Hyperfine van der Waals repulsion between open-shell polar molecules

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We describe a novel type of interaction between open-shell polar molecules at sub-millikelvin temperatures. This hyperfine van der Waals interaction occurs between two molecules in rotational states that differ by one quantum. Normally, this induces resonant dipolar interactions that lead to rapid collisional loss. For specific hyperfine states, however, selection rules prevent this. One can effectively turn off the dipolar interaction by merely flipping a nuclear spin. The resulting van der Waals interaction can be repulsive and can suppress collisional loss rates. We focus on CaF, but show this effect occurs also for MgF, SrF, BaF and YO. We propose this effect could be measured by merging molecules in optical tweezers, where flipping a spin in one of the tweezers enables tuning of collision rates by four orders of magnitude.

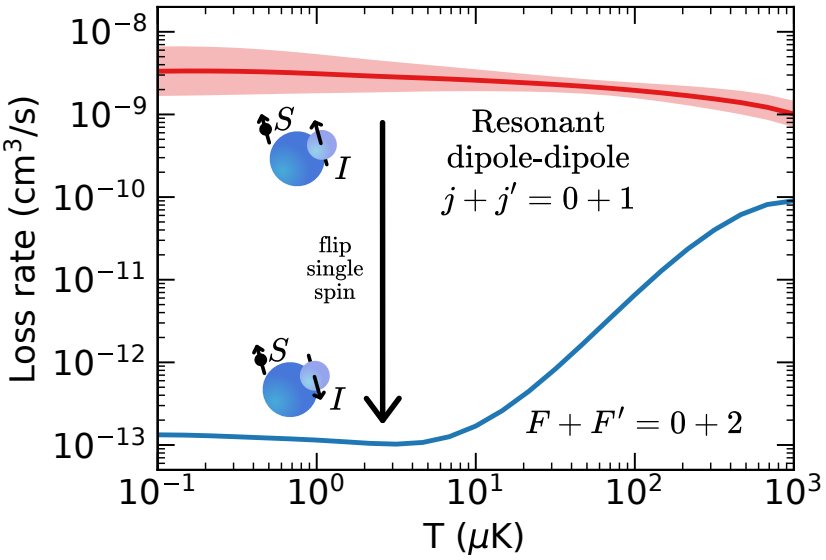

Figure 1: Decreasing CaF collisional loss rates by hyperfine van der Waals repulsion.