Selfconsistent diagrammatic transport for light including time reversal symmetric entropy production

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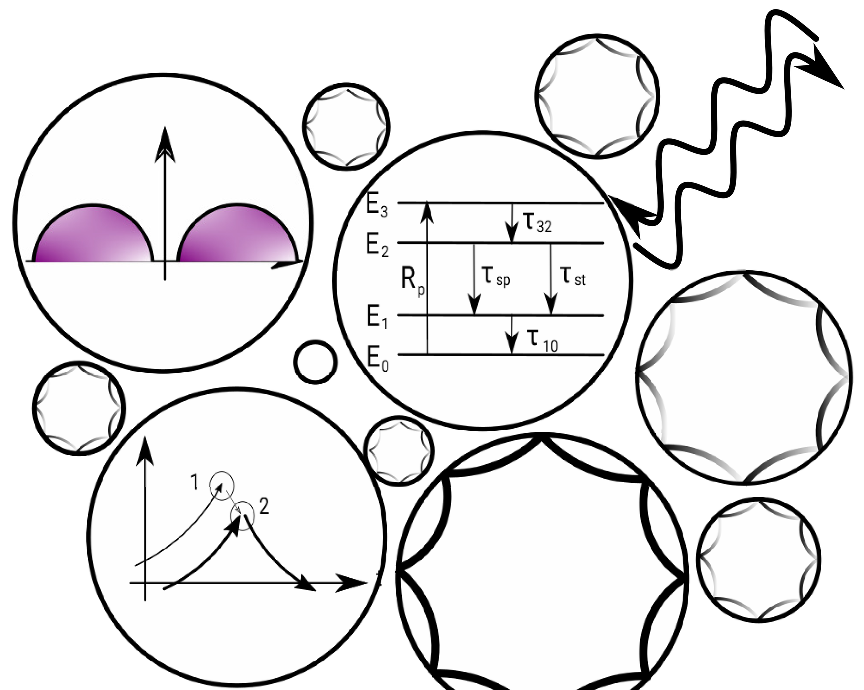
Transport of Light in Random Media including Absorption and Gain – Mono- or Polydisperse Mie Resonators



- Always positive entropy production due to absorption and gain in complex matter, also under time reversal
- Entropy production in lasers is always ≥ 1, also for a monochromatic 4-level laser; time reversal parity is + 1

Generalized Bethe-Salpeter Equation – Continuity Equation and Current Density Equation – Fick's Law

The intensity correlation, the disorder averaged particle-hole Green's function, $\Phi^{\omega}_{\vec{q}\vec{q}'}(\vec{Q},\Omega)$ is described by the Bethe-Salpeter equation

$$\Phi_{\vec{q}\vec{q}'} = G^{R}_{q_+}(\omega_+)G^{A}_{q_-}(\omega_-) \times \left[\delta(\vec{q}-\vec{q}') + \int\frac{d^3q''}{(2\pi)^3}\gamma_{q\,q''}\Phi_{\vec{q}''\vec{q}'}\right]. \qquad (1)$$

Continuity equation and current relaxation equation relate the current correlator J_E to the gradient of the density correlator P_E.

$$P^{\omega}_{E}(\vec{Q},\Omega) = \left[\frac{\omega}{c_p}\right]^2 \Phi_{\rho\rho} \qquad \Phi_{j\rho} = \left[\frac{c_p}{\omega v_E}\right] J^{\omega}_{E}(\vec{Q},\Omega). \qquad (2)$$

