Frequency-independent 1D superfluid response in ^{4}He film adsorbed in nanochannels

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Recently one-dimensional (1D) superfluid responses have been observed for ^{4}He film (nanotube) adsorbed in nanochannels, essentially in the 1D state where elementary excitations observable in the specific heats are only 1D phonons along the channel axis[1]. These responses observed by torsional oscillators are characterized by a gradual increase of the superfluid density and accompanying broad dissipation peak, which completely differ from superfluid onsets observed in ^{4}He systems in higher dimensions. Recent theoretical works have shown that 1D superfluid can be observed in finite systems with respect to the length or/and frequency.

In this study, we have investigated the oscillation-frequency dependence of the 1D superfluid onset for ^{4}He film adsorbed in 2.4 nm channels of FSM silicate, which is implied by existence of a broad dissipation peak observed at the onset. The frequency dependence was studied using two torsional oscillators with different resonance frequencies 1 and 2 kHz simultaneously, as well as the amplitude dependences. Unexpectedly, any detectable differences in the onset temperature have not been observed between two frequencies, which suggests that the observed onset corresponds to the 1D superfluid density in the system with a finite length, rather than the superfluid response determined by the finite oscillating frequency.

1. N. Wada, Y. Minato, T. Matsushita, M. Hieda, J. Low Temp. Phys. **162**, 549 (2011); N. Wada, M. Hieda, R. Toda, and T. Matsushita, to be published in Low Temp. Phys. [Fiz. Nizk. Temp.].

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