Self-organized criticality in quantum crystallization of ^{4}He in aerogel

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We studied crystallization of superfluid ^{4}He in silica-aerogels to investigate the effect of disorder on dynamics of the first order phase transition at very low temperatures. In the low temperature limit, thermal fluctuation ceases and novel quantum phenomena are expected to emerge in the dynamics of the quantum matter. The way of the crystallization of ^{4}He in aerogels showed a dynamical transition due to the competition between thermal fluctuation and disorder: crystals grew via creep at high temperatures and via avalanche at low temperatures[1]. In the avalanche growth, critical overpressure for the nucleation was found to be temperature independent, indicating that crystallization proceeded by the macroscopic quantum tunneling through the disorder[2]. Avalanche size distribution was measured in the quantum growth regime and followed a power law in a length scale smaller than a large-scale cutoff size. Thus the crystallization in the quantum regime showed the self-organized criticality[3]. While the exponent of the power law was nearly temperature independent, the cutoff decreased with warming toward the transition temperature. Recently, it was observed that a superfluid pocket was formed completely surrounded by crystals in an aerogel when the sample cell was pressurized at constant temperatures in the creep regime and, surprisingly, it crystallized by cooling in the quantum regime. This finding would raise a question about the mass transfer which was possibly related to the supersolidity of ^{4}He in aerogel

1. R. Nomura *et al.*, Phys. Rev. Lett. 101, 175703 (2008).
2. H. Matsuda *et al.*, Phys. Rev. E 87, 030401(R) (2013).
3. R. Nomura *et al.*, J. Phys. Soc. Jpn. 80, 123601 (2011).

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