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Controlling atomic interactions and collective effects in thermal vapor cells

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Photonic quantum devices based on atomic vapors at room temperature are intrinsically reproducible, scalable and integrable. Besides quantum memories for single photons, one key device in the field of quantum information processing are on-demand single-photon sources. A promising candidate for their realization relies on the combination of four-wave mixing and the Rydberg blockade effect. This has been demonstrated in 2018 [1] and a second generation with improved repetition rate and brightness is currently in development. Further miniaturization of this experimental set-up is possible by combining photonic structures and atomic vapors on a chip. Those integrated devices additionally lever efficient atom-light interactions below the diffraction limit. In contrast to free-space interactions, atoms aligned within a slot waveguide experience repulsive interactions enhanced by a factor of eight due to the Purcell effect. This leads to a corresponding blue shift, as the atoms are arranged in an essentially one-dimensional geometry, which vanishes above the saturation, providing a controllable nonlinearity at the few-photon level [2].

[1] Ripka et al., Science 362, 6413 (2018)

[2] Skljarow et al., Phys. Rev. Research 4, 023073 (2022)

Category

Other

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