Trace Expressions and Associated Limits for Non-Equilibrium Casimir Torque

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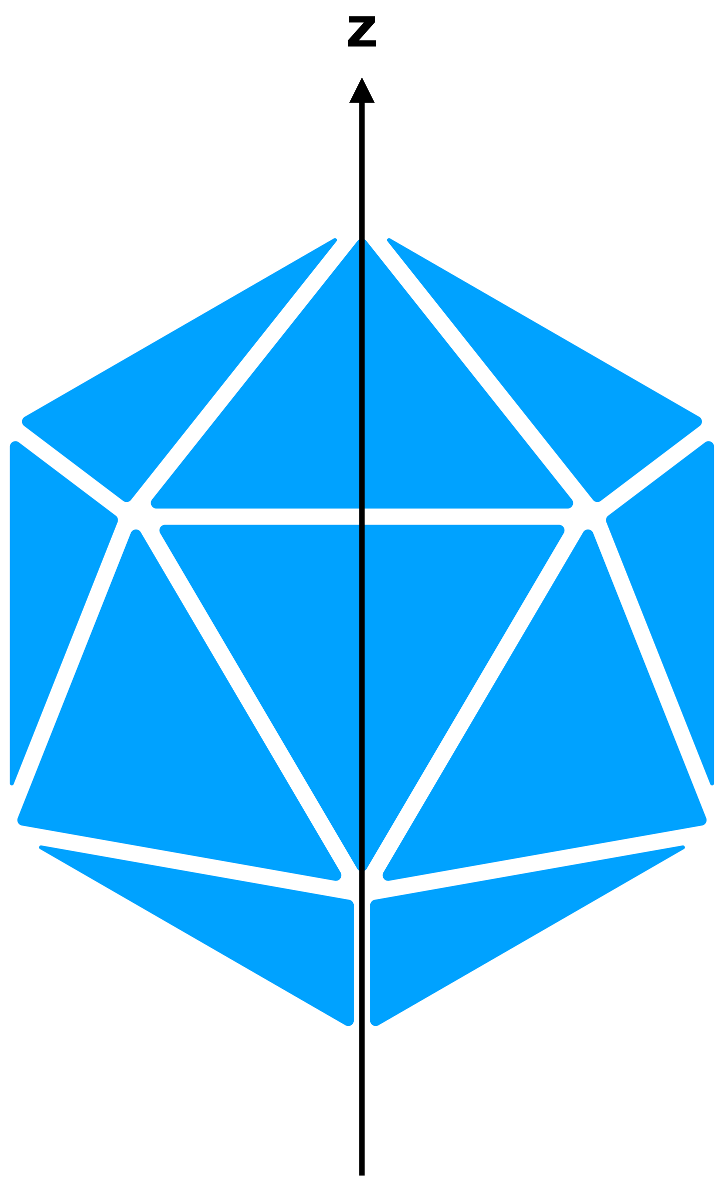
Thermal Casimir Torque on a Single Object



$$\mathbf{F} = \int_V d^3\mathbf{r} \int_{-\infty}^{\infty} d\omega \left[\rho^*(\omega,\mathbf{r})\mathbf{E}(\omega,\mathbf{r}) + \mathbf{J}^*(\omega,\mathbf{r}) \times \mathbf{B}(\omega,\mathbf{r})\right]$$