Conservation Laws: Ward-Takahashi Identity For Open Media - Onsager Scenario

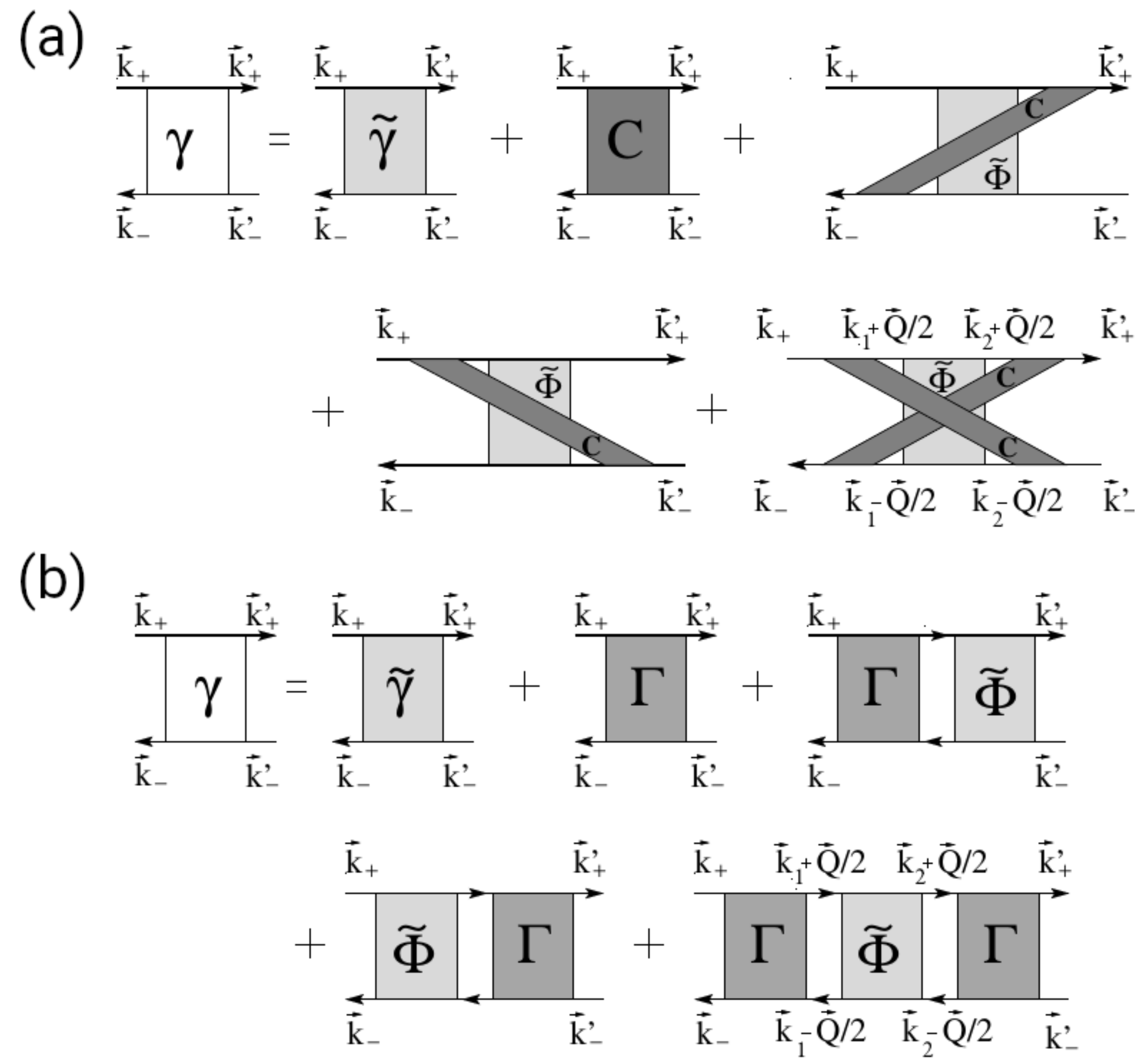
$$\Sigma^{\omega_+}_{\vec{q}_+} - \Sigma^{\omega_-\,*}_{\vec{q}_-} - \int\frac{d^3q'}{(2\pi)^3}\left[G^{\omega_+}_{\vec{q}'_+} - G^{\omega_-\,*}_{\vec{q}'_-}\right]\gamma^{\omega}_{\vec{q}'\vec{q}}(\vec{Q},\Omega) \qquad (3)$$
$$= f_\omega(\Omega)\left[\mathrm{Re}\Sigma^{\omega}_{\vec{q}} + \int\frac{d^3q'}{(2\pi)^3}\mathrm{Re}G^{\omega}_{\vec{q}'}\gamma^{\omega}_{\vec{q}'\vec{q}}(\vec{Q},\Omega)\right].$$

