Quantum Logic Spectroscopy of Molecular Ions

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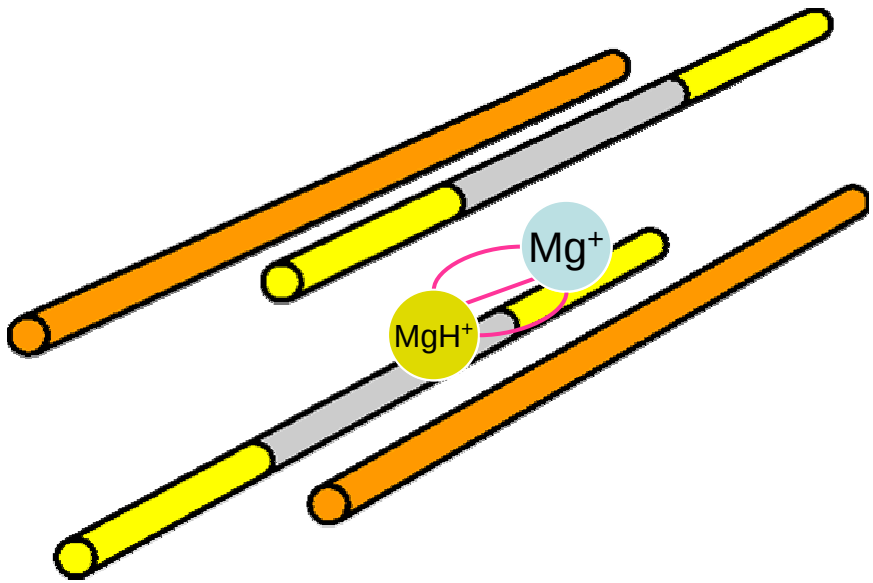
Linear Paul Trap



Coupled vibrational normal-modes

Requirements for Highest-Precision Spectroscopy

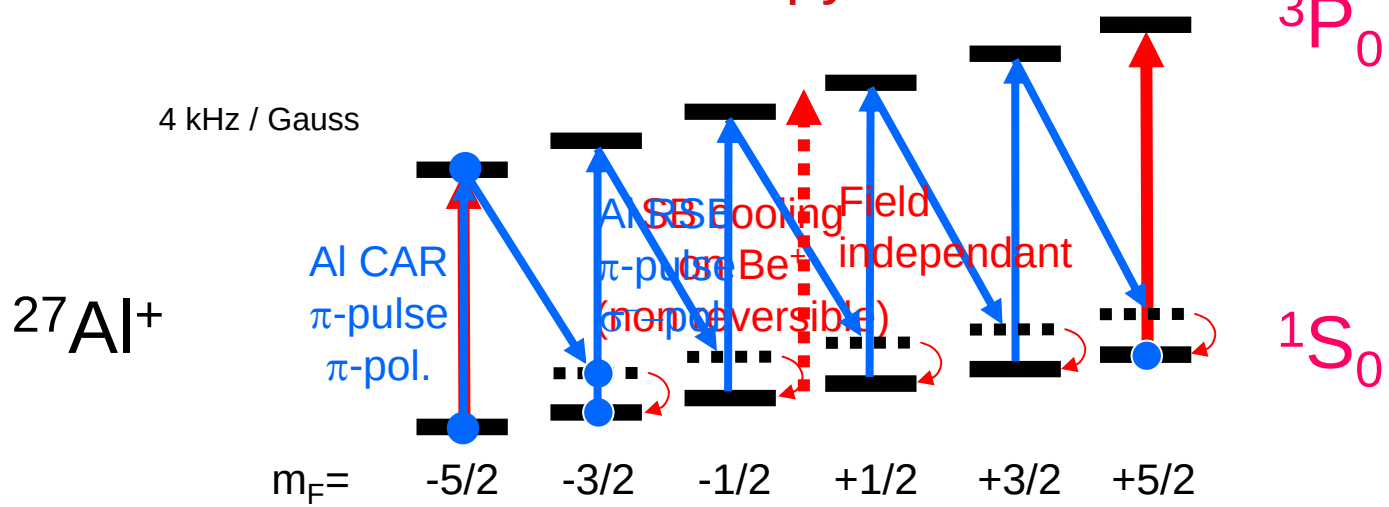
1. Cooling of motional state
2. Preparation of internal state
3. Detection of spectroscopic transition

Quantum Logic Spectroscopy
can help with all three!