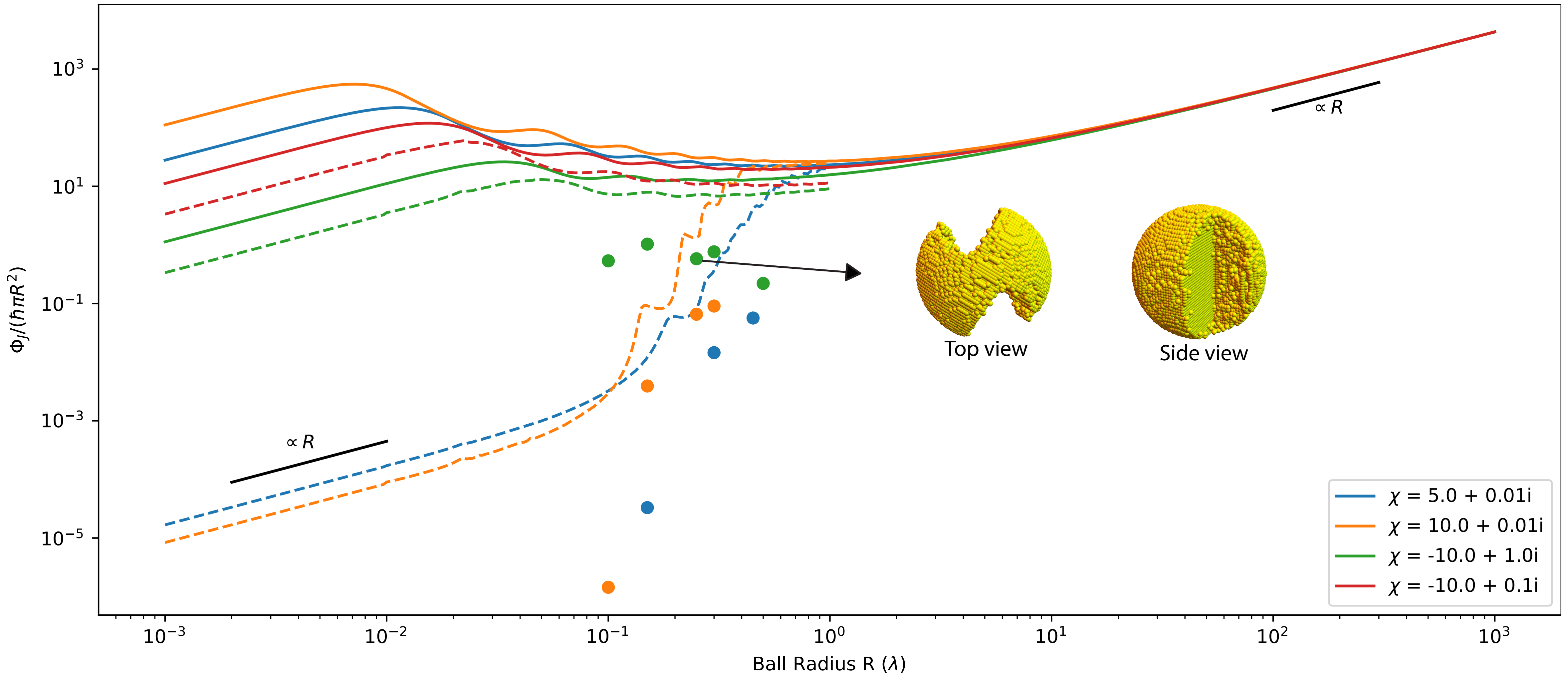
$$\mathbf{F}_{body} = \int_0^{\infty} d\omega (n_{BE}(\omega, T_{body}) - n_{BE}(\omega, T_{env})) \frac{2}{\pi} \mathbf{ImTr}\left[(-\hat{\mathbf{p}}\mathbb{G}_0)(\mathbb{T}^{A}_{body} - \mathbb{T}_{body}\mathbb{G}_0^{A}\mathbb{T}^{\dagger}_{body})\right]$$

Müller and Krüger, *Phys. Rev. A*, 93:032511

$$\boldsymbol{\tau} = \int_V d^3\mathbf{r} \int_{-\infty}^{\infty} d\omega \mathbf{r} \times \left[\rho^*(\omega,\mathbf{r})\mathbf{E}(\omega,\mathbf{r}) + \mathbf{J}^*(\omega,\mathbf{r}) \times \mathbf{B}(\omega,\mathbf{r})\right]$$

$$\boldsymbol{\tau}_{body} \stackrel{?}{=} \int_0^{\infty} d\omega (n_{BE}(\omega, T_{body}) - n_{BE}(\omega, T_{env})) \frac{2}{\pi} \mathbf{ImTr}\Big[-\underbrace{(\mathbf{r}\times\hat{\mathbf{p}})}_{\hat{\mathbf{L}}}\mathbb{G}_0(\mathbb{T}^{A}_{body} - \mathbb{T}_{body}\mathbb{G}_0^{A}\mathbb{T}^{\dagger}_{body})\Big]$$ ✗

