Self-organized Criticality in Quantum Growth Regime of ^{4}He Crystals in Aerogel

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The way of the crystallization of ^{4}He in aerogel shows a dynamical phase transition due to the competition between thermal fluctuation and disorder: crystals grow via creep at high temperatures and via avalanche at low temperatures.[1] In the creep region, crystal growth is faster at higher temperature and becomes slower with cooling and is consistent with the expectation that interface advances via a thermal activation in the disordered media. In the avalanche region, it slightly increases with cooling and saturates at lower temperatures. This temperature independent growth is presumably the result of the macroscopic quantum tunneling through the disorder. We measured the avalanche size distribution and found that the number of smaller size avalanches is larger. The size distribution follows a power law in a length scale smaller than a cutoff size, indicating that system is in a self-organized critical state. This is the first observation of SOC in the quantum growth regime. The exponent of the power law has a weak temperature dependence while the cutoff size becomes larger with cooling.

[1]R. Nomura, A. Osawa, T. Mimori, K. Ueno, H. Kato and Y. Okuda, Phys. Rev. Lett. **101**, 175703 (2008).