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VALIDITY OF KINETIC THEORY FOR RADIATIVE HEAT TRANSFER IN NANOPARTICLE CHAINS

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ABSTRACT. In chains of closely-spaced nanoparticles supporting surface polaritons, near-field electromagnetic coupling leads to collective effects and super-Planckian thermal radiation exchange. Researchers have primarily used two analytical approaches to calculate radiative heat transfer in these systems: fluctuational electrodynamics, which directly incorporates fluctuating thermal currents into Maxwell's equations, and a kinetic approach where the dispersion relation provides modes and propagation lengths for the Boltzmann transport equation. Here, we compare results from the two approaches in order to identify regimes in which kinetic theory is valid and to explain differing results in the literature on its validity. Using both methods, we calculate the diffusive radiative thermal conductivity of nanoparticle chains. We show that kinetic theory is valid and matches predictions by fluctuational electrodynamics when the propagation lengths are greater than the particle spacing.