PhD position at Joly's group at MPL & FAU
Max-Planck Institute and Friedrich-Alexander Universität, Erlangen, Germany

Generation of photon triplets via three-photon parametric down-conversion.

Research field / Keywords: Nonlinear & Quantum optics in microstructured optical fibres

Context
Direct generation of photon triplets via spontaneous third-order parametric down-conversion (TOPDC), which can be seen as the quantum reversal of the third-harmonic generation, has been a long-standing goal in the quantum optics and nonlinear-optics communities. Although the demonstration of TOPDC has recently been realized in the microwave range, it remains a challenging task in the optical range. A large number of theory papers, starting from the 1980s, discussed TOPDC as a source of the famous Greenberger-Horne-Zeilinger states and because it is the lowest-order nonlinear process leading to the generation of a non-Gaussian Wigner function, which is strongly desired in quantum information protocols. TOPDC is based on third-order nonlinearity, therefore optical fibers made from glasses are an ideal platform for its realization. This is in contrast to the common technique of photon pair generation (second-order parametric down-conversion), which is based on second-order nonlinearity and therefore has to be performed in nonlinear crystals.

Project
In this race towards the first demonstration of triplets, we have already studied several systems, including gas-filled hollow-core photonic crystal fibers, hybrid microstructured fiber and sub-micron tapered fibers. Due to chromatic dispersion, inter-modal phase-matching is required. Not only this strongly reduces the spatial pump-triplet overlap and hampers even more the efficiency of the process, but it also means that a high-order spatial mode is required as the pump. The current project is a continuation of our previous studies and will initially focus on the use of sub-micron tapered optical fibers, which seems to be the most promising candidate for the generation of triplets. In a first stage of the thesis, we plan to seed the process at one of the triplet frequencies. The presence of this seeding photon will trigger the generation of the complementary two photons. For each frequency ω_1 of the seed, the two-photon source can be characterized. Next, we will explore the case of unseeded (spontaneous) TOPDC.

The project is a collaboration with the group of Quantum Radiation of Maria Chekhova at the Max-Planck Institute for the Science of Light in Erlangen. The project therefore combines nonlinear optics, photonics and quantum optics. The candidate should have a solid background in photonics. They will integrate the Joly's group at the Friedrich-Alexander Universität and the Max-Planck Institute for the Science of Light in Erlangen.

Application procedure: Interested candidates should submit a personal statement, a full CV (including full details of all University course grades to date and contact details for at least two academic referees) and a copy of transcripts to-date to Prof Nicolas Joly.

A personal statement (750 words maximum) outlining (i) your suitability for the project with reference to the criteria in the person specification, (ii) what you hope to achieve from the PhD and (iii) your research experience to-date.

Contact Max Planck Institute for the Science of Light / FAU
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