Quantum plasticity and supersolidity

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In quantum solids, the position of atoms fluctuates much more than in classical crystals. Atoms may even exchange their positions by tunneling, so that the crystal becomes superfluid while keeping solid properties. This paradoxical phenomenon is called “supersolidity”. It is highly debated as a possible explanation for the anomalous rotation properties of solid 4He.

When trying to understand the supersolidity of solid 4He, we have discovered its quantum plasticity: dislocation lines may also move by quantum tunneling so that the velocity of acoustic shear waves nearly vanishes. Our measurements suggest that in solid 4He, dislocation lines move macroscopic distances at 20 kHz as if they were violin strings.

I will explain why supersolidity may appear only when quantum plasticity disappears.