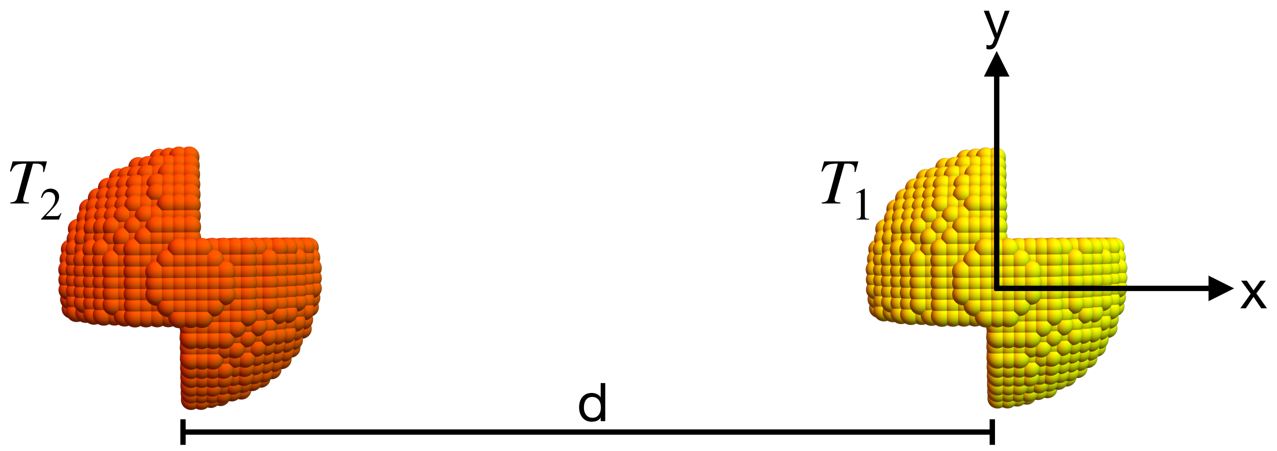
$$n_{BE}(\omega, T) = \frac{1}{\exp\left(\frac{\hbar\omega}{k_B T}\right) - 1}$$

