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On spectral redshift separating near- and far-field intensity resonances

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With recent technological advances it became possible to control light at a nano-scale through the use of nano-particles and nano-structures. At this scale the quantities of interest are related to the near-field and not the far-field, which traditionally has been a quantity of interest. A particular quantity of interest in plasmonics is the near-field electric intensity. It has been recently observed that in highly absorbent particles the resonances in the near-field intensity are red-shifted with respect to the resonances in the far-field. This redshift has been physically explained on the grounds of a damped harmonic oscillator model, and it was demonstrated that the cause of the shift is the contribution of the evanescent waves to the near-field intensity. Although this physical insight is valuable, it does not provide an explicit formula for the redshift. In fact, currently the computation of the redshift is done by brute force, i.e. numerically computing near- and far-field resonance-frequencies, and then taking their difference. This approach is not only cumbersome but it also hides the dependence of the redshift on the physical parameters that might be tuned to increase/decrease the redshift. This control over the redshift is important as it is generally easier to measure far-field quantities than their near-field counterparts. In this presentation, we derive an analogous frequency-shift formula for a dielectric cylinder and a dielectric sphere. This formula is relatively simple and it explicitly shows the dependence of the frequency shift on the physical parameters of the system. Furthermore, in the Rayleigh limit our formula takes a particularly elegant form, which offers additional physical insight into the phenomena.