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Damping of Quantum Vibrations Revealed in Deep Sub-barrier Fusion TAKATOSHI ICHIKAWA, Yukawa Institute for Theoretical Physics, KENICHI MATSUYANAGI, Yukawa Institute for Theoretical Physics, RIKEN Nishina Center — We demonstrate that when two colliding nuclei approach each other, their quantum vibrations are damped near the touching point. To show those, we for the first time apply the random-phase-approximation (RPA) method to the two-body ^{16}O + ^{16}O and ^{40}Ca + ^{40}Ca systems. We show that this damping is responsible for the fusion hindrance phenomena measured in the deep sub-barrier fusion reactions. We calculate the octupole transition strengths for the two nuclei adiabatically approaching each other. The calculated transition strength drastically decreases near the touching point, strongly suggesting the vanishing of the quantum couplings between the relative motion and the vibrational intrinsic degrees of freedom of each nucleus. Based on this picture, we also calculate the fusion cross section for the ^{40}Ca + ^{40}Ca system using the coupled-channel method with the damping factor simulating the vanishing of the couplings. The calculated results reproduce well the experimental data, indicating that the smooth transition from the sudden to adiabatic processes indeed occurs in the deep sub-barrier fusion reactions.

Takatoshi Ichikawa
Yukawa Institute for Theoretical Physics

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