Sympathetic cooling of Zeeman state in Al^+

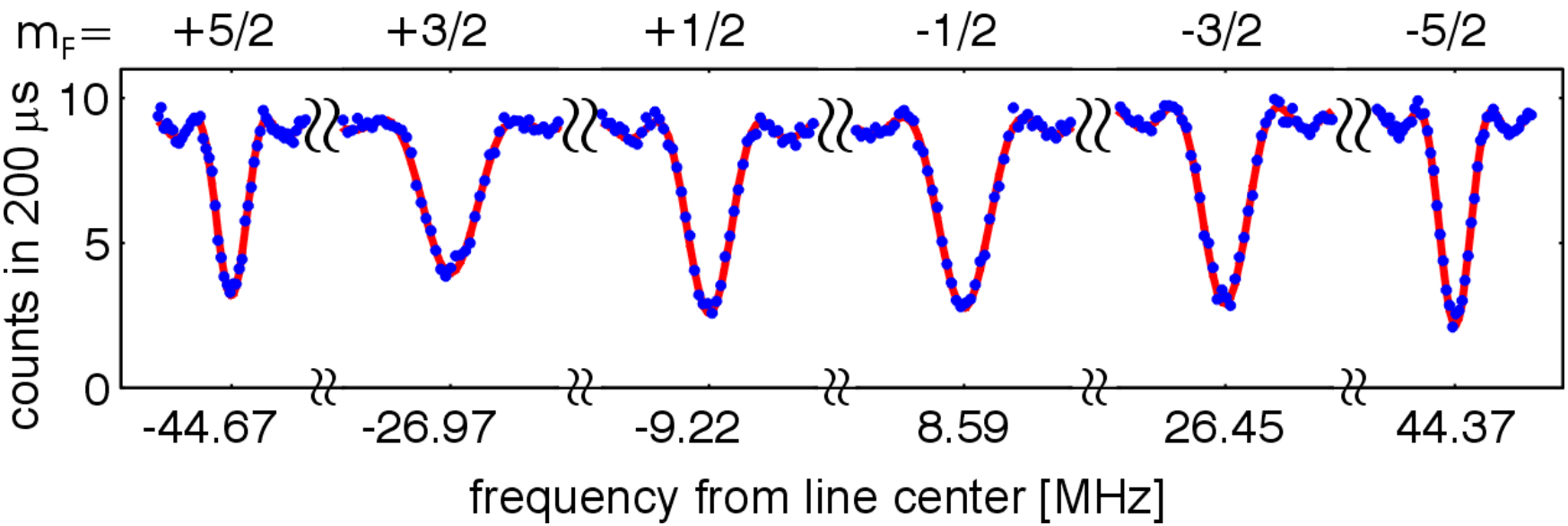
- probe m_F= +/- 5/2 transitions to eliminate linear magnetic field shift
- conventional optical pumping is slow (21 s excited state lifetime!)

