ELECTRIC QUADRUPOLE TRANSITION MEASUREMENTS OF HYDROGEN MOLECULE WITH HIGH PRECISION

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Molecular hydrogen is the most fundamental, and the only neutral molecule expected to be both calculated and measured with extremely high accuracy. High-precision measurements of its spectroscopy, especially the levels at the electric ground state, play an important role in the examination of precise quantum chemistry calculations and some fundamental physical constants. In the infrared region, H_2, being a homonuclear diatomic molecule, only has very weak electric quadrupole transitions. We established a new spectroscopy approach with ultra-high precision and sensitivity as well, based on a laser-locked cavity ring-down spectrometer. An equivalent absorption path-length of thousands of kilometers and a frequency precision of 10^{-5} cm^{-1} have been achieved. Ro-vibrational spectra of the second overtone of H_2 have been recorded. The obtained results will provide a direct examination of the high-accuracy quantum theory. It also shades light on the determination of fundamental physical constants such as the electron/proton mass ratio in a molecular system.