Hydrogen Adsorbed on Liquid Helium:
A Two-Dimensional Bose-Einstein Condensate (Invited)

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Hydrogen atoms adsorbed on the surface of liquid helium form a nearly perfect example of a two-dimensional atomic quantum gas. The substrate, being liquid, is translationally invariant, allowing the atoms to move freely in the lateral plane. The interactions between the adsorbed atoms are weak enough to allow for a description in terms of a weakly interacting Bose gas. The stability of the adsorbed gas against formation of molecules is very high, allowing for surface densities of the order of 10^{13}cm^{-3} to be reached. At such densities quantum degenerate behavior sets in at temperatures compatible with a conventional cryogenic environment, about 100 mK. Moreover, the adsorption energy for the H atoms on liquid helium is so low (1 K) that the surface gas can be studied in equilibrium with its own vapor residing above the surface. The idea of the experiments is to control density and temperature of this vapor. This provides a handle for controlling temperature and chemical potential of the adsorbed gas.

The two-dimensional (2D) analog of Bose-Einstein condensation (BEC) of an atomic vapor has been first achieved using hydrogen atoms in Turku Finland [1]. See also Ref. [2] for a popular explanatory text. In Amsterdam we are carrying out experiments on such an adsorbed 2-d gas but, in contrast to the Turku group, we are able to directly observe the adsorbed atoms optically [3]. At present the achieved phase-space densities in Amsterdam are about one, right at the edge of the quantum degenerate regime. A modified apparatus is now used to enter the degenerate regime. In this contribution the principles of the experiments in Turku and Amsterdam will be described in an introductory fashion and results will be discussed. Also we will discuss why 2D BEC is of interest and why H atoms are so suitable to do these experiments.

[1] A.I. Safonov, S.A. Vasilyev, I.S. Yasnikov, I.I. Lukashevich, and S. Jaakkol, *Phys. Rev. Lett*. **81**, 4545 (1998).
[2] T.W. Hijmans, *Physics World* **12**,17 (1999).
[3] A.P. Mosk, M.W. Reynolds, T.W. Hijmans, and J.T.M. Walraven, *Phys. Rev. Lett*. **81,** 4440 (1998).