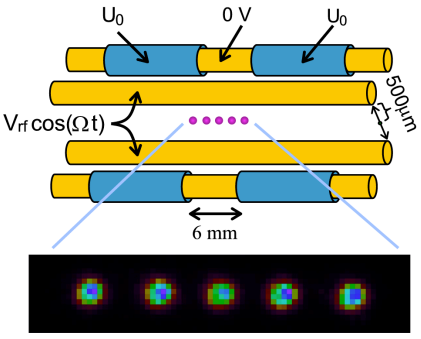
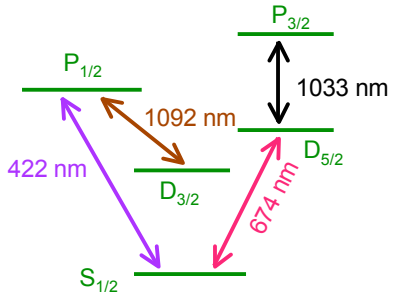
Trapped and Laser-cooled $^{88}Sr^+$ Ions

Dana Berkeland and Veronique Tassin (P-21)



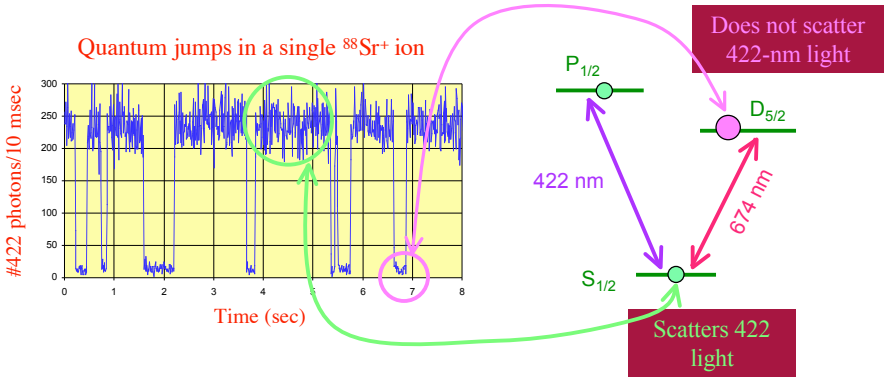
- Sr^+ ions confined in linear rf trap
- Localized to ~100 nm after laser cooling
- Image of 5 ions taken by collecting light scattered by the cooling laser beam
- Also detect fluorescence with photon-counting PMT



- Doppler cool ions using 422-nm transition
- 1092-nm laser pumps ions out of $eD_{3/2}$ state
- **1033-nm laser** pumps ions out of $D_{5/2}$ state
- Drive narrow $S_{1/2}$–$D_{5/2}$ transition with 674 laser

Current Experiment: Are Quantum Jumps Random?

- Drive cooling + $S_{1/2} - D_{5/2}$ transitions quantum jumps



- Single ion = very clean test of randomness of quantum mechanical processes
- Vitally important to cryptography
- Perform many extensive tests quantum jumps statistics
- Have analyzed 250,000 events

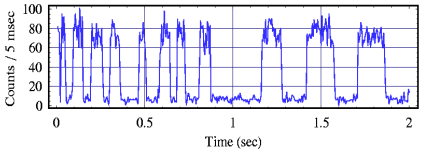
Presenter: Dana Berkeland

In Development: Quantum Logic Gate

Have demonstrated several requirements for quantum logic:

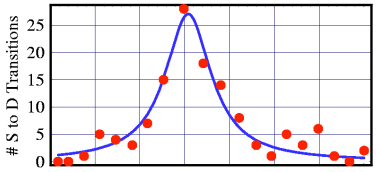
Many ions/qubits:

Efficient detection of transitions to $D_{5/2}$ state:



Progressing towards cooling to motional ground state (i.e. initializing qubit state)

Coherent manipulation of states:



(Laser linewidth = **4 kHz**)