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Evaporative cooling and tetramer association of MW-shielded ground-state polar molecules

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Ultracold polar molecules promise a wide range of exciting new opportunities for quantum information processing, quantum simulations, cold chemistry, and precision measurements. I will present how microwave (MW) shielding of ground-state NaK molecules stabilizes collisions allowing us to evaporate dipolar molecules in 3D to quantum degenerate temperatures of 0.36 times their Fermi temperature.
Furthermore, we find a novel type of scattering resonances due to field-linked bound states between two MW-dressed molecules. We show that those resonances offer tuneability similar to Feshbach resonances for atoms and even allow the association of tetratomic molecules. We can create more than 1000 (NaK)^2 molecules with temperatures below 150 nK and lifetimes of 8 ms. The measured binding energy and lifetime agree well with parameter-free calculations, which outlines pathways to further increase the lifetime of the tetramers. Our results demonstrate a universal tool for assembling ultracold polyatomic molecules from smaller polar molecules and constitute a significant step towards a new crossover between a dipolar BCS superfluid and a polyatomic BEC.

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