

Abstract Submitted
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Towards a Molecular Lattice Clock: Magic-Wavelength Vibrational Spectroscopy of Sr₂ KON H. LEUNG, CHIH-HSI LEE, STANIMIR KONDOV, CHRISTIAN LIEDL, TANYA ZELEVINSKY, Columbia University — Homonuclear diatomic molecules tightly confined at ultracold temperatures allow for high-precision spectroscopy and coherent control over their quantum states. These qualities offer novel pathways for tests of fundamental physics, such as searches for temporal drifts in the fundamental constants and “fifth forces”, in addition to probing quantum chemistry in the ultracold regime. Here we report the progress in building a molecular lattice clock with ultracold ⁸⁸Sr₂ molecules trapped in an optical lattice, with the goals of testing molecular QED, improving constraints on nanometer-scale gravity, and potentially providing a model-independent test of the temporal variation of the electron-proton mass ratio. These involve precise metrology of the binding energies of vibrational states spanning the ground-state potential. We locate several vibrational states by employing two-photon spectroscopy. To eliminate differential light shifts and decoherence due to the lattice, we demonstrate a new type of magic wavelength based on narrow polarizability resonances. Additionally, we present results on ultracold photodissociation where we demonstrate magnetic field control of matter-wave interference in the emerging photofragment angular distributions, and probe the quantum-quasiclassical transition behavior at increasing photofragment energies, finding excellent agreement with a multi-channel quantum chemistry model.

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