Dynamics of Crystal-Superfluid Interface of ^{4}He Far from Equiriblium

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^{4}He quantum crystals grow from superfluid liquid very rapidly at low temperatures. This is because mass and heat transport processes in the bulk are negligible due to the swift superflow and the minimal release of the latent heat. High mobility of the crystal-superfluid interface allows one to observe novel interfacial phenomena which are sometimes hidden in the classical systems by the dissipations.

Acoustic radiation pressure is the second order acoustic effect which is usually small but can push an object in the direction of the acoustic waves. Crystal-superfluid interface of ^{4}He is so mobile that such tiny force was enough to induce crystallization and melting in a very short period [1, 2]. Acoustic radiation pressure was used as a tool to deform ^{4}He crystals largely and relaxation of the highly anisotropic interface was investigated after the deformation. Anomalous relaxation shapes such as needle-like or irregular shapes were observed depending on temperature. Relaxation time was highly dependent on the direction of the deformation whether it was crystalized or melted.

Effect of the superflow on the crystal shape was also investigated by observing ^{4}He crystals falling in superfluid. During the falling, upper surface of the crystal became rough and lower surface became facetted [3]. This is possibly caused by the superflow around the crystal which induced the melting in the upper surface and the crystallization in the lower surface. When it collided with the bottom, pulse-like wave traveled around the surface from the contact point and the crystal transformed itself quickly to adjust to a new boundary condition. We also investigated how crystals fell when a small needle was placed in the falling path. The crystal surface was drawn and stretched by the needle. This strange interaction between the crystal and the needle was probably induced by the superflow around the crystal but is not well understood at present.

Other nonequilibrium phenomena such as formation and rising of a superfluid droplet in ^{4}He crystals [2] and relaxation and Ostwald Ripening of ^{4}He crystals in reduced gravity will also be presented [4].

1. R. Nomura, Y. Suzuki, S. Kimura, and Y. Okuda, Phys. Rev. Lett. **90**, 075301 (2003).
2. Y. Okuda and R. Nomura, J. Phys. Soc. Jpn. **77**, 111009 (2008).
3. R. Nomura, T. Yoshida, A. Tachiki, and Y. Okuda, New J. Phys. **16**, 113022 (2014).
4. T. Takahashi, H. Ohuchi, R. Nomura, and Y. Okuda, Sci. Adv. **1**, e1500825 (2015).