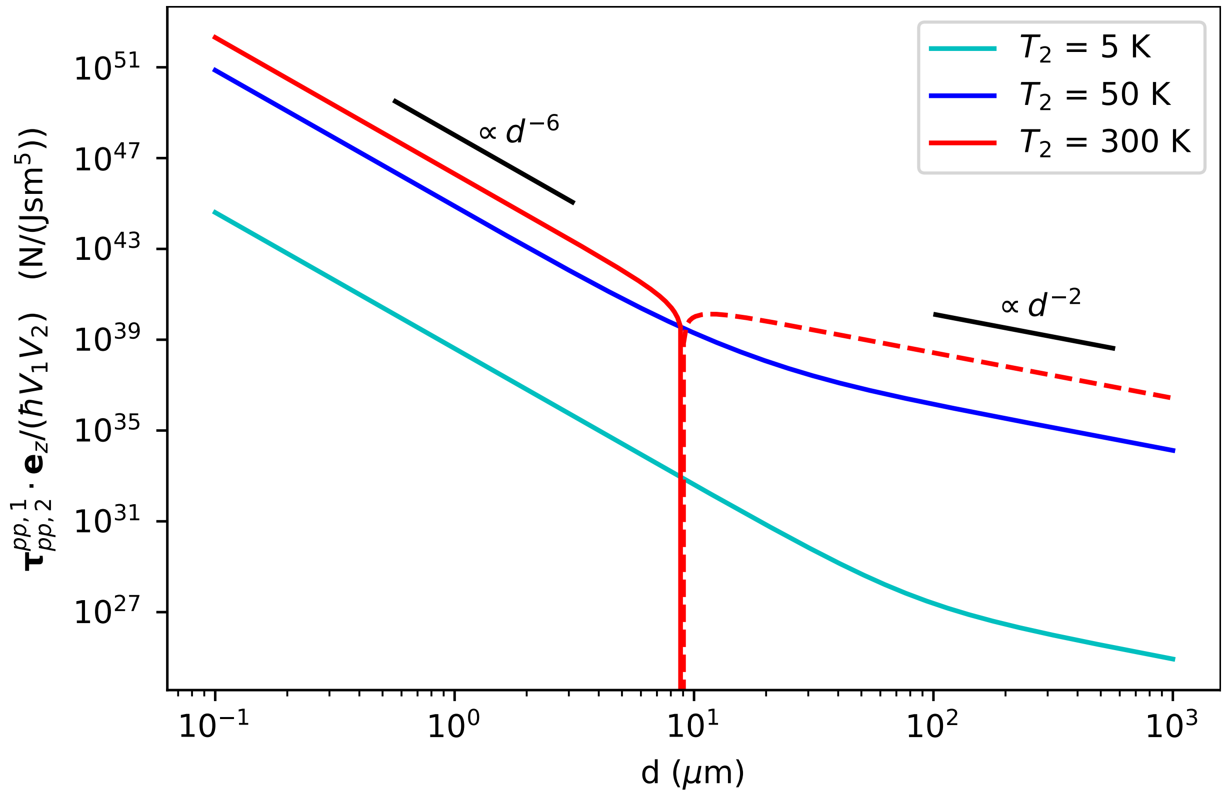


Two Objects and the Point Particle Limit

$$\boldsymbol{\tau}^{(\alpha),neq}(T_{env}, \{T_\beta\}) = \boldsymbol{\tau}^{(\alpha),eq}(T_{env}) + \sum_\beta (\boldsymbol{\tau}^{(\alpha)}_\beta(T_\beta) - \boldsymbol{\tau}^{(\alpha)}_\beta(T_{env}))$$

$$\boldsymbol{\tau}^{pp,1}_{pp,2} \cdot \mathbf{e}_z = -\frac{2}{\pi}\int_0^{\infty} d\omega \frac{(\omega/c)^4}{e^{\frac{\hbar\omega}{k_B T_2}} - 1} \mathbf{ImTr}_{cmp}[(\hat{J}_z\mathbb{G}_0)(\mathbf{r}_1,\mathbf{r}_2)\overline{\overline{\alpha}}_2^{A}\mathbb{G}_0^{\dagger}(\mathbf{r}_2,\mathbf{r}_1)\overline{\overline{\alpha}}_1^{\dagger}]$$





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The longitudinal component and screening of the Casimir interaction between spheres

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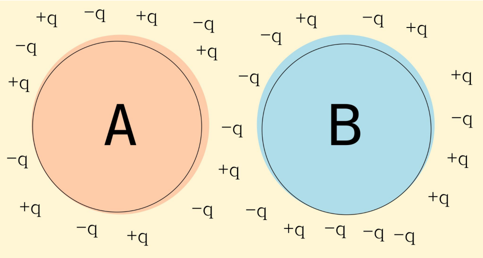
1. Overview
2. The Casimir effect and optical tweezers
3. The scattering approach
4. The scattering matrix
5. Final remarks



Quantum and Thermal Electrodynamic Fluctuations in the Presence of Matter: Progress and Challenges

Jul 11, 2022 - Jul 14, 2022

UC SANTA BARBARA
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UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

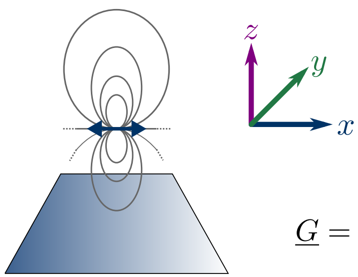
A time-domain approach for the Casimir-Polder interaction

Bettina Beverungen, Philip Trøst Kristensen,
Francesco Intravaia and Kurt Busch

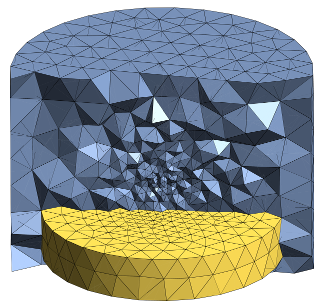
Max Born Institute

Humboldt-Universität zu Berlin

- **Numerical calculation of fluctuation-induced interactions**



$$\underline{G} = \begin{pmatrix} G_{xx} & G_{xy} & G_{xz} \\ G_{yx} & G_{yy} & G_{yz} \\ G_{zx} & G_{zy} & G_{zz} \end{pmatrix}$$



