

The Overtone Spectrum of Molecular Hydrogen and Methane in the Visible: Recent Measurements

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The increasing precision and accuracy of modern high-resolution spectroscopic observations of cosmic sources has to some extent driven the need for improved laboratory data and refined theories of atoms and molecules. This paper describes spectroscopic facilities in the Department of Physics and Astronomy at Denison University and recent measurements of some of the overtone spectra of molecular hydrogen and methane in the visible portion of the spectrum. For molecular hydrogen, we have recently completed the measurement of pressure shifts, line strengths and shapes, self-broadening coefficients and line positions for the S(0) and S(1) quadrupole transitions in the 4-0 vibration-rotation band. The data were obtained using a high-resolution dye laser system coupled to a White-type cell of unique optical design which is capable of obtaining optical paths of over 6 km. Using this system we also were able to detect — for the first time in the laboratory — the S(1) line of 5-0 band and to estimate its line strength and pressure-broadening coefficient. For methane, we have initiated a program to measure the strong visible and near-infrared absorption bands at moderate and eventually high resolution. Due to the complex and unresolved nature of these bands, empirical measurements of the absorption coefficient as a function of temperature have been carried out. These measurements were made using a lower-resolution dye laser system interfaced with a coolable three-meter basepath Chernin cell adjusted for optical paths up to one kilometer and at temperatures down to 123 K. It is hoped that these measurements of the overtone spectrum of hydrogen and methane will be of use in modeling the extended atmospheres of cool stars.

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