In presence of loss or gain, effects are enhanced by the prefactor

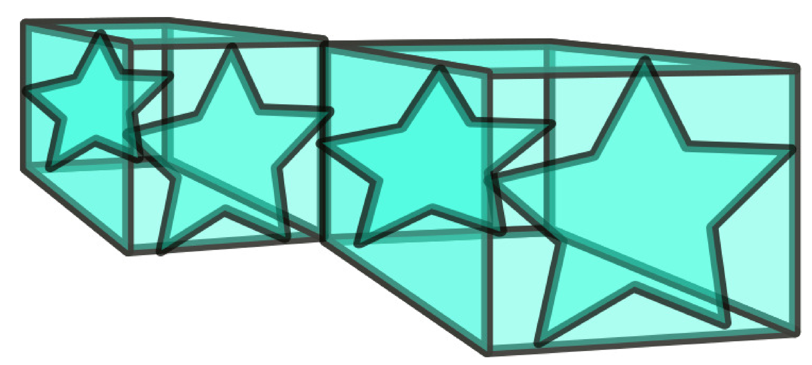
$$f_\omega(\Omega) = \frac{(\omega\Omega\mathrm{Re}\Delta\epsilon + i\omega^2\mathrm{Im}\Delta\epsilon)}{(\omega^2\mathrm{Re}\Delta\epsilon + i\omega\Omega\mathrm{Im}\Delta\epsilon)}, \qquad (4)$$

which now does not vanish in the limit of $\Omega \to 0$. $\Delta\epsilon = \epsilon_s - \epsilon_b$ is the dielectric contrast.

Disentangeling the Cooperon Contribution for Complex Media



Weighted Essentially Non-Oszillatory Solvers (WENO) – Numerical Self-Consistency for Diffusion Equations



- adaptive stencils in the sense of adaptive meshes, cluster methods
- capable for non-linearities and roughes, steep gradients (compare discontinuous Galerkin methods)
- Lax-equivalence theorem: convex combination of all candidates of lower- order difference quotients of the stencil with an attributive weight $g_i = \frac{1}{h+D_i^2}$; D_i are the smoothness indicators of the stencil. The variable $h > 0$ is the machine accuracy prohibiting a division by 0.

