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Quasi-ballistic thermal transport from a nanoscale hotspot observed using ultrafast coherent extreme ultraviolet beams QING LI, MARK SIEMENS, JILA, University of Colorado at Boulder, RONGGUI YANG, Department of Mechanical Engineering, University of Colorado at Boulder, KEITH NELSON, Department of Chemistry, MIT, ERIK ANDERSON, Lawrence Berkeley Labs and Center for X-Ray Optics, MARGARET MURNANE, HENRY KAPTEYN, JILA, University of Colorado at Boulder — We study thermal transport from a nanoscale hotspot into a bulk material using ultrafast, coherent, extreme ultraviolet beams. When the size of the hotspot is smaller than the mean free path of the energy-carrying phonons in the substrate, we measure a decrease in energy transport compared with the diffusive Fourier law prediction. This is the first observation and quantitative measurement of quasi-ballistic thermal transport from a nanoscale heat source. Our results show that the Fourier law can be corrected to describe energy dissipation from nanostructures into the bulk by introducing a size-dependent ballistic thermal resistance. This finding could have significant impact on the thermal management and reliability of emerging nanoscale devices, and nano-enabled energy systems.

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