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Optical clocks based on molecular vibrations as probes of time-varying mass ratios

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Some models of quantum gravity and some classes of dark matter predict temporal changes in the fundamental constants. Changes in the “constants” could manifest themselves as drifts or oscillations in their values. Molecular vibrations and rotations involve the motion of the nuclei themselves. They thus provide a system that is relatively simple to model while also sensitive to the ratio of the nuclear mass – and thereby the proton mass – to the electron mass. There are several proposed approaches to using molecules in these searches. The extra degrees of freedom in molecules that enable these searches also bring challenges to their precise control. This talk will give an overview of ongoing work in this area as well as details about experiments at Amherst College with singly ionized diatomic oxygen molecules, both in a beam and a trap.

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