PRECISE MEASUREMENT OF VIBRATIONAL TRANSITION FREQUENCY OF OPTICALLY TRAPPED MOLECULES

MASATOSHI KAJITA, *Nat. Ins. Info. Comm. Tech., Koganei, Tokyo 184-8795, Japan*; GEETHA GOPAKUMAR,MINORI ABE, and MASAHIKO HADA, *Dep. of Chemistry, Tokyo Metro. Univ., Hachioji, Tokyo 192-0397, Japan*.

We propose to measure the $X^2\Sigma\,(v, N, F, M) = (0, 0, 3/2, \pm 3/2) \rightarrow (v_u, 0, 3/2, \pm 3/2)\,(v_u = 1, 2, 3, 4, , , ,)$ transition frequencies of X^6Li molecules with the uncertainty lower than 10^{-16} (X: ^{174}Yb, ^{88}Sr, ^{40}Ca). Molecules are produced by photo-association of cold atoms and trapped in the optical lattices. Measurement with molecules in optical lattices is particularly advantageous for precision measurements because (1) the molecules and probe laser interact for a long time, (2) molecules are localized within the Lamb-Dicke region, (3) the measurement is possible with a large number of molecules, and (4) collision effects are suppressed (molecules are trapped at different positions in 2D lattices).

Using the proper trap laser frequency, the Stark shift induced by the trap laser is eliminated as the Stark energy shift of the upper and lower states are equal (magic frequency). When the trap laser frequency is shifted from the magic frequency by 1 MHz, the Stark shift is less than 3×10^{-15}.

The $N = 0 \rightarrow 0$ transition is one-photon forbidden, and it is stimulated by Raman transition using two lasers. When one of two Raman lasers is higher than the magic frequency and another is lower, the total Stark shift induced by two Raman lasers can be eliminated.

Measurement of molecular vibrational transition frequencies is useful to test the variation in the proton-to-electron mass ratio. The ^{1}S$_0$-^{3}P$_0$ transition frequencies of ^{27}Al$^+$ ion or ^{87}Sr atom are useful as the reference.