

Abstract Submitted  
for the DAMOP15 Meeting of  
The American Physical Society

**Implementation of Universal-Not Gate on an Embedding Quantum System with a Trapped Ion**<sup>1</sup> KUAN ZHANG, XIANG ZHANG, JIAJUN MA, MILE GU, KIHWAN KIM, Center for Quantum Information, IIIS, Tsinghua University, Beijing, P. R. China, JAYNE THOMPSON, VLATKO VEDRAL, Centre for Quantum Technologies, National University of Singapore, Singapore — Quantum version of Universal-Not (U-Not) gate, that transforms any qubit state into its orthogonal counterpart, is principally forbidden by quantum mechanics. Here, we use an embedding scheme that encodes each qubit within an extended Hilbert space, to emulate the effect of implementing a U-Not gate on an arbitrary qubit state. This enables us to emulate antiunitary operations such as complex conjugation [1,2]. Strikingly, in the presence of U-Not gate the mutual information between two qubit systems can be increased or decreased by local operations. First, we prepare two qubits in the same state, where one is in internal degree of freedom and the other is in motional mode of a  $^{171}\text{Yb}^+$  ion. After applying the U-Not gate to the internal qubit, indeed, we observe that the mutual information has changed.

[1] J. Casanova, et al., Phys. Rev. X 1, 021018 (2011).

[2] X. Zhang, et al., arXiv:1409.3681 (2014).

<sup>1</sup>This work was supported by the National Basic Research Program of China under Grants No. 2011CBA00300 (No. 2011CBA00301), the National Natural Science Foundation of China 11374178, 11450110058, 61033001 and the National Research Foundation of Singapore.

Kuan Zhang  
Center for Quantum Information, IIIS,  
Tsinghua University, Beijing, P. R. China

Date submitted: 30 Jan 2015

Electronic form version 1.4