Institutul Național de Fizică și Inginerie Nucleară
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Seminar general

Coherence Domains in Matter Interacting with Radiation

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The coupling of the electromagnetic field to matter polarization (dipole interaction) is examined in order to assess the possibility of setting up a coherent state. It is found that coherence domains may set up in matter, their internal phases being arranged in a periodic lattice, as a consequence of, basically, a two-level interaction, which leads to a long-range ordered state, governed by a macroscopic occupation of both the photon state and the two levels. The non-linear equations of motion are solved for the new, non-perturbative ground-state, which is energetically favourable, provided the coupling strength exceeds a critical value. The elementary excitations with respect to this ground-state are derived, their energy being non-trivially affected by interaction. The "thermodynamics" of the coherent phase is computed and the super-radiant phase transition is re-derived in this context.

The main message is that atomic or molecular particles interacting with electromagnetic radiation may arrange their internal phases as if they feel their own position in space, such an arrangement being energetically, and statistically, favourable under certain critical conditions regarding the coupling strength and the temperature. For highly polarized particles, relatively tightly packaged, such critical conditions are feasible.

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