09 Meeting of
The American Physical Society

**Individual addressing of ions using a magnetic field gradient in a surface-electrode ion trap** SHANNON X. WANG, JAROSLAW LABAZIEWICZ, YUFEI GE, ISAAC L. CHUANG, MIT — The ability to address individual ions is an important issue in using multiple trapped ions to perform quantum operations. Previous efforts have included using precisely focused laser beams aimed at only one ion at a time1, which poses a significant technical challenge. An alternative is to use field-dependent transitions and a magnetic field gradient to shift the transition frequencies of ions as a function of position. This requires good stability of the local field in order to achieve desired fidelity of quantum operations. In a cryogenic $Sr^+$ ion trap we use the $^5S_{1/2} \rightarrow^4 D_{5/2}$ transition as an optical qubit, which can be Zeeman shifted using a bias field. We demonstrate individual addressing of trapped ions in a microfabricated surface-electrode trap using a magnetic field gradient generated on-chip. A frequency splitting of 310(2) kHz for two ions separated by 5 um is achieved. Selective single qubit operations are performed on one of two trapped ions with an average of 2.2 $\pm$ 1.0% crosstalk. Coherence time as measured by the spin-echo technique is unaffected by the field gradient. With appropriate phase correction, we present a scheme to realize two-ion gates.

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Date submitted: 27 Jan 2009 Electronic form version 1.4