Novel quantum technology based on atomic vapour cells

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Photonic quantum devices based on atomic vapours at room temperature combine the advantages of atomic vapours being intrinsically reproducible and highly nonlinear with scalability and integrability. We show the integration of photonic and electronic components into vapour cells and 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 where cooperativities on the order of 1 are within reach. In the future integrated optical and electronic circuits in atomic vapour cells will enable applications in quantum sensing and quantum networks. As examples we discuss microwave detection and trace gas sensing.