Light induced inverse-square law interactions between nanoparticles: "Mock Gravity" at the nanoscale
(Supplemental Material)

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Light induced forces are generally not pairwise additive due to multiple recurrent scattering effects. Here we present numerical results of the interaction forces between three resonant nanoparticles. When the particles' extinction cross section is dominated by absorption, i.e. at a Fröhlich resonance, our results indicate that assuming pairwise interactions is a good approximation even for relatively high particle densities.

To estimate the relevance of many-body interactions, we have considered the three-particle problem sketched in the inset of Fig. S1. The total force on particle "B" is calculated by solving self-consistently the three couple dipole equations (including all multiple scattering effects) in a stationary random field and compared with the pairwise sum of the two body forces. While in absence of absorption three-body forces can be relevant, they are negligible for strongly absorbing nanoparticles as it can be seen in Fig. 4 for a relative B-to-C distance $\Delta = 0.2\lambda_F$ (larger Δ values give the same conclusion). We then expect pairwise interactions to be a good approximation even for relatively high particle densities, ρ.

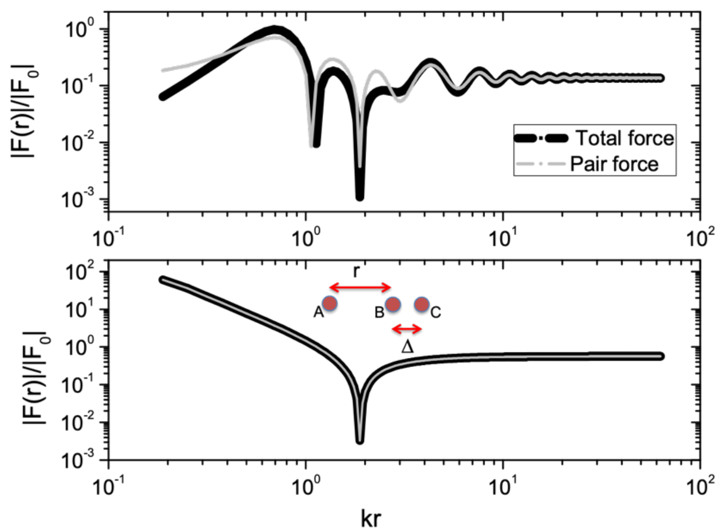

FIG. S1. Three-body forces. Log-log plot of the absolute value of the optical force on a particle "B", fixed at the origin, due to the presence of two particles: Particle "A" is at a distance −r from the origin and "C" is at +Δ ($\Delta = 0.2\lambda$ is fixed). Grey lines correspond to the sum of two body forces $F_{BC} + F_{BA}$ and thick black lines to the self-consistent three-body forces acting on "B".
(a) Forces for non-absorbing particles at resonance as in Fig. 1 in the main text.
(b) Forces for absorbing particles as in Fig. 2 in the main text ($\Gamma_0 = 10^{-3}\omega_F$).