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DISSIPATION OF SOUND AND SHEAR WAVES IN CONFINED CHANNELS

Hannes Holey[1,2,*], Peter Gumbsch[1] and Lars Pastewka[2]

[1] Institute for Applied Materials, Karlsruhe Institute of Technology, Straße am Forum 7, 76131 Karlsruhe, Germany, www.iam.kit.edu/cms/

[2] Department of Microsystems Engineering (IMTEK), University of Freiburg, Georges-Köhler-Allee 103, 79110 Freiburg, Germany, www.imtek.uni-freiburg.de/laboratories/simulation/

[*]Corresponding author: hannes.holey@kit.edu

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Sound and shear waves in dense fluids decay with a rate that scales quadratically with the wavevector. This can be used to measure transport coefficients such as heat conductivity [1] or shear viscosity [2] in bulk equilibrium molecular dynamics (MD) simulations. However, in highly confined systems, such as in nanofluidic devices or in lubrication, the assumption of a bulk fluid no longer holds and fluid-wall interactions become increasingly important at smaller gap heights.

Here, we present through continuum and atomistic simulations, how geometric properties of the channel and fluid-wall slip determine an upper bound for the relaxation time of sound and shear waves in the long wavelength limit. From a continuum perspective, this behavior can be explained by the reduction of dimensionality in the lubrication equations, whereas atomistic simulations reveal a transition in spectral attenuation from "bulk-like" to "channel-like" at characteristic wavelengths. We discuss our findings in the context of rough surfaces with self-affine surface topography [3] as found in many technological or geological applications.

References

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