Scaling of thermal resistivity of $^4$He in restricted geometries

CHONGSHAN ZHANG, D. P. LANDAU, CENTER FOR SIMULATIONAL PHYSICS, UNIVERSITY OF GEORGIA, ATHENS, GA TEAM — The thermal resistivity and its scaling function in quasi-2D $^4$He systems are studied by Monte Carlo and spin-dynamics simulation of the classical 3D XY model on $L \times L \times H$ lattices with $L \gg H$. Open boundary conditions are applied along the $H$ direction and periodic boundary conditions along the $L$ directions. A hybrid Monte Carlo algorithm is adopted to efficiently deal with the critical slowing down $^1$. Fourth-order Suzuki-Trotter decomposition of exponential operators is used to solve numerically the coupled equation of motion for each spin. The thermal conductivity is calculated by a dynamic current-current correlation function. Our results are consistent with a universal scaling function $F(X) = (L/\xi_0)^{\pi/\nu}(\rho/\rho_0)$, $X = (L/\xi_0)^{1/\nu}t$ using known values of the critical exponents $\pi$ and $\nu$ ($\rho = \rho_0 t^{-\pi}$ is the thermal resistivity, and $\xi = \xi_0 t^{-\nu}$ is the correlation length). The thermal resistivity scaling function agrees well with the available experimental results $^2$ for slabs using the temperature scale and thermal resistivity scale as free fitting parameters.

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