Near-resonant light scattering by an atom in a state-dependent trap

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The optical properties of a fixed atom are well-known and investigated. For example, the extraordinarily large cross section of a single atom as seen by a resonant photon is essential for quantum optics applications. Mechanical effects associated with light scattering are also well-studied, forming the basis of laser cooling and trapping, for example. Despite this, there is one fundamental problem that surprisingly has not been extensively studied, yet is relevant to a number of emerging quantum optics experiments. In these experiments, the ground state of the atom experiences a tight optical trap formed by far-off-resonant light, to facilitate efficient interactions with near-resonant light. However, the excited state might experience a different potential, or even be anti-trapped. We systematically analyze the effects of unequal trapping on near-resonant atom-light interactions. In particular, we identify regimes where such trapping can lead to significant excess heating, and a reduction of total and elastic scattering cross sections associated with a decreased atom-photon interaction efficiency. Understanding these effects can be valuable for optimizing quantum optics platforms where efficient atom-light interactions on resonance are desired, but achieving equal trapping is not feasible.

References

[1] paper in arxiv soon available (I hope I can update my application form until the 30th)

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