- Be^+ assisted state preparation
- Reduced Zeeman state entropy

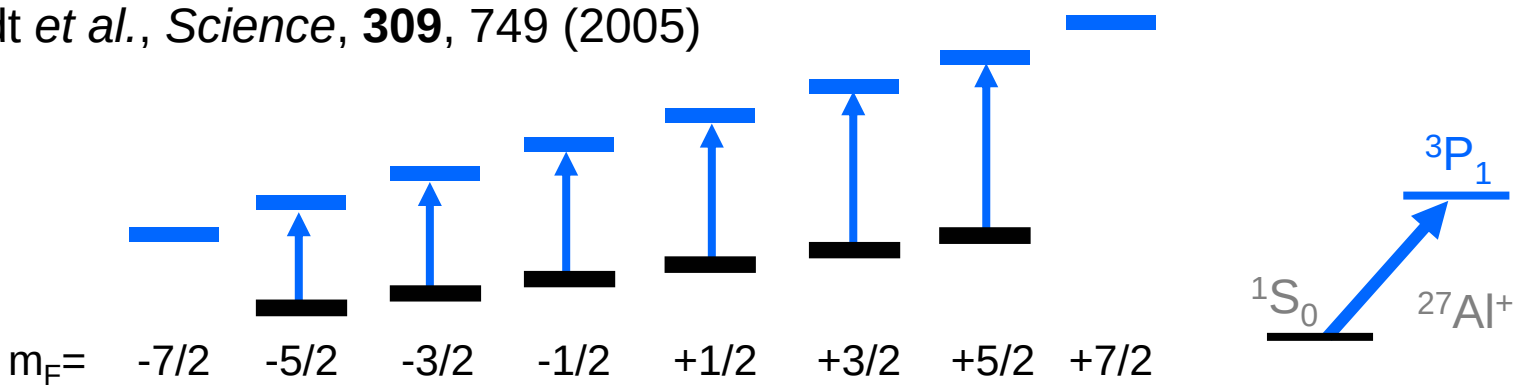


energy levels not to scale

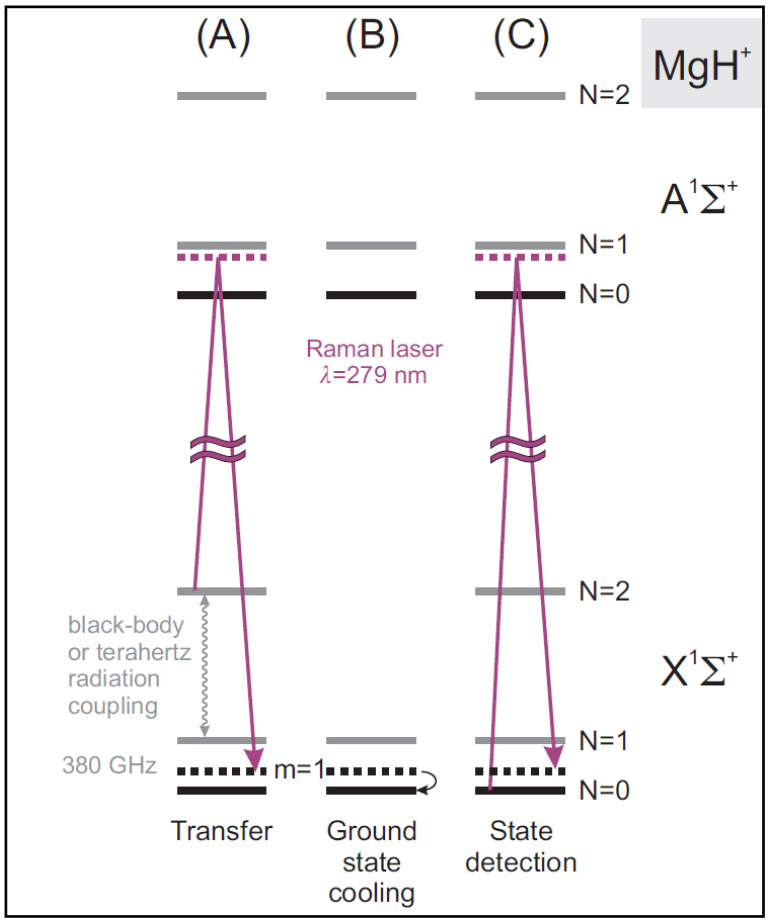
Spectroscopy of Zeeman States



P.O. Schmidt *et al.*, *Science*, **309**, 749 (2005)



Internal state cooling of MgH^+



motional cooling
+
sideband transitions
=
reduced state entropy

Figure 2 in:
P. O. Schmidt *et al.,* Proc. NNP 2006