- **Discontinuous Galerkin time domain method**

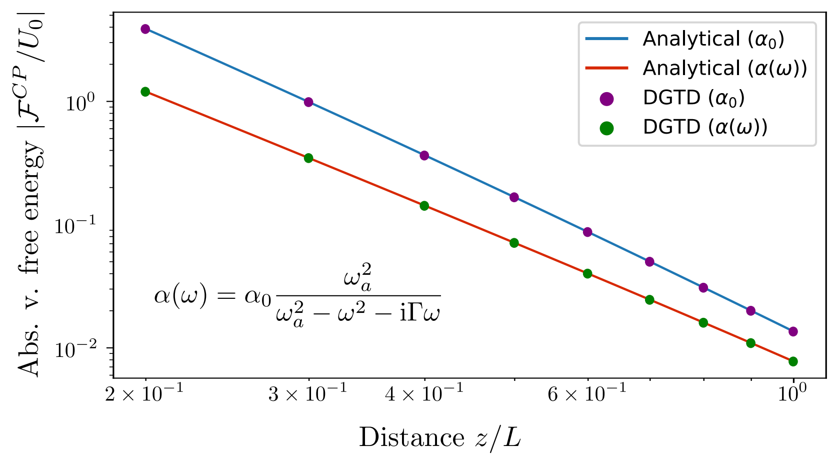
- **Casimir-Polder**

atom

$$\mathcal{F}^{CP} = -\frac{\hbar}{2\pi}\mathrm{tr}\int_0^\infty \mathrm{d}\omega\,\omega^2 \mathrm{Im}\left[\underline{\alpha}(\omega)\underline{G}(\mathbf{r}_0,\mathbf{r}_0,\omega)\right]$$

