ATOM OPTICS

OPTICS AND MOLECULAR MATERIALS LABORATORY

By using lasers and magnetic fields, gaseous atomic samples can be cooled from room temperature to about 1 µK. We develop techniques to manipulate cooled atomic samples, analogously to guiding light with lenses and mirrors. At ultra-low temperatures, atoms start behaving as waves and even an atomic laser has been realized.

So far the research efforts in the field of cooling and trapping of neutral atoms and molecules have mainly focused on studying the fundamental aspects of modern quantum physics. One of the most promising means for practical applications of quantum optics is the technology based on the creation of microscopic atom traps on the surface of a solid substrate.

The research in our laboratory is focused on the development and experimental realization of microscopic atom traps and guides on a transparent, rewriteable permanent-magnet atom chip. The atom chip we use is a dielectric gadolinium-gallium-garnet substrate coated with a thin film of a magnetically hard ferrite-garnet, $(BiYTmGd)_3(FeGa)_5O_{12}$. The trapping magnetic fields for the atoms are created by magnetization patterns recorded in the film by magneto-optical means. Up to now we have realized on-chip magneto-optical trapping of ^{85}Rb atoms. The shape and position of the atomic cloud can be modified during the experiment.

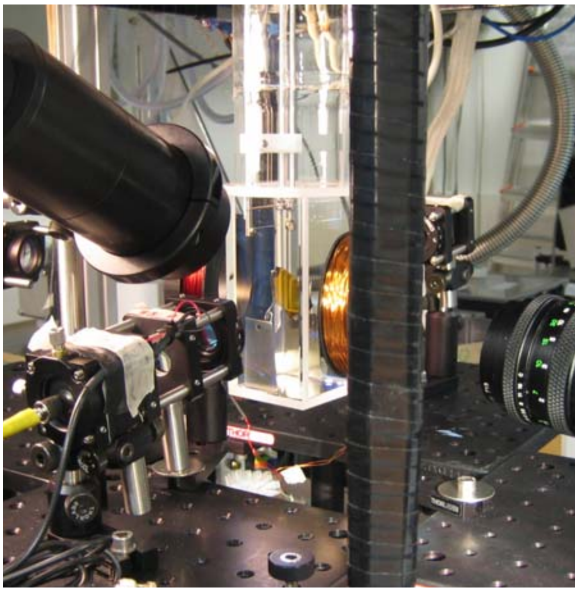

Figure 1. Experimental setup: the transparent atom chip is located inside an ultra-high vacuum glass cell with optical access for laser beams and imaging.

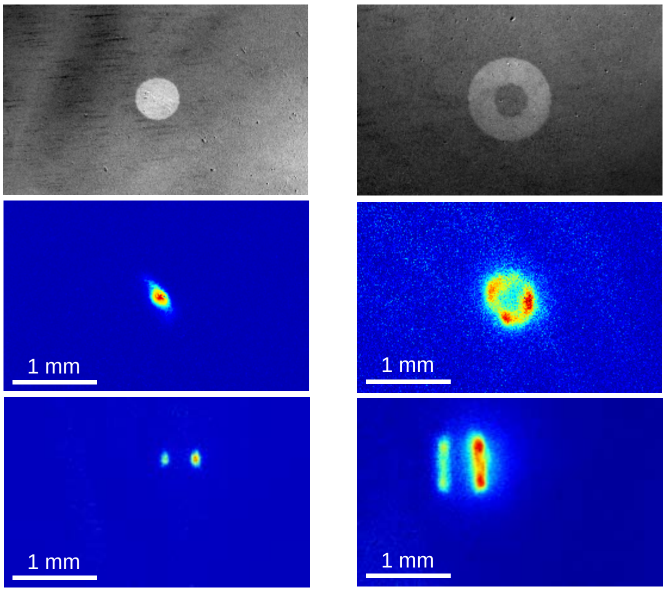

Figure 2. Top row: two different magnetization patterns on the chip. Middle row: front views of the resulting trapped atomic clouds. Bottom row: side views of the same traps.

Funding:

Academy of Finland, Graduate School GETA, Jenny and Antti Wihuri Foundation

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Recent Publications:

1. A. Jaakkola, A. Shevchenko, K. Lindfors, M. Hautakorpi, E. Il'yashenko, T. H. Johansen, and M. Kaivola, *Reconfigurable atom chip on a transparent ferrite-garnet film*, Eur. Phys. J. D **35**, 81-85 (2005).
2. A. Shevchenko, T. Lindvall, I. Tittonen, and M. Kaivola, *Microscopic electro-optical atom trap on an evanescent-wave mirror*, Eur. Phys. J. D **28**, 273-276 (2004).
3. A. Shevchenko, A. Jaakkola, T. Lindvall, I. Tittonen, and M. Kaivola, *Method for obtaining high phase-space density in a surface-mounted atom trap*, Appl. Phys. B **79**, 367-370 (2004).
4. M. Hautakorpi, A. Shevchenko, and M. Kaivola, *Spatially smooth evanescent-wave profiles in a multimode hollow optical fiber for atom guiding*, Opt. Commun. **237**, 103-110 (2004).
5. A. Shevchenko, M. Kaivola, and J. Javanainen, *Thermodynamics of a multicomponent-atom sample in a tightly compressed atom trap*, Phys. Rev. A **70**, 011403(R) (2004).