Experimental observation of one-dimensional superradiance lattices in a Bose-Einstein condensate

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Abstract

We measure the superradiant emission in a one-dimensional superradiance lattice (1D SL) of a Bose-Einstein condensate (BEC) based on a configuration of standing wave-coupled electromagnetically induced transparency (EIT). Resonantly excited to a superradiant state, the BEC is further coupled to other collective excited states, which form a 1D SL, by the two coupling fields of the EIT. The directional emission of one of the superradiant excited state in the 1D SL is measured. The emission spectra depend on the band structure, which can be controlled by the frequency and intensity of the standing-wave coupling laser fields. This work provides a platform for investigating the collective Lamb shift of on-resonantly excited superradiant states in BEC atoms and paves the way for realizing higher dimensional superradiance lattices, where topological phenomena can be simulated.

FIG.1

The experimental configuration of the 1D superradiance lattice in BEC. (a) Energy diagram of D1 transition of 87Rb. (b) The experimental geometry and the laser configuration. There are three planes, the plane of the two coupling beams, the plane of the probe-superradiant beams, and the equal intensity plane of the coupling beams.

FIG.2

Superradiant emission spectra for the different angles of the incident probe beam. The data points are simply connective with black lines and the red curve is the theoretical fitting.