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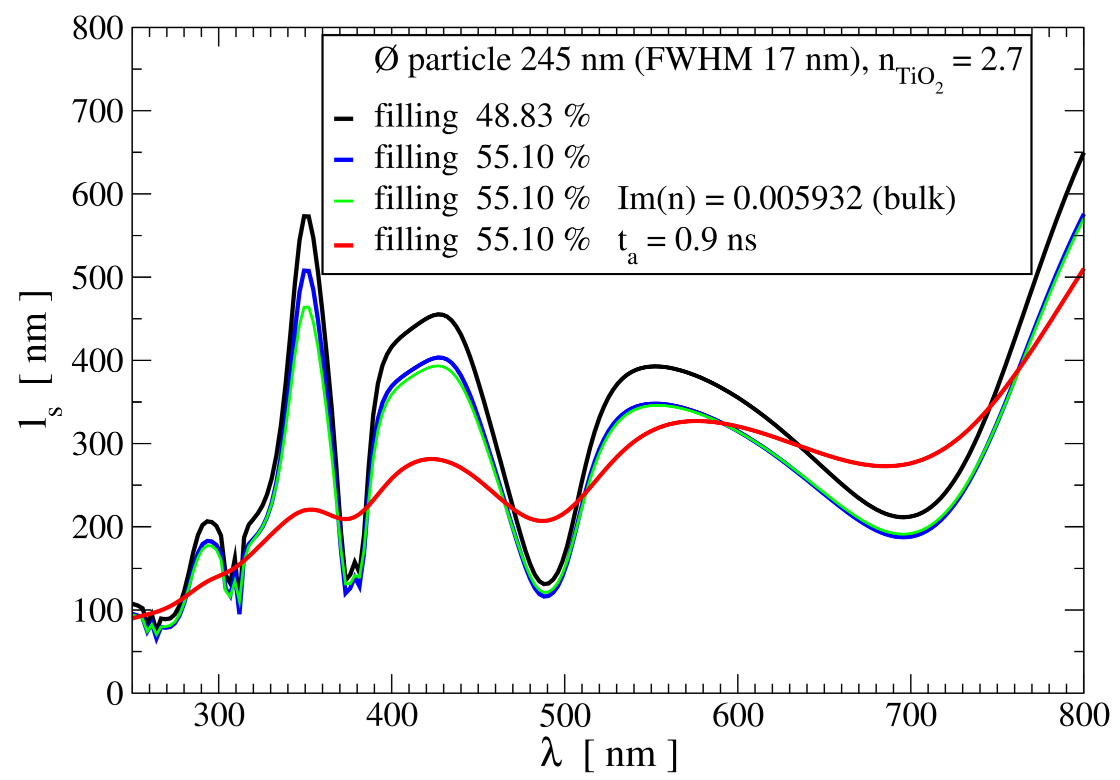
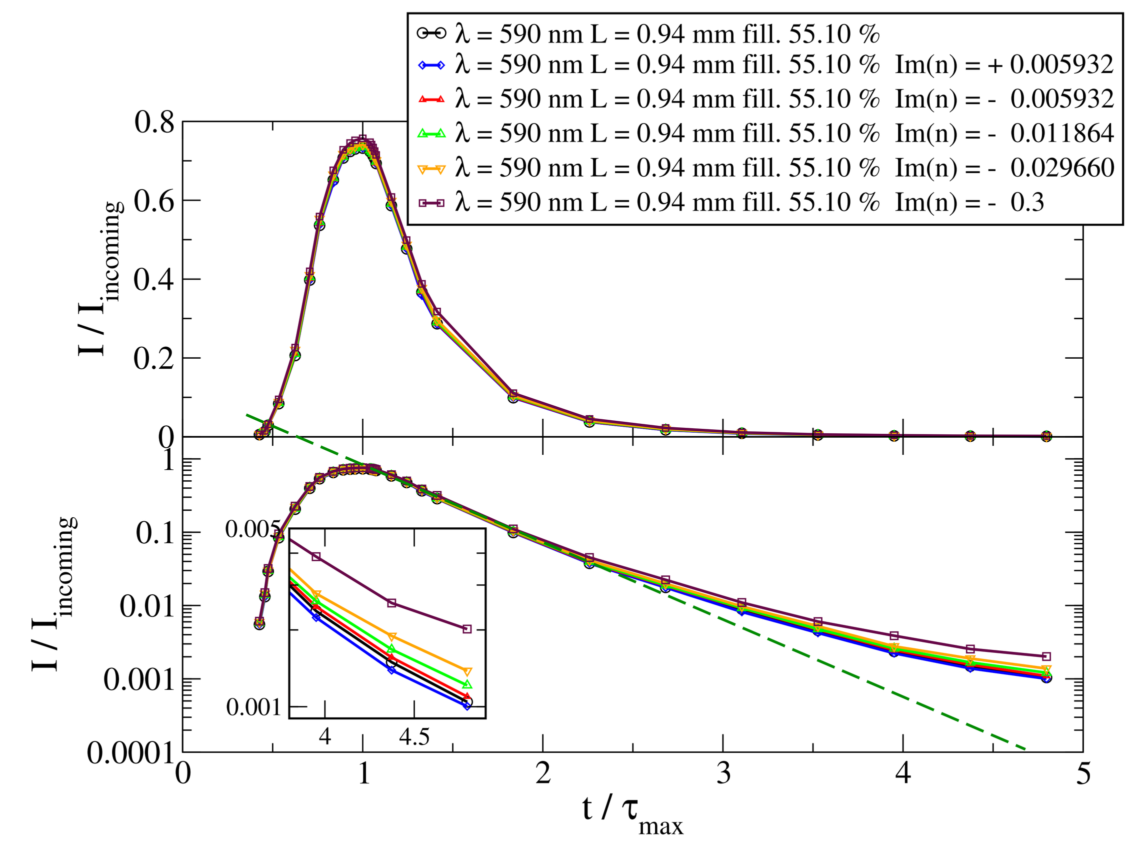
Selfconsistent Diffusion and Anderson Localization



Single Particle Characteristsics: Scattering mean free path $l_s = \frac{1}{2\mathrm{Im}(\sqrt{q^2+i\mathrm{Im}\Sigma(\omega)})}$ for disordered samples of TiO_2 Mie spheres, $n = 2.7$, with a Gaussian distribution of scatterers peaked at $2\,r_{scat} = 245.0\,nm$.



The mean square width $\sigma^2(t) = \frac{\int r^2 P_E(r,t)\,d^2r}{\int P_E(r,t)\,d^2r}$ is a measure of Anderson localized photons.

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