Power law behavior of quantum crystallization of ^{4}He in aerogel

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Two different crystallization processes of ^{4}He in aerogels, observed as creep at high temperatures and avalanche at low temperatures[1], have been clarified from both the crystallization rate[2] and nucleation probability measurements[3] that the former is via the thermal activation and the latter is via the macroscopic quantum tunneling. In the quantum tunneling regime, a power law behavior was observed in the avalanche size distribution[2]. This is the first demonstration of the self-organized criticality at low temperatures where the quantum nature dominates the dynamical properties of the system. The large-scale cut-off of the power law distribution decreased toward the transition temperature which is probably caused by a dissipation effect on the quantum tunneling. We further investigated the intervals and distances of two successive avalanches and found that they also follow power law distributions. The distance distribution deviated from the power law in the small and large scales; deviation in the small scale is the finite size effect of the avalanches, while the deviation in the large scale is the effect of aerogel size.

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Section: QS - Quantum solids

Keywords: quantum solids, aerogel, crystal growth