Quantum bit detection using stimulated Raman adiabatic passage

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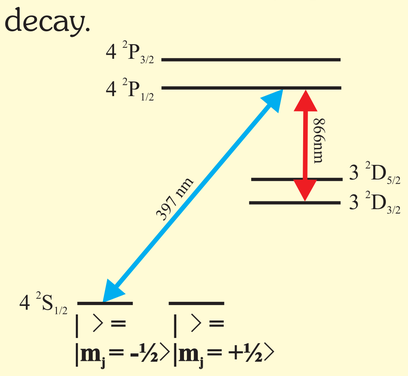
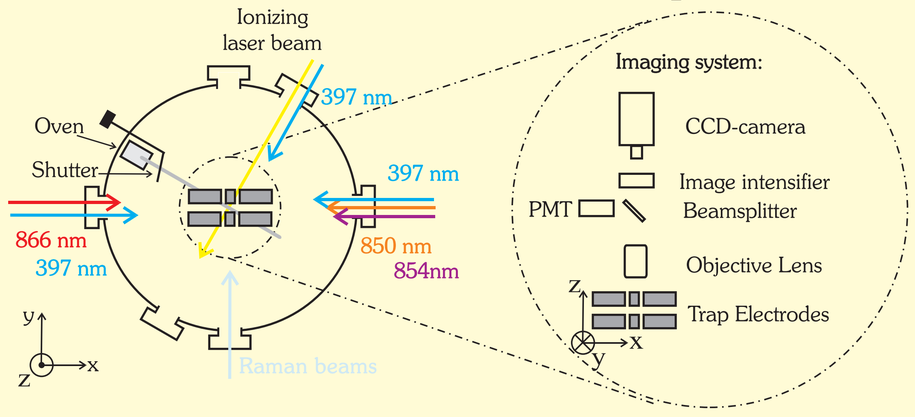
Our qubit

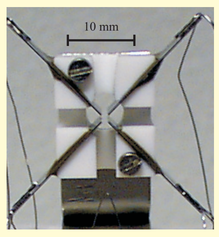
We intend to use the two Zeeman sublevels (| > and | >) of the $^2S_{1/2}$ ground state of $^{40}Ca^+$ as our qubit. This qubit choice has the advantage that the coherence time will not be limited by spontaneous decay.

