PhD/Postdoc on Nonlinear neuromorphic nanophotonics

The rapidly increasing demand for artificial intelligence (AI) models has exposed fundamental limitations in conventional digital information-processing hardware, prompting a paradigm shift in hardware design. Traditional computing architectures were based on general-purpose processing, in which a single central processing unit handled all computational tasks. In contrast, modern systems increasingly rely on specialized hardware, which are tailored to specific mathematical operations and significantly accelerate AI workloads. At the same time, entirely new analog computing approaches have emerged as an important research direction.

Among these new approaches to AI hardware, diffractive photonic networks are extremely promising since light as information carrier possesses fundamental advantages over electronic systems. These advantages include an extremely large bandwidth that enables ultrafast processing, high degrees of parallelization in diffractive systems, as well as low propagation losses that reduce power consumption and mitigate heat-related performance limits. Owing to these intrinsic properties, optical computing hardware holds the potential to achieve unprecedented levels of performance combined with a drastic reduction of energy consumption and minimal latency.

While major progress has been achieved in diffractive photonic networks in the last years, the scalability of the approach will depend critically on the availability of nonlinear photonic activation functions. Thus, we are seeking to hire a PhD student and a postdoctoral researcher to work on concepts for the realization of highly multimode nonlinear devices, which will allow the ultrafast processing of massively parallelized streams of information. The PhD project or postdoctoral qualification field can be shaped to the preferences of the candidates, but should incorporate the encoding of broad-bandwidth data streams onto complexly shaped light distributions by spatial light modulators, the realization of diffractive photonic elements based on metasurface, the nonlinear interaction of the diffracted light fields in different nonlinear material platforms available in the laboratory for Nano & Quantum Optics, as well as the training of the resulting nonlinear nanophotonic systems for benchmark classification tasks.

The project will offer the possibility for the candidates to achieve qualification in a modern field of photonics, connected to highly relevant applications. Thus, besides the fundamental scientific challenges there will also be opportunities to engage with industry partners on the subject. The work will be embedded in a team effort at the laboratory for Nano & Quantum Optics.

Depending on the abilities and preferences of the PhD candidate/postdoc the following subjects will be covered:

- Design, experimental realization, and characterization of nonlinear photonic diffractive neural networks.
- Development and realization of optical setups for realizations of photonic AI.
- Nanotechnologies for the realization of diffractive photonic elements and metasurfaces.
- Rigorous modelling of nonlinear nanophotonic processes.
- Development of training algorithms for photonic diffractive neural networks.

Required qualification for PhD applicants:

- Master's degree in physics, photonics, electrical engineering, or comparable.

Required qualification for postdoc applicants:

- Doctorate/PhD in physics, photonics, electrical engineering, or comparable.

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