Universidade Federal da Paraíba
Centro de Ciências Exatas e da Natureza
Programa de Pós-Graduação *Stricto Sensu* em Física

Ciclo de Colóquios 2019.1

Colóquio nº 1

"Super- and subradiance in a dilute cloud of cold atoms"

RESUMO: The problem of the interaction of N atoms with a laser beam and vacuum modes can give rise to many interesting phenomena concerning the spontaneous emission of light and its propagation in the medium. The cooperative effects, for example, such as superadiance and subradiance, are effects related to the coherence created between the atoms when a photon is emitted spontaneously by a single excited atom. Superradiance can be defined as the enhancement of the spontaneous emission due to constructive interference of the scattered light. Its counterpart, subradiance, is the trapping of some remaining light due to destructive interference. In cold atoms, some previous theoretical works predict and characterize these two cooperative effects in a large and diluted atomic cloud, in the regime of low intensities and large detunings of the incident laser. The theoretical model is a coupled-dipole model for two-level atoms driven by a low-intensity field and in the scalar approach. The experiment consists in measuring the super- and subradiant decay rates from the temporal emitted intensity after the switch off of the incident laser in the steady state. Our experimental setup consists in a magneto-optical trap of rubidium 87 atoms at large resonant optical thicknesses. A probe beam excites the atoms close to the D2 line. The intensity emitted is detected by a single photon detector with no afterpulsing and a calibration procedure allows us to determine the resonant optical thickness of the cloud and its temperature. In this work, we report the experimental observation of super- and subradiance in a large cloud of cold atoms. For subradiance, the main result is the linear evolution of the characteristic time with the resonant optical thickness of the cloud and its independence of the detuning. For superradiance, we observe superradiance out of the forward direction. We verify the validity of our interpretations with the predictions of the coupled-dipole model. Finally, we discuss the interplay of subradiance and radiation trapping, as well as theoretical predictions for: a setup of a phased cloud, to control the subradiant amplitude emission; and temperature effects, where subradiance is shown to be robust in a large range of temperatures..

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