DEVELOPMENT OF LASER SPECTROSCOPIC METHOD USING SUPERFLUID HELIUM FOR THE STUDY OF LOW-YIELD NUCLEI

Kei Imamura[1, 2], Tomomi Fujita[2, 3], Tsuyoshi Egami[2, 4], Taishi Nishizaka[2, 4], Aiko Takamine[2], Daiki Tominaga[2, 4], Takafumi Kawaguchi[2, 4], Wataru Kobayashi[2, 4], Makoto Sanjo[2, 4], Takeshi Furukawa[5, 2], Yuichi Ichikawa[2], Takashi Wakui[6], Hitoshi Odashima[1], Hideki Ueno[2], and Yukari Matsuo[4, 2]

[1]Department of Physics, Meiji University, 1-1-1 Higashi-mita, Tama-ku, Kawasaki, Kanagawa 214-8571, Japan
[2]RIKEN Nishina Center (RNC), 2-1 Hirosawa, Wako-shi, Saitama 351-0198, Japan
[3]Department of Physics, Osaka University, 1-1 Machikaneyama, Toyonaka, Osaka 560-0043, Japan
[4]Department of Advanced Science, Hosei University, 3-7-2 Kajino-cho, Koganei-shi Tokyo 184-8548, Japan
[5]Department of Physics, Tokyo Metropolitan University, 1-1 Minami-osawa, Hachioji-shi, Tokyo 192-0397, Japan
[6]Reserach Center of Charged Particle Therapy National Institute of Radiological Sciences, 4-9-1 Anagawa Inage-ku, Chiba-shi, Chiba 263-8555, Japan

We have developed a laser spectroscopy technique utilizing superfluid helium (He II). This technique is named OROCHI (Optical RI-atoms Observation in Condensed Helium as Ion-catcher). Owing to the high stopping efficiency of He II and a largely blue-shifted of atomic (optical) absorption spectra in He II, our technique is expected to be capable of the study of low-yield nuclei. In our technique, high energetic ion beams produced at accelerator facilities are injected into He II. Almost all ions are neutralized during their stopping process and trapped as neutral atoms. We perform production of spin polarized atom using an optical pumping method. The Zeeman/hyperfine structure splitting of the atoms is measured using laser-RF (radio frequency)/MW (microwave) double resonance method to determine their nuclear spin/electromagnetic moment from the measured energy splitting, respectively.

So far, we conducted a series of experiments using $^{84\text{-}87}$Rb ion beams (66 MeV/u, 10^3-10^4 pps) delivered from the RIPS beam line at RIKEN. We successfully observed double resonance spectra for Rb atoms trapped in He II. However, we found that the signal-to-noise ratio of the obtained spectra was not high enough for the application to lower yield species due to an inefficient suppression of background signals from laser stray light and an insufficient RF/MW irradiation power. In order to overcome the difficulties, we have renewed a photo-detection system and an RF/MW irradiation system. Offline experiments are also performed to verify the improvement. We report on the present status of the improvement of experimental apparatus and an online experiment plan.