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Fluctuation-induced couplings between superfluids and boundary solids

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This talk adresses the transport properties of superfluids like Helium II when taking into account the internal degrees of freedom of boundary solids. Indeed, superfluids have the special property of managing frictionless transport due to their absence of viscosity below a critical velocity. In such systems, the boundary solids are often described a simple boundary condition where the wavefunction of the fluid must be vanish. However this neglects that solids do have internal degrees of freedom which may couple with the excitation modes of the superfluid, leading to a friction at its boundaries even below the critical velocity. These fluctuation-induced effects, based on a retarded van der Waals interaction, have already been studied for solid-solid friction and more recently for room-temperature solid-liquid friction, leading to the discovery of exciting phenomena in the field of nanofluidics. Here, using a perturbative field theory, we explore these couplings at low temperature in the context of superfluids and determine what are the proper dynamical boundary conditions for the fluid. Thus, we investigate how mode couplings impact the exceptional transport properties of superfluids.

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