









# Master in Photonics – "PHOTONICS BCN" Master ERASMUS Mundus "EuroPhotonics"

## MASTER THESIS PROPOSAL

## Dates: April 2023 – July or September 2023

Laboratory: Optoelectronics Group Institution: ICFO – The Institute of Photonic Sciences City, Country: Barcelona, Spain

**Title of the master thesis:** Experimental control of high-dimensional entanglement for multicore fibre-based QKD

#### Name of the master thesis supervisor and co-supervisor:

Email address: <u>valerio.pruneri@icfo.eu</u> for supervisor, and <u>alvaro.cuevas@icfo.eu</u> for cosupervisor Phone number: +34 935534052 Mail address: Mediterranean Technology Park, Avinguda Carl Friedrich Gauss, 3, 08860 Castelldefels, Barcelona

Keywords: High dimensional entanglement; Multicore fiber (MCF); Entangled photon source

### Summary of the subject (maximum 1 page):

Quantum entanglement is one of the most fascinating property of quantum physics, being remarked by the Nobel prize in physics this year. Quantum technologies require the generation, control, distribution and measurement of unique photonic states such as the entangled one, which have no classical counterpart. In the field of quantum communications, high-dimensional entangled states enable high-rates quantum key distribution or ensure strong security protocols. However, their manipulation often requires many technological resources that quickly scale with the system dimensionality, then making experimental implementations very challenging.

For the present project, the student will work with a multi-disciplinary team of experts of the Optoelectronics Group (Optogroup) at ICFO, aimed at generating high-dimensional entangled states in the spatial and polarization degrees of freedom mainly, by employing spatial light modulation (SLM) and distribution through special multicore fibres (MCFs). The student will utilize SLM devices for entangled photon sources (EPSs) either in NIR and telecom spectra, which allows to control the free space-to-fibre coupling, as well as the propagation dynamics mediated by the photonic state preparation and core-to-core crosstalk.









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The candidate will have to work extensively with software-hardware integration, which comprises extraction of data from scientific cameras or single-photon detectors, custom manipulation of SLM devices, utilization of MCFs, among other technologies.

#### **Objectives:**

- Design and implementation of an optical system for optimal free-space to MCF coupling.
- Manipulation of quantum light dynamics in special MCFs though input state modulation.
- Documentation of the results in a written form (e.g. report, thesis, ...)

#### Additional information:

Required skills:

- Strong programming skills (e.g. Python, Matlab, Labview)
- Medium knowledge in quantum mechanics and photonics