Three-Dimensional Boltzmann Gas and Possible Singlet Bound State of ^{3}He Film Formed in Nanopore of HMM-2

N. Wada[a], D. Tokioka[a], M. Kuno[a], R. Toda[b], M. Hieda[a], and T. Matsushita[a]

[a]Department of Physics, Nagoya University, Nagoya 464-8602, Japan
[b]Cryogenic Research Center, The University of Tokyo, Yayoi, Tokyo 113-0032, Japan

We have realized a new gas state of ^{3}He film adsorbed on ^{4}He-preplated nanopore wall of HMM-2 whose pores 2.7 nm in mean diameter regularly connect in three-dimension (3D) with a period 5.5 nm. In the case of a thick ^{4}He-preplating of 1.7 atomic layers, specific heat C/n_3 of a dilute ^{3}He film was observed to be $1.37(\pm 0.10)\,R$, where R is the gas constant, down to the lowest temperature (28 mK) measured. The constant specific heat indicates the Boltzmann gas state of the ^{3}He film of which C/n_3 is much larger than R of the 2D gas and close to $1.5\,R$ of the 3D ideal gas. For a ^{4}He-preplating of 1.2 layers, C/n_3 of the ^{3}He film was observed to be $1.45(\pm 0.10)\,R$ down to 0.6 K, indicating the ideal 3D Boltzmann gas. With decreasing the temperature, C/n_3 shows a maximum of $\approx 3.2\,R$ at 0.17 K, followed by a drop to be almost zero at the lowest temperature 28 mK. The result suggests a singlet bound state with a gap energy about 0.2 K. Large binding energy of a singlet dimer has been calculated for ^{3}He atoms adsorbed in a nanopore[1]. The calculated binding energy is strongly changed by the adsorption potential on the nanopore wall.

1. K. Yamashita, and D.S. Hirashima, J. Phys. Soc. Jpn. **80**, 114602 (2011).

Section: LD - Low dimensional and confined systems

Keywords: ^{3}He film, Nanopore, Three-dimensional gas, Singlet bound state