MID-IR SATURATION SPECTROSCOPY OF

HELIUM HYDRIDE MOLECULAR ION

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The study of helium hydride molecular ion (HeH^+) has been extensively discussed in several areas including physics, chemistry and astronomy. Such charming two-electron diatomic compound is thought to be the first molecular species and is of the fundamental importance in the formation and the cooling of our early Universe. Especially for some re-ionization reactions in the early time, the ro-vibrational excitation in HeH^+ induced by the collision with electron plays the role of the coolant in shocked gas-phase cloud, cooling flow galaxies and some interstellar clouds. Besides, the precise experimental measurement of the HeH^+ provides a promising tool for the verification of fundamental physics, testing the theoretical model of molecular structure, energy levels and our current understanding of QED theory.

Recently, we are able to observe the high-resolution spectrum using the nonlinear saturation spectroscopic technique and PPLN optical parametric oscillator (OPO). In this paper we present the first direct measurement of the absolute ro-vibrational transition frequencies in the fundamental band ($v= 1 \leftarrow 0$) of HeH^+.

The HeH^+ ions were produced in an ethanol cooled extended negative glow discharge tube at -70 ^oC with mixtures of helium and hydrogen. The negative glow region of discharge was extended by applying an axial magnetic field of 300 gauss. To obtain the saturation signal, we use a continuous-wave, singly resonant, single frequency and widely tunable OPO. The pump frequency and signal frequency of OPO are compared with the modes of a fiber optical frequency comb which is referred to a GPS-disciplined rubidium clock. We observed the spectrum by scanning the pump laser frequency and demodulated by a lock-in amplifier. The investigations of the linewidth and the frequency measurement will be presented.