Cavity-Enhanced Precision Spectroscopy of Molecules

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Precise determination of ro-vibrational transition frequencies of molecules is interested in metrology as well as fundamental physics. However, the accuracy is often limited by miscellaneous broadening effects (Doppler, collision, etc) and the weakness of the transitions. The use of high-finesse optical cavities not only enhances the detection sensitivity, but also provides a strong laser field which may saturate weak overtone transitions. Cavity-enhanced spectroscopy techniques combined with frequency combs allow us to determine the center frequencies of molecular Lamb dips with sub-kHz accuracy. Precise two-photon spectroscopy was also implemented with milli-Watt narrow-linewidth lasers. In this talk, I will present our recent progress in precision spectroscopy of the hydrogen molecule and also the demonstration of a “clock” based on infrared molecular transitions. Precise frequencies of the molecular hydrogen may allow a determination of the proton-to-electron mass ratio, and the comparison between the molecular clock and an atomic clock may provide a detection of the variation of fundamental constants or a probe of the mass-dependent new physics.