Hot topic presentation

Ionization threshold of Rb_2 molecule measured by the electric field-dependent Rydberg-state spectroscopy

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Recent experiments involving hybrid ion-atom systems in the ultracold domain ($T < 1\mu$K), which is dominated by s-wave collisions, are expected to provide a rich experimental platform with new phenomena and applications[1]. For the specific case of Rb, weakly bound Rb_2^+ ions have been observed after a single cold $^{87}Rb^+$ ion was injected inside a ^{87}Rb Bose-Einstein condensate[2]. Modeling of such experiments requires the precise knowledge of the ground state $X^2\Sigma_g^+$ of the molecular ion[3] and thus the ionization threshold of Rb_2

In this work we have measured the ionization threshold of the $^{85}Rb_2$ molecule in a supersonic beam using resonantly enhanced 2-photon ionization (RE2PI) by applying two lasers of different wavelengths through a well chosen intermediate state. The first photon frequency is resonant with $^{85}Rb_2$ $X^1\Sigma_g^+(v=0) - B^1\Pi_u(v_B=2)$ transition while the second photon frequency is swept allowing to address either different Rydberg levels of the molecule which could be ionized by a pulsed electric field, or vibrational levels of the molecular ion thus ionizing the molecule without an electric field.

Ionization spectra recorded at different electric field values (see Figure 1) exhibit several lines and an enhancement of the background of the signal which remain the same after a given frequency independent of the field intensity thus corresponding to the ionization threshold. The lines are identified as the pulsed field-ionized (PFI) Rydberg components of the spectra. In addition, we identify vibrational levels of Rb_2 Rydberg states associated to vibrational levels of $Rb_2^+, v^+ = 0, 1, 2, 3, ...$ The ionization threshold energy of the $^{85}Rb_2$ molecule is measured $E_i = 31498(1)$ cm^{-1} (with a dissociation energy of $D_0 = 6158(1)$ cm^{-1}). This value is 150 cm^{-1} higher than the previous one measured by Bellos et al.[4] and is in better agreement with recent theoretical models.

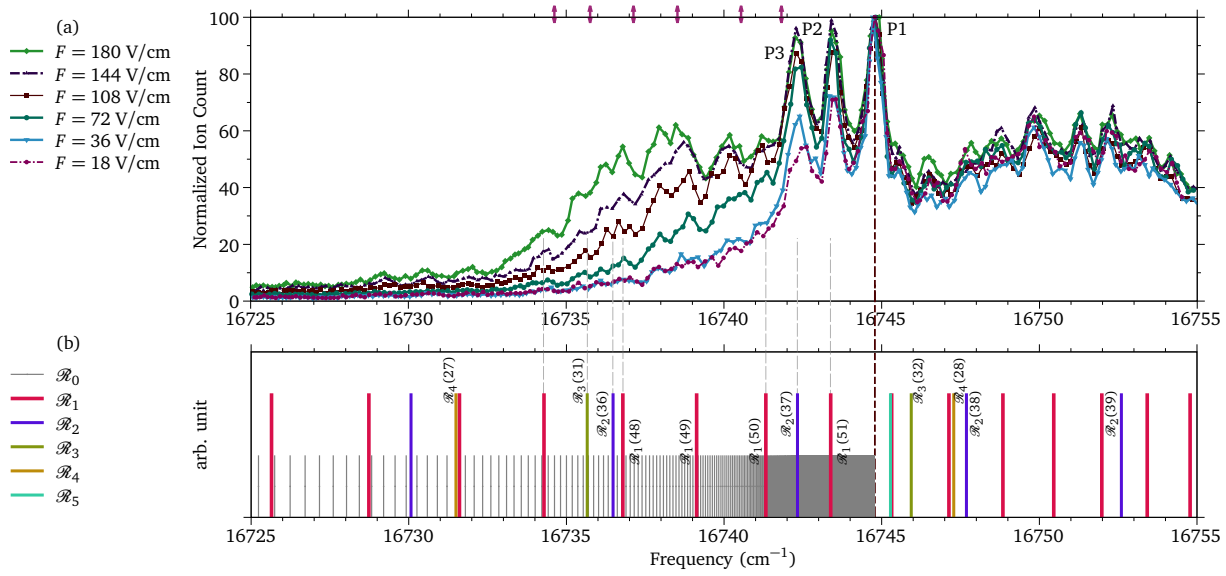

Figure 1: (a) Normalized Rb_2^+ ion count as a function of the second photon frequency for several electrical fields (F=180, 144, 108, 72, 36, and 18 V/cm). (b) Rydberg states associated with the vibrational levels of $^{85}Rb_2^+$,$X^2\Sigma_g^+$ $v^+ = 0, 1, 2, ...$ labeled as $\mathscr{R}_0$, $\mathscr{R}_1$, $\mathscr{R}_2$ ..., respectively.

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