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Photon localization and Dicke superradiance in atomic gases: crossover to a "small world" network ERIC AKKERMANS, Technion and Yale University, AHARON GERO, Technion, ROBIN KAISER, Nice University —

We study photon propagation in a gas of N atoms, using an effective Hamiltonian that accounts for photon mediated atomic dipolar interactions. The configuration average density $P(\Gamma)$ of photon escape rates is obtained from the spectrum of the $N \times N$ random matrix $\Gamma_{ij} = \sin(x_{ij})/x_{ij}$, where x_{ij} is the dimensionless random distance between any two atoms expressed in units of the photon wavelength. A scaling function is defined to study photons escape rates as a function of disorder and system size. We show that for a strong enough disorder, photons do not escape the gas. This localization is described using a mapping of this problem onto statistical properties of random networks. We show that there is no localization phase transition as expected in disordered systems without correlation, but rather a cross-over between localized and delocalized photons. The mean field solution of this problem displays a "small world" behavior. In the Dicke limit, we recover localization associated to cooperative effects.

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