SU2P Entrepreneurial Fellows

Case Study:- Armand Niederberger

Title: Nanophotonic Simulations

Introduction

The goals of this project were threefold. First, to develop a hard-ware description language for quantum-optical circuits, likely to play a role in future nanophotonic applications. Second, to adapt numerical optimization techniques borrowed from aerodynamics to quantum optics and electrodynamics. Third to start an international network of scientists and entrepreneurs, and connect SU2P with this international community.

Numerical simulation of nanophotonic devices

Electrical engineers have developed a number of tools for efficiently studying complex circuits. One widely-used language to describe integrated circuits, to simulate their behaviour and to work on different levels of complexity of a device is VHDL: the “VHSIC Hardware Description Language”. The fellowship adapted VHDL to be used for quantum optics, which lead to the definition of QHDL: the Quantum Hardware Description Language. At the core of QHDL is the description of connections between the various functional entities of a circuit. Based on this plain-text circuit map, a wrapper program then calculates the mathematical model of the whole abstract quantum circuit. At this point, it is possible to define concrete physical parameters such as wavelengths of light, absorption coefficients, and the like. This finally defines a concrete device which can be simulated and analyzed numerically. Stanford collaborators are currently completing the computational framework based on QHDL

Efficient optimization of nanophotonic devices

Numerical simulations of nanophotonic circuits typically depend on a large number of parameters. Given that one simulation typically takes anywhere between hours to weeks to complete, it is clear that blind parameter scans requiring dozens to hundreds of simulations are not realistic. Armand adapted efficient optimization techniques borrowed from aerodynamics research to tackle these complex problems. He has shown that the “adjoint method” can be used for optimizing a given parameter for waveguide slabs. With his colleagues he is currently investigating the applicability of the “adjoint” approach to subwavelength gratings.

WIN - the Worldwide Innovation Network

Dr. Thomas Baer and Armand have started organizing conferences on entrepreneurship for the scientific community. In fact, Tom and Armand were key partners in the International OSA Network of Students (IONS), which connects PhD Students and young scientists from Europe, the Americas, Asia, and Australia. With the WIN Project, they will build upon their experience in connecting likeminded people to foster entrepreneurship and innovation worldwide.

Personal development

Armand feels this SU2P fellowship was extremely beneficial for his research career, and his entrepreneurial ambitions. During this project, he has helped develop QHDL, which is believed to be the foundation for future research and development of nanophotonic circuits. Further-more, Armand adapted a numerical optimization technique using “adjoints” which is new to the quantum circuit and nanophotonic devices community. The results of Armand’s SU2P fellowship are currently being applied directly to research and development at Hewlett Packard laboratories.

.

SU2P