material properties

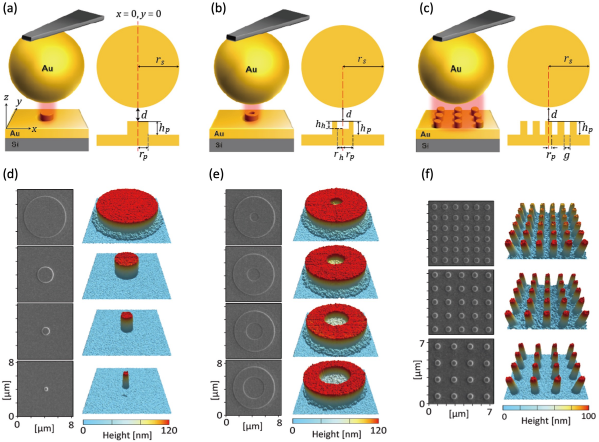
geometry



- **Local & nonlocal material models**

Exact Casimir force calculations between a structured surface and a sphere

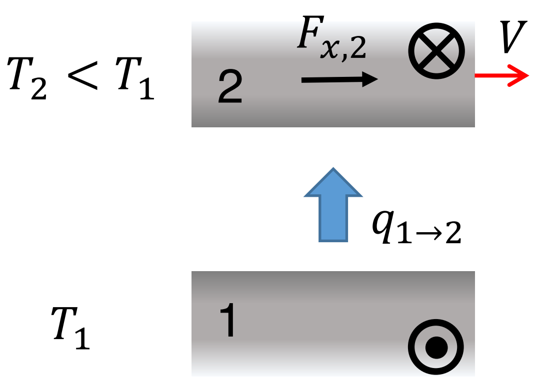
B. Spreng and J. N. Munday



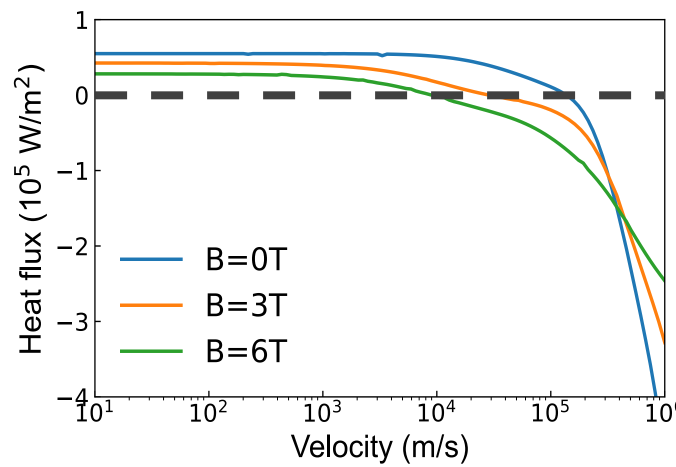
Moving Media as a Photonic Heat Pump

Yoichiro Tsurimaki, Renwen Yu, Shanhui Fan, Stanford University

System



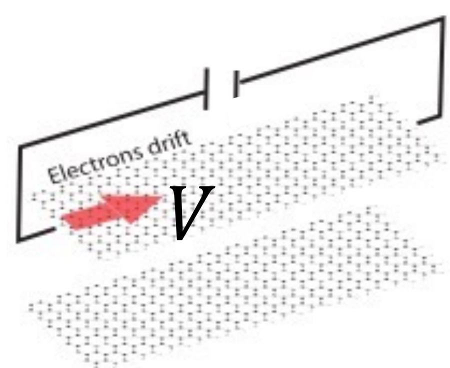
Heat and momentum transfer analysis



Thermodynamic efficiency

$$\eta = \frac{\gamma F_{x,2} V - (\gamma - 1) q_{z,1\to2}}{q_{z,1\to2}} \leqq 1 - \frac{T_2}{T_1}$$

Two graphene sheets

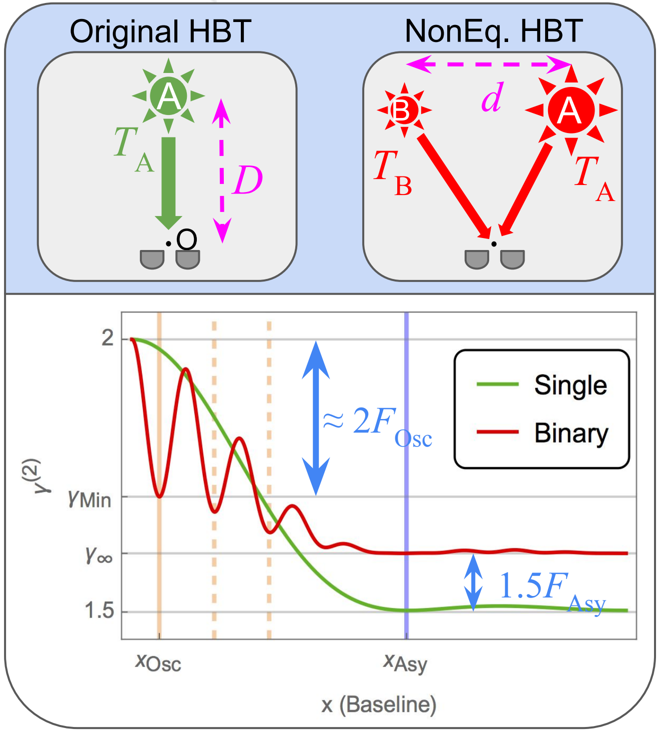


Nonequilibrium Hanbury-Brown-Twiss experiment: Theory and application to binary stars

ELECTRODYNAMICS.ORG

Adrian Rubio López

PURDUE UNIVERSITY



- How can we use field correlations for characterizing nonequilibrium binary systems (stars or cold atoms)?
- How can we implement the Hanbury-Brown and Twiss experiment for measuring the temperatures of stars?
- What is the optimal strategy for measurements?

Adrian E. Rubio López, Fanglin Bao, Ashwin K. Boddeti, Hyunsoo Choi, and Zubin Jacob, in preparation.

Casimir latching