Novel quantum devices based on atomic vapor cells

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Photonic quantum devices based on atomic vapors at room temperature combine the advantages of atomic vapors being intrinsically reproducible and highly nonlinear with scalability and integrability. We show the integration of photonic and electronic components into vapour cells. In the future integrated optical and electronic circuits in atomic vapor cells will enable applications in quantum sensing and quantum networks.

As an example we report a first demonstration of an on-demand single-photon source based on four-wave mixing (FWM) and the Rydberg blockade effect.

We also investigate an integrated optical chip immersed in atomic vapour providing several waveguide geometries for spectroscopy applications. This includes integrated ring resonators, Mach Zehnder interferometers, slot waveguides and counter propagating coupling schemes. This work demonstrates a next step towards miniaturization and integration of alkali atom spectroscopy and provides a platform for further fundamental studies of strong atom light coupling.

As a further example for future applications we discuss a novel scheme for trace gas sensing using Rydberg excitation.