Quantum optics with giant atoms: Decoherence-free interaction between giant atoms in waveguide quantum electrodynamics.

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In quantum optics, atoms are usually approximated as point-like compared to the wavelength of the light they interact with. However, recent advances in experiments with artificial atoms built from superconducting circuits have shown that this assumption can be violated. Instead, these artificial atoms can couple to an electromagnetic field in a waveguide at multiple points, which are spaced wavelength distances apart. Such systems are called giant atoms. They have attracted increasing interest in the past few years (e.g., see the review in [1]), in particular because it turns out that the interference effects due to the multiple coupling points allow giant atoms to interact with each other through the waveguide without losing energy into the waveguide (theory in [2] and experiments in [3]). This talk will review some of these developments. Finally, we will also show how a giant atom coupled to a waveguide with varying impedance can give rise to chiral bound states [4].

[1] A.F. Kockum, Quantum optics with giant atoms – the first five years, https://arxiv.org/abs/1912.13012.

[2] A.F. Kockum, G. Johansson, F. Nori, Decoherence-Free Interaction between Giant Atoms in Waveguide Quantum Electrodynamics, Phys. Rev. Lett. 120, 140404 (2018).

[3] B. Kannan, et al., Waveguide quantum electrodynamics with superconducting artificial giant atoms, Nature 583, pp. 775 (2020).

[4] X. Wang, T. Liu, A.F. Kockum, H.R. Li, F. Nori, Tunable Chiral Bound States with Giant Atoms, Phys. Rev. Lett. 126, 043602 (2021).