A guidonics-based quantum circuit

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Integrated quantum photonics has emerged over the last years as an ideal platform for quantum technology due to inherent features like stability, scalability and mode matching. Notably, a new direction, based on integrated photonic lattices, has found potential applications for quantum information and metrology like quantum walks, quantum gates and entanglement sources [1]. Recently, generation of photon-encoded W states and perfect transfer of a quantum state have been experimentally demonstrated in coupling-constant engineered arrays of waveguides (guidonic circuits) [2,3].

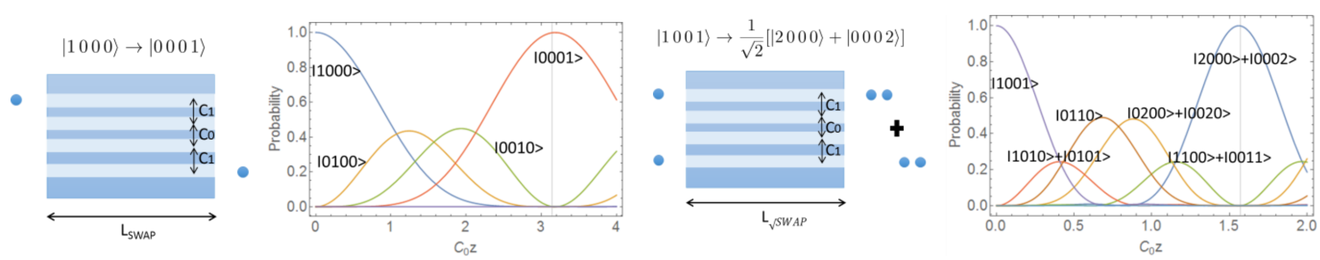

Figure 1: *Swap* and √*swap* guidonic circuits in a 4 waveguides-array. Appropriate engineering of the coupling constants leads to different unitaries with applications in quantum integrated optics. We show two examples: perfect transfer of a single photon (left), and generation of a NOON state from two input single photons (right).

In this communication, we propose two simple building blocks that together can build compact, low-loss and highly-reproducible integrated quantum circuits. These are waveguide arrays-based *swap* and √*swap* gates. Suitable engineering of the coupling constants ratio C_1/C_0 and propagation length L, yields the desired quantum gate, as illustrated on Figure 1 for four waveguides-arrays. Remarkably, the √*swap*- gate produces entanglement as a directional coupler would, but without the need of bends to couple light in and out. We have fabricated a compact guidonic circuit from these elements. Nesting these building blocks together with nonlinear and reconfigurable elements, such as those that can be found in Lithium Niobate current technology [4], complex circuits [5] for quantum information processing can be developed.

The authors acknowledge the support of the French Agence Nationale de la Recherche (ANR), under grant ANR-14-CE26-0038-02 (project INQCA). This work is also supported by a public grant overseen by the French National Research Agency (ANR) as part of the "Investissements d'Avenir" program (Labex NanoSaclay, reference: ANR-10-LABX-0035).

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