DAMOP14-2014-000068

Abstract for an Invited Paper
for the DAMOP14 Meeting of
the American Physical Society

Precision measurements with an ultracold molecular clock

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High-precision spectroscopy has been instrumental in the progress of atomic physics. In this talk, we extend precision spectroscopy techniques to ultracold diatomic strontium molecules tightly trapped in an optical lattice, and discuss the results from the point of view of molecular and fundamental science. For weakly bound molecules near the atomic threshold corresponding to the narrow intercombination transition, we observe peculiar and unexpected physics, including multiply forbidden transitions and anomalously large linear and quadratic Zeeman shifts. The Zeeman shifts are highly sensitive to nonadiabatic mixing angles of the molecular wave functions. For the first time, we quantitatively compare the electric- and magnetic-dipole transition strengths for forbidden transitions in molecules, and discuss the dependence on the internuclear separation. In addition, we study ground state molecules, and discuss the present status of the molecular lattice clock and the physics it is able to probe. Magic-wavelength spectroscopy is successfully demonstrated for a range of narrow molecular transitions.