Rovibrational Cooling of Cs_2 Molecules

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Abstract

Methods for producing (translationally) cold molecules from cold atoms lead to the production of vibrationally and rotationally excited molecules, ie. with significant residual internal energy. For additional applications with cold molecules, the challenge is therefore to prepare and control molecules in the ground vibrational and rotational state. Here we demonstrate the transfer of several rotational and vibrational levels of cesium molecules into absolute ground state (V = 0, J = 0). This manipulation is realized by the use of two lasers, exciting all the populated rovibrational state but the final one. The target state thus behaves like a dark state where molecules pile up thanks to the repetition of absorption-spontaneous emission cycles. A shaped broadband laser is used to cool a molecular vibration via an optical pumping mechanism that transfers population in the ground vibrational state [1], whereas a narrowband laser is scanned in order to manipulate the more compressed rotational spectra. The simplicity of the method suggests that it can be extended to other molecules and to molecular beams.

References

[1] M. Viteau et al., Science 321, 232 (2008).