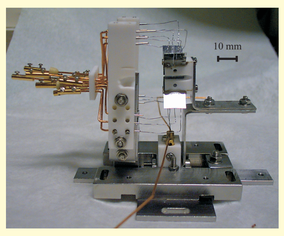


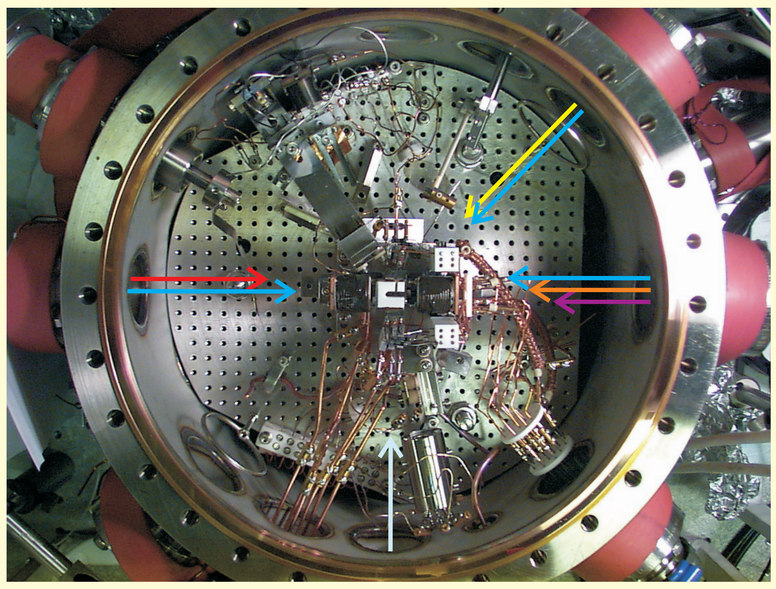
Relevant levels in $^{40}Ca^+$

Experimental setup



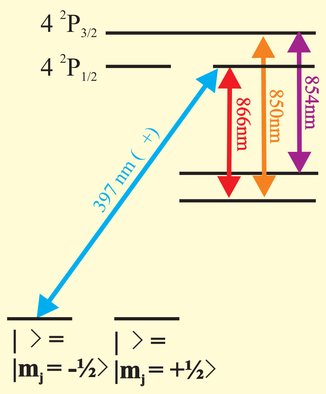




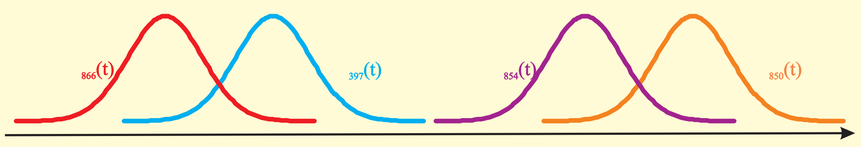


Internal state detection using a double STIRAP sequence

Detection Scheme



Counter intuitive pulse sequence

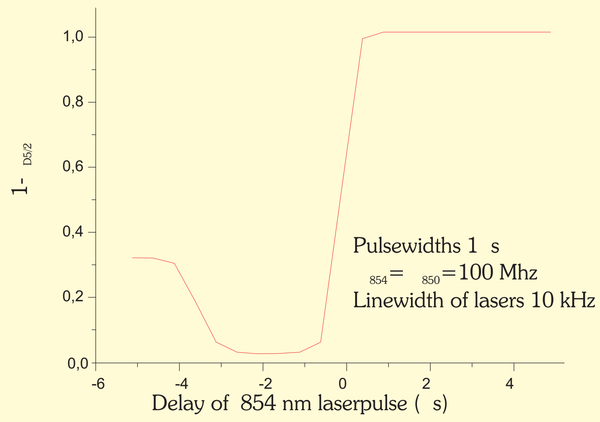


Parameters

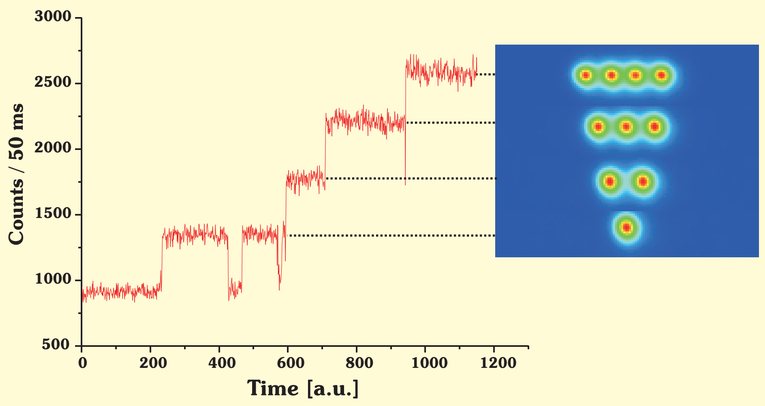
- Pulse durations ~ 1 s
- Pulse separation ~ 1 s
- Rabifrequencies ~ 100 MHz
- Laser linewidth ~ 10 kHz

