AlGaAs photonic devices for quantum information

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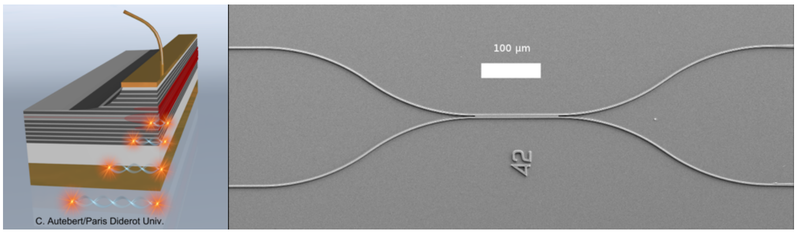
Nonclassical states of light are key components in quantum information science; in this domain, the maturity of semiconductor technology offers a huge potential in terms of ultra-compact devices including the generation, manipulation and detection of many quantum bits [1]. Among the different resources under development, on-chip entangled photon sources play a central role for applications spanning quantum communications, computing and metrology. In this talk I will present our last achievements on AlGaAs photonic devices emitting non-classical states of light at room temperature via spontaneous parametric down conversion; the choice of this platform combines the advantages of a mature fabrication technology, photon pair emission in the C-telecom band, a direct band-gap and a high electro-optic effect. The characterization of the quantum states emitted by such devices demonstrates their ability to produce highly indistinguishable and entangled photons [2]. Different device designs can be adopted depending on the target application: geometries producing copropagating photon pairs are particularly interesting to generate broadband strongly anticorrelated frequency states which can be used for instance in multiusers quantum key distribution protocols [3]. Moreover, the cavity effect due to modal reflectivity at the waveguide's facets allow engineering the joint spectrum of the emitted biphoton state to get comb-like spectral correlations, leading high dimensional frequency entangled state (or qudits). Geometries generating counterpropagating photon pairs with a transverse pump configuration allow engineering and control a large variety of frequency states: separable states are produced to monolithically integrate heralded single photon sources and beam splitters [4], while original quantum states featuring non-Gaussian entanglement are obtained through amplitude and phase engineering of the pump beam.



The compliance of these sources with electrical pumping, together with the possibility to fabricate versatile and massively parallel circuits make the AlGaAs platform a promising candidate for real-world quantum information technologies.

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[2] C. Autebert et al 'Integrated AlGaAs source of highly indistinguishable and energy-time entangled photons', Optica 3, 143 (2016).
[3] C Autebert et al. 'Multi-user quantum key distribution with entangled photons from an AlGaAs chip', Quantum Sci. Technol. 1, 01LT02 (2016).
[4] J. Belhassen et al. 'On-chip III-V monolithic integration of heralded single photon sources and beamsplitters', Appl. Phys. Lett. 112, 071105 (2018).