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Resonant Fluorescence in a Two-Level Atom and the Terahertz Gap

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Abstract : Terahertz radiation occupies a range of frequencies somewhere from 100 GHz to approximately 10 THz, just between microwaves and infrared waves. This range of frequencies holds promise for many useful applications in experimental applied physics and technology. At the same time, reliable, simple techniques for generation, amplification, and modulation of electromagnetic radiation in this range are far from been developed enough to meet the requirements of its practical usage, especially in comparison to the level of technological abilities already achieved for other domains of the electromagnetic spectrum. This situation of relative underdevelopment of this potentially very important range of electromagnetic spectrum is known under the name of the 'terahertz gap.' Among other things, technological progress in the terahertz area has been impeded by the lack of compact, low energy consumption, easily controlled and continuously radiating terahertz radiation sources. Therefore, development of new techniques serving this purpose as well as various devices based on them is of obvious necessity. No doubt, it would be highly advantageous to employ the simplest of suitable physical systems as major critical components in these techniques and devices. The purpose of the present research was to show by means of conventional methods of non-equilibrium statistical mechanics and the theory of open quantum systems, that a thoroughly studied two-level quantum system, also known as an one-electron two-level 'atom', being driven by external classical monochromatic high-frequency (e.g. laser) field, can radiate continuously at much lower (e.g. terahertz) frequency in the fluorescent regime if the transition dipole moment operator of this 'atom' possesses permanent non-equal diagonal matrix elements. This assumption contradicts conventional assumption routinely made in quantum optics that only the non-diagonal matrix elements persist. The conventional assumption is pertinent to natural atoms and molecules and stems from the property of spatial inversion symmetry of their eigenstates. At the same time, such an assumption is justified no more in regard to artificially manufactured quantum systems of reduced dimensionality, such as, for example, quantum dots, which are often nicknamed 'artificial atoms' due to striking similarity of their optical properties to those ones of the real atoms. Possible ways to experimental observation and practical implementation of the predicted effect are discussed too.

Keywords : terahertz gap, two-level atom, resonant fluorescence, quantum dot, resonant fluorescence, two-level atom
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