Chiral Quantum Optics

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A paradigmatic setting in quantum optics is the interaction of a single photon and a single quantum emitter. This light-matter interface primer constitutes the basis for deterministic single-photon source, photonic quantum gates, and quantum nonlinear optics, with diverse applications in quantum technology. In the past decades modern nanophotonic tools have been introduced in quantum optics in attempts of controlling light-matter interaction [1]. These methods give new opportunities by allowing to engineer light-matter coupling, but remarkably novel physical effects appear as well. For example, the tight transverse confinement of light in modern nanophotonic waveguides entails that a sizeable longitudinal component of the electric field is induced. This effect locally breaks the symmetry between forward and backward photon emission and scattering. We review the physics of such chiral light-matter interaction and its potential applications for novel integrated quantum photonic devices or quantum network architectures [2].

[1] Lodahl et al., Rev. Mod. Phys. 87, 347 (2015).
[2] Lodahl, Mahmoodian, Stobbe, Schneeweiss, Volz, Rauschenbeutel, Pichler, Zoller, Nature 541, 473 (2017).