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Stark quantum beat of Kr in V.U.V. region

Hajime TOKUNAGA*[1], Hidemasa YOSHIDA[1], Tomohiro AOTO[1], Osamu IWAI[1]
Hiroshi YOSHII[2] , Tatsuji HAYAISHI[2] , Kenji ITO[3] , Yumio MORIOKA[1]
[1]Institute of Phys. Univ. of Tsukuba, Tsukuba, Ibaraki 305-8571 Japan
[2]Institute of Appl. Phys. Univ. of Tsukuba, Tsukuba, Ibaraki 305-8573 Japan
[3]IMSS, High Energy Accelerator Research Organization, Ohho, Tsukuba, Ibaraki 305-0801 Japan

Introduction

We have obtained Stark Quantum Beat (SQB) spectrum under a static electric field in vacuum ultraviolet fluorescence decay spectra of Kr atom resonance lines. Kr was excited by pulsed vacuum ultraviolet light in a synchrotron single bunch operation. SQB spectroscopy is based on the quantum interference effect between two levels which are in close proximity. When an atom under the static electric field was excited by polarized light to magnetic sublevels M=0 and $|M|=1$ simultaneously, SQB appears in the fluorescent decay spectra due to the quantum interference effect between the two levels. From the beat period we can determine the frequency and the energy between the levels.

Experiment

The experiments were performed on beamline 20A. The synchrotron radiation was monochromatized by a 3-m normal incidence Eagle mounted scanning monochromator equipped with a 2400 lines/mm gold-coated grating. When the entrance and exit slit were set to be 10 μm, the monochromator has a resolusion (E/ΔE) of about 60,000. Synchrotron radiation in a single bunch operation had a pulse width of approximately 50 psec and a repetition period of 624 nsec. The target gas was supplied by the jet nozzle and crossed perpendicularly to the excited light. Fluorescence emitted from the excited Kr atom was detected by the MCP and set to detect a 45° gradient to the direction of the electric field.

Result

Fig.1 shows the obtained fluorescence excitation spectrum of Kr covering the Rydberg series converging to $^2P_{3/2}$ and $^2P_{1/2}$ ionization thresholds by synchrotron multi bunch operation. We applied a DC electric field less than 1[kV/cm] to the interaction region and observed the Stark quantum beat spectra. Fig.2 shows time resolved fluorescence spectra of the Kr 8d[1/2]$_1$ state at field free and applied electric field by single bunch operation. The spectra were Fourier transformed and shown in the right side. The observed beat frequencies varied proportionally to the square of the external electric field. The theoretical energy gap between the M=0 and $|M|=1$ levels can be calculated using a *jl*-coupling scheme.

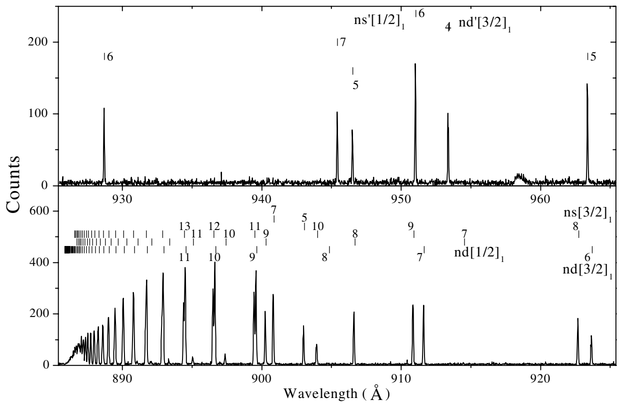

Fig.1 Fluorescence spectrum of Kr.

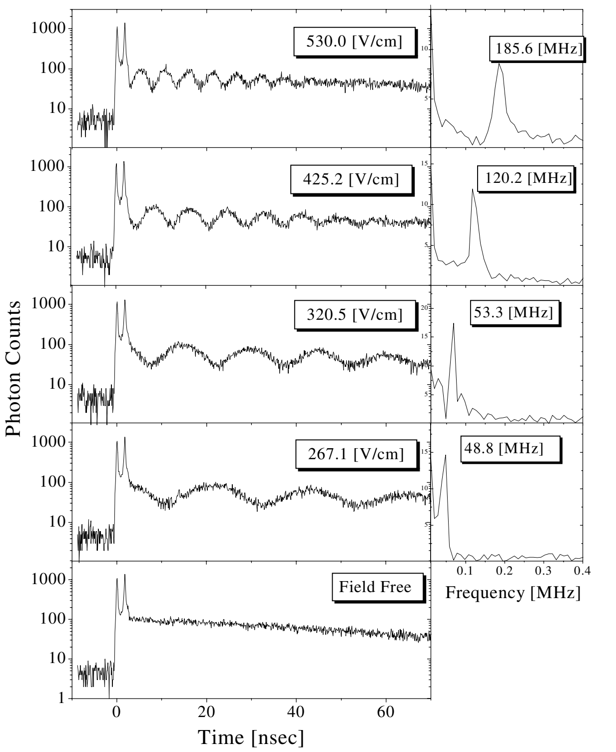

Fig.2 Left figures shows SQB spectra of the Kr 8d[1/2]$_1$ state. Figures on the right show Fourier spectra of the left ones.

*hajimail@mug.biglobe.ne.jp