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Anomalous Elasticity of ^{4}He Films at the Quantum Phase Transition KEIYA SHIRAHAMA, Keio University, DAISUKE TAKAHASHI, Ashikaga Institute of Technology, TAKAYUKI KOGURE, HITOMI YOSHIMURA, RAMA HIGASHINO, Keio University — ^{4}He films on solid substrates exhibit a quantum phase transition between localized (nonsuperfluid) and superfluid states by changing coverage n. We have made torsional oscillator (TO) studies for ^{4}He films adsorbed on nanoporous glasses. A TO with localized films showed an apparent "supersolid" behavior, an increase in TO frequency f with broad peak in Q^{-1}. Combining with FEM analyses for TO's with different designs, we conclude that the behavior results from the softening of adsorbed ^{4}He films at high temperatures. The features in f and Q^{-1} are fitted well to a Debye-like activation with a distributed energy gap Δ, so the elasticity is accounted by thermal excitation of localized atoms to an "extended" state. As the critical coverage n_c approaches the gap decreases to zero with a powerlaw $\Delta \propto (n - n_c)^{1.2}$. Assuming that the ^{4}He chemical potential $\mu(n)$ is located in the middle of the gap, we can estimate the elastic constant $\kappa^{-1} = n^2 \partial\mu/\partial n$. The elasticity agrees with shear moduli of ^{4}He films obtained from the FEM analysis within factor of three. The energetics proposed from the elastic behavior naturally explains other properties of He films adsorbed on disordered substrates.

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