Near-field energy and momentum transfer between bodies with non-reciprocal materials or out of local equilbrium

Shanhui Fan[1]

[1] *Department of Electrical Engineering, Ginzton Laboratory, Stanford University, Stanford, CA 94305*
shanhui@stanford.edu

Presentation type: Invited Speaker

In the vast majority of fluctuational electromagnetic study on near-field heat transfer or fluctuation-induced forces, one considers bodies made of non-reciprocal materials, and moreover one assumes that each of these bodies are in local thermal equilibrium. In this talk, we show that the use of non-reciprocal materials, or bodies that are out of thermal equilibrium, introduce new opportunities for the study of fluctuational electrodynamics. In particular, we show that a persistent heat current at equilibrium can exist in a many-body system consisting of bodies made of non-reciprocal materials.[1] We also show that with the introduction of a non-zero chemical potential, one can achieve photon-based solid-state heat pump with performance exceeding standard thermo-electric devices[2, 3], or strong repulsive non-equilibrium Casimir forces [4].

References

[1] Zhu, Linxiao, and Shanhui Fan. Persistent Directional Current at Equilibrium in Nonreciprocal Many-Body Near Field Electromagnetic Heat Transfer. Physical Review Letters 117, no. 13 (2016): 134303.

[2] Chen, Kaifeng, Parthiban Santhanam, Sunil Sandhu, Linxiao Zhu, and Shanhui Fan. Heat-Flux Control and Solid-State Cooling by Regulating Chemical Potential of Photons in near-Field Electromagnetic Heat Transfer. Physical Review B - Condensed Matter and Materials Physics 91, no. 13 (2015): 134301.

[3] Chen, Kaifeng, Tianyao P. Xiao, Parthiban Santhanam, Eli Yablonovitch, and Shanhui Fan. High-Performance near-Field Electroluminescent Refrigeration Device Consisting of a GaAs Light Emitting Diode and a Si Photovoltaic Cell. Journal of Applied Physics 122, no. 14 (2017): 143104.

[4] Chen, Kaifeng, and Shanhui Fan. Nonequilibrium Casimir Force with a Nonzero Chemical Potential for Photons. Physical Review Letters 117, no. 26 (2016): 267401.