Questions and answers for Module 5

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1 Questions

1. How can an optical near field be realized?
2. How can a dressed photon be detected ?
3. Write the effective interaction operator for an optical near field.
4. Write the bare interaction of the multipolar Hamiltonian.
5. Write the effective interaction potential for the dressed photons.

2 Answers

1. When a nonometric nanoparticle is illuminated with propagating light, it scatters light as usual, which finally propagates to the far field and gets diffracted. During this process a photon gets emitted from an electron from the illuminated nanoparticle. The energy of this photon get localized at the surface of the nanoparticle and hence becomes a virtual photon. This photon can also be re-absorbed within a short time. Thus unlike the free photon, which after getting emitted from the electron and gets propagated as conventional scattered light, the above mentioned photon gets coupled to the electron in an unique manner and hence is forced to be within the vicinity of the electron. Due to this coupling, a dressed photon is born and is known as the virtual photon. In this manner, a virtual cloud of photons thus gets formed around the illuminated nanoparticle. This non-propagating virtual photon cloud forms the optical near field.

2. The dressed photon, in principle, can be detected only if the second nanoparticle is placed close to and within the vicinity of the first nanoparticle engulfed by the dressed photon cloud.

3. $$\hat{H'}_{eff} = \frac{1}{\sqrt{P\hat{J}^{\dagger}\hat{J}P}}(P\hat{J}H'\hat{J}P)\frac{1}{\sqrt{P\hat{J}^{\dagger}\hat{J}P}}.$$

4. $$H_{int} = -\mu_{(1)}.\hat{\mathbf{D}}_{\perp}.(\mathbf{c}_1) - \mu_{(2)}.\hat{\mathbf{D}}_{\perp}(\mathbf{c}_2).$$

5. $$V_{eff}(r) = -\frac{\mathbf{m}_s, \mathbf{m}_p}{3}\sum j = s, p(A\Delta_{j+}^2\frac{e^{\Delta_{j+}\gamma}}{\gamma} - B\Delta_{j-}^2\frac{e^{-\Delta_{j-}\gamma}}{\gamma}).$$