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Ultracold Molecular Clock in a State-Insensitive Optical Lattice CHIH-HSI LEE, STANIMIR KONDOV, CHRISTIAN LIEDL, KON H. LEUNG, TANYA ZELEVINSKY, Columbia Univ — Techniques originally developed for atomic clocks can be adapted to ultracold molecules, with applications ranging from quantum-state-controlled ultracold chemistry to searches for new physics. We present recent experimental results on the $^{88}Sr_2$ molecular clock which allows us to test molecular QED, search for mass-dependent fifth-force interactions, and potentially probe the electron-to-proton mass ratio variations. The oscillator of such a molecular clock consists of the frequency difference between two vibrational levels in the electronic ground state. The transition between the levels is driven by a pair of Raman lasers via an off-resonant excited state. We have achieved transitions from weakly bound to multiple deeply bound ground states. Trap-insensitive spectroscopy is crucial for extending coherent molecule-light interactions. We have demonstrated the magic wavelength technique for molecules by manipulating the optical lattice frequency near narrow polarizability resonances. This technique allows us to increase the coherence time a thousandfold and to narrow the 30 THz vibrational transition initially to 100 Hz. Long coherence times of molecular state superpositions are useful not only for fundamental metrology but also for quantum information.

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