A propos du centre ou de la direction fonctionnelle

The Inria Sophia Antipolis - Méditerranée center counts 34 research teams as well as 8 support departments. The center's staff (about 500 people including 320 Inria employees) is made up of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrative staff 1/3 of the staff are civil servants, the others are contractual agents. The majority of the center's research teams are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Four teams are based in Montpellier and two teams are hosted in Bologna in Italy and Athens. The Center is a founding member of Université Côte d'Azur and partner of the I-site MuSE supported by the University of Montpellier."

Contexte et atouts du poste

This postdoctoral project will be conducted in the Nachos project-team, in close collaboration with researchers from the Acumes project-team at the Inria Sophia Antipolis-Méditerranée research center, and CRHEA - Centre de Recherche sur l'Hétéro-Epitaxie et ses Applications (http://www.crhea.cnrs.fr) - in Sophia Antipolis.

Nachos is a joint project-team between Inria and the Jean-Alexandre Dieudonné Mathematics Laboratory at University Nice Sophia Antipolis. The team gathers applied mathematicians and computational scientists who are collaboratively undertaking research activities aiming at the design, analysis, development and application of innovative numerical methods for systems of partial differential equations (PDEs) modeling nanoscale light-matter interaction problems. In this context, the team is developing the DIGoGENE5 software suite (https://digogenes.inria.fr/), which implements several Discontinuous Galerkin (DG) type methods tailored to the systems of time- and frequency-domain Maxwell equations, possibly coupled to differential equations modeling the behaviour of propagation media at optical frequencies. DIGoGENE5 is a unique numerical framework leveraging the capabilities of DG techniques for the simulation of multiscale problems relevant to nanophotonics and nanophotonics. Inria.

A propos d'Inria

Inria, l'institut national de recherche dédié aux sciences du numérique, promeut l'excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l'interface d'autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

Consultation de candidature

Les demandes de candidature doivent être adressées par courrier ou par mail à:

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n’est pas garanti.

Informations générales

- Thème/Domaine : Schémas et simulations numériques
- Ville : Sophia Antipolis
- Date de prise de fonction souhaitée : 2020-03-01
- Durée de contrat : 12 mois
- Date limite pour postuler : 2019-12-31

Contacts

- Equipe Inria : NACHOS
- Recruteur : Lanteri Stéphane
- Prelateri@inria.fr

Mission confiée

Conventional optical components such as lenses, wave plates and holograms rely on light propagation over distances much larger than the wavelength to shape wavefronts. In this way, substantial changes of the amplitude, phase or polarization of light waves are gradually accumulated along the optical path. Flat, ultrathin optical components dubbed “metasurfaces” can produce abrupt changes over the scale of the free-space wavelength in the phase, amplitude and/or polarization of a light beam [1]-[2]. Metasurfaces are generally created by assembling arrays of miniature, anisotropic light scatterers (that is, resonators such as optical antennas). The spacing between these nanostructures and their dimensions are much smaller than the wavelength. As a result, the metasurfaces, on account of Huygens principle, are able to mold optical wavefronts into arbitrary shapes with subwavelength resolution by introducing spatial variations in the optical response of the light scatterers. However, designing metasurfaces is generally a challenging inverse problem.

The recent numerous discoveries in nanophotonics, driven by the achievements in nanofabrication processes and characterization techniques, require revisiting the traditional electromagnetic design paradigm. Specific and rigorous strategies for the design of nanostructures are not yet fully established. The geometries that have been studied and designed so far need additional refinements by a fullwave electromagnetic simulation carried out by sweeping the relevant geometrical parameters through a given range. This time-consuming design approach exacerbates the delay between proof of concept devices and marketable technology. On the other hand, the automation of the design of nanostructures by rigorous inverse design strategies [3]-[4] could make very large search spaces easily accessible, where the user could look for a specific nanostructure meeting specific needs with unparalleled accuracy. Contrary to the solution of a direct problem, which simply aims at determining the electromagnetic field scattered by a given nanostructure of prescribed shape, size and composition, under assigned excitation conditions, the inverse design problem consists of determining the characteristics of the scattering object, based on the desired properties of the scattered electromagnetic field. The general objective of this postdoctoral project is to develop a methodology for the rigorous inverse design of planar optical devices based on passive and active metasurfaces. In order to do so, high order discontinuous Galerkin (DG) solvers from the DIGoGENE5 software suite (https://digogenes.inria.fr/) developed in the Nachos team will be combined with statistical learning-based global optimization strategies [3] from the DiceOptim R toolbox developed by the Acumes team. Both teams are partners of the ANR OPERA project that was launched in May 2019 and which is funded by the French Defense procurement Agency.


Principales activités
The following methodological topics will be addressed:

- Modeling and characterization of metasurfaces. High order DG solvers of the system of 3D Maxwell equations will be adapted to cope with the modeling features relevant to metasurfaces. Both time-domain and frequency-domain modeling settings will be considered with specific variants of the DG method that are implemented in the DIoGENeS software suite.
- Problem parameterization. The influence of the parameterization of nanophotonic device geometries will be investigated, by comparing ad-hoc representations (Gielis’ formula) to generic geometrical models (B-Spline based free-form deformation). Multilevel parameterization techniques will also be studied. The selected parameterization strategies will be implemented in new modules that will be integrated in the DIoGENeS software suite afterwards.
- Optimization strategies. One overarching goal here will be to design inverse design strategies capable of dealing with large area planar optic devices. This will probably represent the more prospective and challenging part of this postdoctoral project, which will require to investigate various directions for reducing the computational overhead when dealing with metasurfaces with several hundreds to several thousands nanostructures.

Compétences
Candidates must hold a PhD degree in applied mathematics/scientific computing/applied physics.

Required knowledge and skills are: a sound knowledge of numerical analysis and development of finite element type methods for solving PDEs; a concrete experience in numerical modeling for computational electromagnetics; strong software development skills, preferably in Fortran 95/2008.

A previous research experience in applied nanophotonics will clearly be an asset for this position.

Avantages
- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.);
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours;
- Professional equipment available (videoconferencing, loan of computer equipment, etc.);
- Social, cultural and sports events and activities;
- Access to vocational training;
- Social security coverage;

Rémunération
Gross Salary: 2653 € per month