

Blackbody Friction on a Moving Nanoparticle: An Exactly Soluble Model

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Quantum electromagnetic field fluctuations can induce a frictional force on a neutral but polarisable particle that is moving uniformly through free space filled with blackbody radiation. If the particle has purely real intrinsic polarisability, before being dressed by radiation, the only dissipative mechanism is through its interaction with the radiation field fluctuations. In this case, the particle is guaranteed to be in the non-equilibrium steady state (NESS), where it absorbs and emits energy at the same rate. However, if the particle is intrinsically dissipative, the corresponding intrinsic dipole fluctuations provide a further dissipative mechanism. In this case, the particle can be out of NESS, where it gains or loses net internal energy; indeed, it will be in NESS only if its temperature is equal to a special NESS temperature, which is a function both of its velocity and of the temperature of the blackbody radiation. Using a Lorentz oscillator model for a spherical nanoparticle, we obtain exact analytical expressions for the frictional force that the particle experiences and for the net radiation power that it absorbs. The frictional force and the NESS temperature derived from these analytical expressions are compared with corresponding numerical results for the case of a gold nanosphere.