Maximum absorption by homogeneous magneto-dielectric sphere

In order to obtain a benchmark for electromagnetic energy harvesting, we investigate the maximum absorption efficiency by a magneto-dielectric homogeneous sphere illuminated by a plane wave, and we arrive at several novel results. For electrically small spheres we show that the optimal relative permeability and permeability of materials where \( r, \mu r \geq 1 \) is \((1+i3)\) independent of sphere size, while that of metamaterials is \((-2+i5)\), where the imaginary part \( \delta \) decreases strongly with decreasing sphere size. For larger spheres we show that while maximum absorption efficiency occurs at the resonances of the spherical modes, there exists a wide plateau of high absorption efficiency when material intrinsic impedance is constant; in the case of free-space intrinsic impedance and electrical radius \( \kappa=1 \), the absorption efficiency becomes 2.8. The investigation is analytic/numerical and based on the Lorenz–Mie theory combined with the optical theorem.
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