Understanding blue-detuned magneto-optical traps for molecules

Qinshu Lyu [1,†], Joe Cox [1], Jonas Rodewald [1], Kai Voges [1], Chris Ho [1], Michael Tarbutt [1]

[1]Centre for Cold Matter, Imperial College London, Prince Consort Road, London SW7 2AZ, United Kingdom
†corresponding author's email: ql820@ic.ac.uk

In a normal, red-detuned magneto-optical trap (MOT) of molecules, sub-Doppler heating competes with Doppler cooling resulting in high temperature and low density. A solution to this problem is to first capture the molecules in a red-detuned MOT, and then switch to a blue-detuned MOT where sub-Doppler cooling dominates. This lowers the temperature and increases the density [1].

Several blue-detuned molecular MOTs have been implemented [2, 3, 4, 5]. A recent implementation relies on a pair of orthogonally polarized frequency components spaced by only a few MHz, less than the transition linewidth [5]. We identify the origin of the confining force in this MOT which relies on the formation of a time-independent dark state at non-zero magnetic field, where the Larmor precession matches the difference frequency between the components of the light. We present both experimental and simulation results supporting this mechanism. The results are important for efficient loading of molecules into optical dipole traps, and for evaporative cooling to quantum degeneracy.

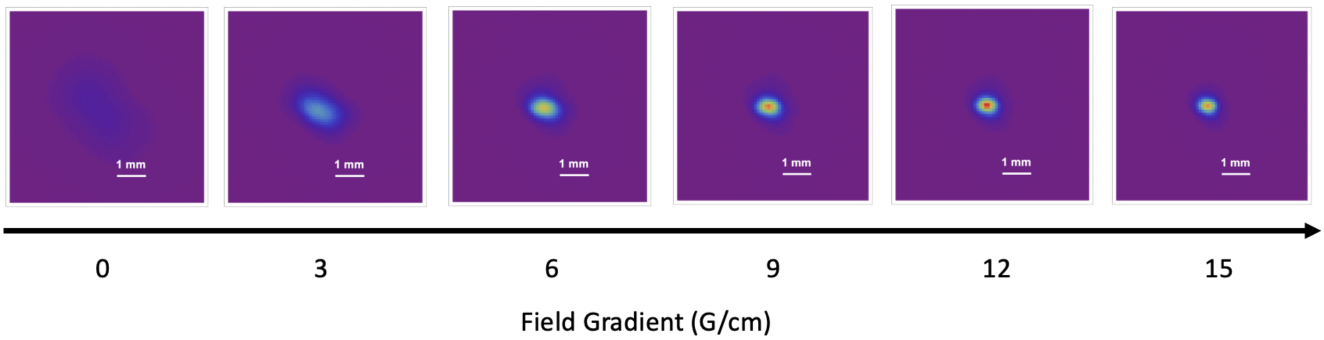

Figure 1: Compression of the blue MOT.

References

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