Observation of atom-surface interaction near dielectric surface using ultracold rubidium atoms

Go Tanaka*, Yutaka Kobayashi*, Satoshi Shibata*, Satoshi Tojo* [1]

[*] Department of Physics, Chuo University, 1-13-27 Kasuga, Bunkyo, 112-8551, Tokyo, Japan

Synopsis We investigate atom behaviors near dielectric surface by manipulating ultracold rubidium atoms in an optical trap. We confirm optical lattice generating by interference between incident and reflected trap beams, and observe light emissions of cold atoms in an optical lattice using high resolution observation system with position dependence near the surface. We will report on a comparison of frequency shift in the vicinity of surface with free space.

Precise manipulation of laser-cooled atoms is a powerful technique for investigation of atom-surface interactions owing to neutral atoms having high operationality caused by high-sensitive to light and magnetic fields [1, 2]. We have studied higher-order interactions between laser-cooled atoms and an optical near-field, and explore phenomena of atoms in a local vicinity of surface.

We have prepared laser-cooled ^{87}Rb atoms and loaded them into focus region of far-off resonant optical trap (FORT) with the wavelength of 1064 nm. We have realized to transport trapped atoms into the region of several micrometers from a glass surface with 10^6 atoms at below 6 μK, which is implemented by changing in an amount of displacement of a sub-micrometer stage in the trapping laser system. For observation of atom-surface interaction, we have installed a photon counting system composed by a hemispherical lens, an aspherical lens, an imaging lens and a CCD camera as shown in Fig. 1(a).

Cold atoms are loaded into optical lattices near the surface which are formed by the interference between incident and reflected laser beam of FORT on dielectric surface and generate periodic deep and narrow potentials [2]. We also confirm the lattice formation using the parametric resonance measurement.

The highly spatial resolution system can make us investigate atom-surface interactions and ultracold collisions in dielectric surface potential with extreme precision. We have derived light emission image using CCD camera as shown in Fig. 1(b). The sharp and higher intensity region indicates high density emission of atoms in optical lattices. We will report on atomic behaviors near dielectric surface in light field in comparison with those in free space.

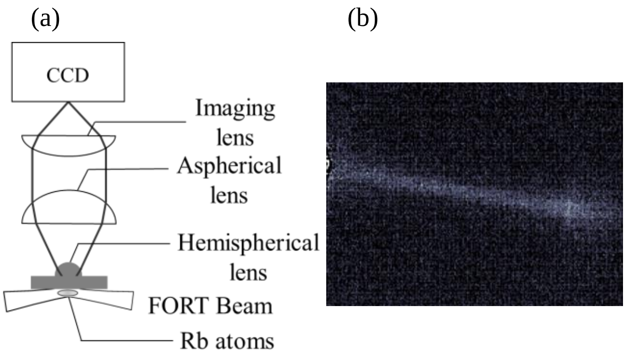

Figure 1(a) Schematic of observation system for cold atoms near surface. (b) An emission image of ultracold Rb atoms in an optical lattice and FORT.

References

[1] H Bender, Ph W Courteille, C Marzik, C Zimmermann, and S Slama 2010 *Phys. Rev. Lett.* **104** 083201

[2] J. I. Grillen, W. S. Bakr, A.Peng, P. Unterwaditzer, S. Fölling, and M. Greiner 2009 *Phys. Rev. A* **80** 021602(R)

[1] E-mail: tojo@phys.chuo-u.ac.jp