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OROCHI experiment: Laser spectroscopy of RI atoms in superfluid helium for measurements of nuclear spins and electromagnetic moments

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We have been developing a new laser spectroscopy technique named as OROCHI (Optical RI-atom Observation in Condensed Helium as Ion-catcher) for measurements of nuclear spins and electromagnetic moments of low yield exotic radioisotopes (RIs). In this technique, we use superfluid helium (He II) liquid as a stopping material of RI beam in which in-situ laser spectroscopy of the RI atoms stopped in He II is carried out. The characteristic features of He II, i.e. high trapping efficiency of He II liquid for accelerated ion beams and the characteristics of atomic spectra in He II, enables us to measure the nuclear spins and moments of the extremely low yield RIs. So far, we have demonstrated the feasibility of our method to deduce the nuclear spins and moments with stable Rb, Cs, Ag and Au isotopes supplied into He II by laser sputtering technique. In addition, we have also succeeded in observing laser-radiowave/microwave double resonance signals of $^{84-87}$Rb atoms injected into He II as energetic ion beam. In these on-line experiment, the $^{84-87}$Rb isotope beams (intensity: up to 10^5 particles/s) were provided with RIPS beamline in RIKEN, and introduced into He II filled in a cryostat. Special care was taken in controlling the stopping position of injected Rb isotopes. Aluminum energy degraders of varied thickness from 0 to 0.8 mm were placed upstream of the beam injection window of the He II cryostat for optimizing the stopping position The $^{84-87}$Rb atoms stopped and then neutralized in He II were optically pumped and polarized with circularly polarized pumping laser light whose wavelength were tuned to 780 nm, D1 absorption line of Rb atoms in He II. The polarized atoms were subjected to irradiation of radiowave or microwave, and then we demonstrated the double resonance spectroscopy for observing the Zeeman transition of $^{84-87}$Rb atoms and the hyperfine transition of ^{87}Rb, respectively In this presentation we will show the details of OROCHI technique and the present status of our development, in particular the result of the recent on-line experiment.