Collective photon emission of correlated atoms in free space

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Superradiance is one of the enigmatic problems in quantum optics since Dicke introduced the concept of enhanced spontaneous emission by an ensemble of identical two-level atoms, situated in collective highly entangled Dicke states [1-5]. While single excited Dicke states have been investigated since a long time, the production of Dicke states with higher number of excitations remains a challenge. In our approach, we generate these states via successive measurement of photons at particular positions starting from the fully excited system [6–10]. In this case, if the detection is unable to identify the individual photon source, the collective system cascades down the ladder of symmetric Dicke states each time a photon is recorded. We apply this scheme to demonstrate directional super- and subradiance with two trapped ions [11]. The arrangement for preparing the Dicke states and subsequently recording directional super- and subradiance corresponds to a generalized Hanbury Brown and Twiss setup. This shows that the two fundamental phenomena of quantum optics, Dicke superradiance and the Hanbury Brown and Twiss effect, are two sides of the same coin.

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