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SPECTRAL PROPERTIES OF SUPERFLUORESCENCE

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ABSTRACT

The $(\omega, \vec{k})$ spectral properties ot the superfluorescence emission from two and three levels atoms are presented for the first time. Transverse and fluctuations effects are included in the calculation to simulate the Cesium measurements in the far field region.

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SUMMARY

The spectral and far-field properties of the superradiance (1), superfluorescence (2) emission evolving from an optically thick medium with finite transverse boundaries are presented for the first time in ω and k space ; the equations of motion are those of FELD and al (3) ; propagation model with transverse variation of the density and laplacian coupling is used, as in MATTAR and al (4), in conjunction with quantum fluctuations for the initiation process, as introduced by HAAKE and al (5) and POLDER and al (6). No mean field approximation (7) is introduced, instead a rigorous numerical Maxwell-Bloch solver is used (8). This study represents a generalisation of MATTAR and al (9) results for small or near unity FRESNEL numbers, and DRUMMOND and al (10) for large FRESNEL number calculations. A transverse ring structure for the k spatial spectrum is reported similar to LEBERRE and al C.W. ring calculations (11). The $(\omega, \overline{k})$ spectrum characteristics are shown as a functionnal of a FRESNEL number defined with a BEER length a associated with an atomic density N and a cooperative time τ_R as defined by BOWDEN and al (12). Additional calculations illustrating the spectral changes due to the pump dynamics (reshaping and depletion) in a three level system (13), two colours far field structure (concentric shells-rings) are presented consistent with measurements (14).

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PROPRIETES SPECTRALES DE LA SUPERFLUORESCENCE

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RESUME

Les propriétés spectrales en (ω, k) de l'émission de superfluorescence d'atomes à 2 et 3 niveaux sont présentées pour la 1ère fois. Les effets transverses et les effets de fluctuation sont pris en compte dans les calculs, afin de simuler les résultats expérimentaux sur le Césium en champ lointain.