PRECISION SATURATED ABSORPTION SPECTROSCOPY OF H_3^+

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Abstract:

In our previous work on the Lamb dips of the ν_2 fundamental band of H_3^+, the saturated absorption spectrum was obtained by the third-derivative spectroscopy using frequency modulation [1]. However, the frequency modulation also causes error in absolute frequency determination. To solve this problem, we have built an offset-locking system to lock he OPO pump frequency to an iodine-stabilized Nd:YAG laser. With this modification, we are able to scan the OPO idler frequency precisely and obtain the profile of the Lamb dips. Double modulation (amplitude modulation of the idler power and concentration modulation of the ion) is employed to subtract the interference fringes of the signal and increase the signal-to-noise ratio effectively. To Determine the absolute frequency of the idler wave, the pump wave is offset locked on the R(56) 32-0 a_{10} hyperfine component of $^{127}I_2$, and the signal wave is locked on a GPS disciplined fiber optical frequency comb (OFC). All references and lock systems have absolute frequency accuracy better than 10 kHz. Here, we demonstrate its performance by measuring one transition of methane and sixteen transitions of H_3^+. This instrument could pave the way for the high-resolution spectroscopy of a variety of molecular ions.

[1] H.-C. Chen, C.-Y. Hsiao, J.-L. Peng, T. Amano, and J.-T. Shy, Phys. Rev. Lett. 109, 263002 (2012).