98% Transfer

Simulation of STIRAP population transfer from $D_{3/2}$ to $D_{5/2}$

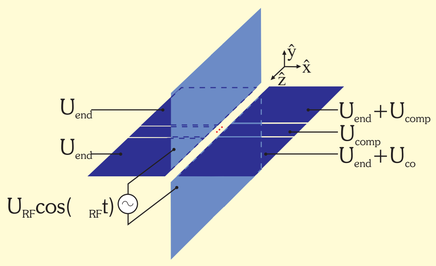


PMT signal

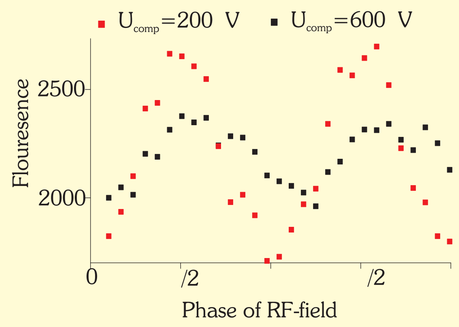


Minimizing micromotion

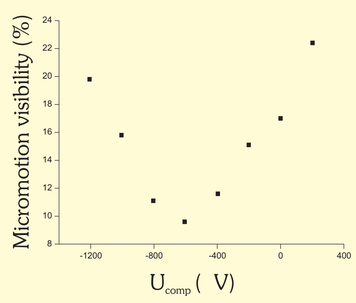
Electrode configuration



Micromotion signal of single ion



Minimizing micromotion

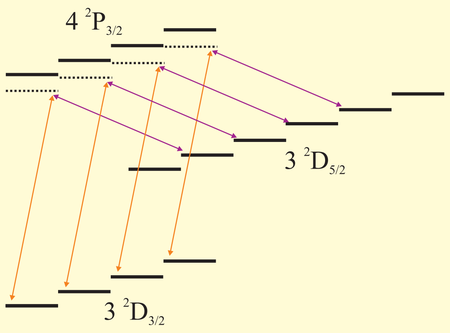


Raman resonances

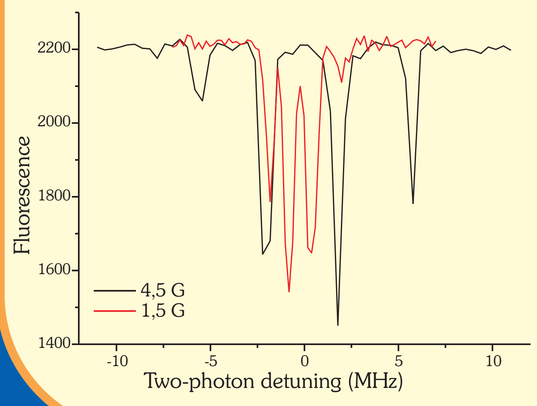
Zeeman splitting:

$$E_{Zeeman} = m_J g_J \ _B B$$
$$= m_J g_J 2 \quad 1{,}4\,\text{MHz/G}$$

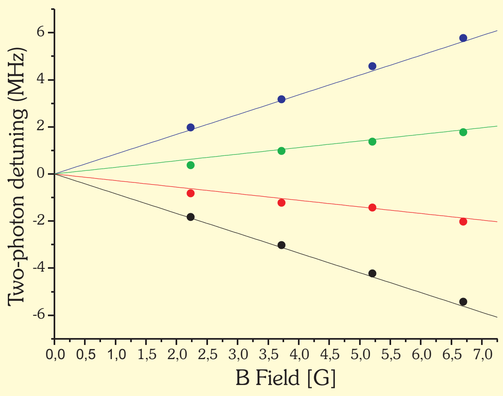
Lasers applied polarized with respect to the direction of the applied B-field.



Measurement of resonances:

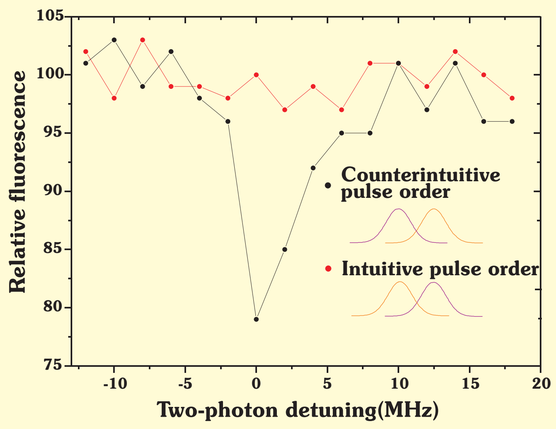


Lineshift due to B-field:

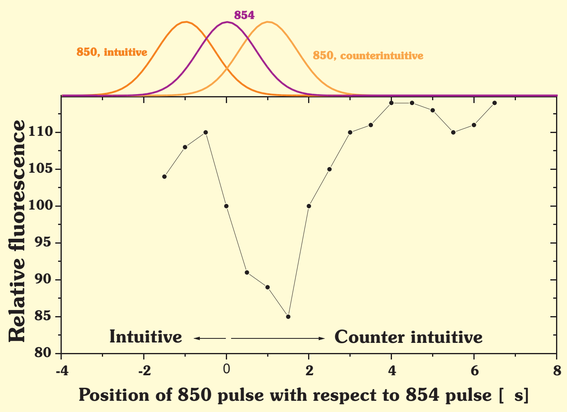


Very preliminary STIRAP results

Frequency scan



Delay scan



Further information: www.phys.au.dk/iontrapgroup dittem@phys.au.dk