Offre n°2024-08398

Post-Doctoral Research Visit F/M Computational design of next-generation optical metasurfaces

Le descriptif de l'offre ci-dessous est en Anglais

Type de contrat : CDD

Contrat renouvelable : Oui

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

Niveau d'expérience souhaité : De 3 à 5 ans

A propos du centre ou de la direction fonctionnelle

The Inria center at Université Côte d'Azur includes 42 research teams and 9 support services. The center's staff (about 500 people) is made up of scientists of different nationalities, engineers, technicians and administrative staff. The teams are mainly located on the university campuses of Sophia Antipolis and Nice as well as Montpellier, in close collaboration with research and higher education laboratories and establishments (Université Côte d'Azur, CNRS, INRAE, INSERM ...), but also with the regional economic players.

With a presence in the fields of computational neuroscience and biology, data science and modeling, software engineering and certification, as well as collaborative robotics, the Inria Centre at Université Côte d'Azur is a major player in terms of scientific excellence through its results and collaborations at both European and international levels.

Contexte et atouts du poste

Atlantis is a joint project-team between Inria and the Jean-Alexandre Dieudonné Mathematics Laboratory at Université Côte d'Azur. The team gathers applied mathematicians and computational scientists who are collaboratively undertaking research activities aiming at the design, analysis, development and application of advanced numerical methods for solving systems of partial differential equations (PDEs) modelling nanoscale light-matter interaction problems. In this context, the team is developing the DIOGENeS [https://diogenes.inria.fr/] software suite, 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. DIOGENeS also includes a component dedicated to the optimization of geometrical characteristics of nanostructures driven by some performance objective in the contex of inverse design strategies of nanophotonic setups. DIOGENeS is a unique numerical framework leveraging the capabilities of DG techniques for the simulation of multiscale problems relevant to nanophotonics and nanoplasmonics.

One important line of research of the team during the last years has been dedicated to improve the capabilities of these numerical tools to produce novel inverse design methodologies for optical metasurfcaes. In the last decade metasurfaces, i.e. 2D arrays of optical nanoantennas with subwavelength size and separation [1] have revolutionized the field of linear optics with the promise to replace bulky and difficult-to-align optical components with ultrathin and flat devices like metagratings, metalenses and metaholograms, which can also implement new functionalities in terms of aberrations correction and arbitrary wavefront shaping. In the recent years, by combining a high-fidelity DG-based fullwave solver in the time-domain [2] with a statistical learning-based global optimization method [3], we have introduced innovative inverse design methodologies for mono-objective optimization of metadeflectors [4], multi-objective optimization of RGB metalenses [5] and robust optimization of metadeflectors [6].

[1] W. Chen, A.Y. Zhu and F. Capasso. *Flat optics with dispersion-engineered metasurfaces.* Nature Review Material, vol. 5, 604 (2020)

[2] S. Lanteri, C. Scheid and J. Viquerat. *Analysis of a generalized dispersive model coupled to a DGTD method with application to nanophotonics*. SIAM Journal on Scientific Computing, Vol. 39, No. 3, pp. A831–A859 (2017)

[3] D. Jones. *Efficient global optimization of expensive black-box functions*. Journal of Global Optimization, Vol. 13, No. 4, pp. 455-492 (1998)

[4] M. Elsawy, S. Lanteri, R. Duvigneau, G. Brière, M.S. Mohamed and P. Genevet,*Global optimization of metasurface designs using statistical learning methods*, Scientific Reports, Vol. 9, No. 17918, (2019)

[5] M. Elsawy, A. Gourdin, M. Binois, R. Duvigneau, D. Felbacq, S. Khadir, P. Genevet an S. Lanteri, *Multiobjective statistical learning optimization of RGB metalens*, ACS Photonics, Vol. 8, No. 8, pp. 2498–2508 (2021)

[6] M. Elsawy, M. Binois, R. Duvigneau, S. Lanteri, and P. Genevet,*Optimization of metasurfaces under geometrical uncertainty using statistical learning*, Optics Express 29(19), 29887–29898 (2021)

Mission confiée

Our achievements in [4]-[5]-[6] are concerned with linear and passive metasurfaces. A more recent work has been dedicated to active, i.e., tunable, metasurfaces [7]. A first goal of this postodoctoral project will be to delve into novel modeling techniques for the design of next-generation metasurfaces. We will consider two modern topics in metasurface design:

1. **Active and dynamically tunable metasurfaces**. The objective will be to explore novel active metasurface designs enabled by advanced materials such as liquid crystals and phase-change materials. Special attention will be given to the dynamic modeling of such systems, including thermal effects, liquid crystal dynamical behavior, and their integration into tunable and reconfigurable devices.
2. **Nonlinear metasurfaces**. The goal will be to exploit the latest breakthroughs in the modeling and design of nonlinear metasurfaces, focusing on second-harmonic generation, wave mixing, and other nonlinear effects. Different modeling approaches ranging from the state-of-the art linear approximation to advanced nonlinear modelling techniques to achieve superior accuracy and performance.

[7] M.M.R. Elsawy, C. Kyrou, H. Mikheeva, R. Colom, J.Y. Duboz, K.Z. Kamali, S. Lanteri, D. Neshev and P. Genevet.
Universal active metasurfaces for ultimate wavefront molding by manipulating the reflection singularities.
Laser & Photonics Review, Vol. 17, No. 7, pp. 200880 (2023)

Principales activités

Dealing with the above physical contexts regarding dynamicity / tunability and nonlinearity, well require investigating advanced material models and adapt numerical methods currently implemented in teh DIOGENeS software suite.

The second important objective of this postodoctoral project will be to setup inverse design workflows based on the EGO optimization algorithm for unveiling novel metasurface designs with ultimate properties allowing effective operation of active and dynamically tunable metasurfaces on one hand, and nonlinear metasurfaces on the other hand.

The Atlantis team is currently involved in collaborations with several groups of physicisits who are actively working on the fabrication and characterizartion of such metasurfaces. Therefore, the third goal of this project will be to foster these collaborations through experimental demonstrations of the capabilities of the proposed virtual metasurface designs thanks to our adavanced cinoutational modeling, and copublication in high rank journals.

Compétences

Required knowledge and skills on theory and methodology: computational electromagnetics, finite element methods for PDEs, numerical optimization.

Sound knowledge of nanophotonics, metasurface, metamaterial.

Software development skills : Python and Fortran 2003, parallel programming with MPI and OpenMP.

Relational skills : team worker (verbal communication, active listening, motivation and commitment).

Other valued appreciated : good level of spoken and written english.

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 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
- Contribution to mutual insurance (subject to conditions)

Rémunération

Gross Salary : 2788 € per month.

Informations générales

- **Thème/Domaine :** Schémas et simulations numériques
  Calcul Scientifique (BAP E)
- **Ville :** Sophia Antipolis
- **Centre Inria :** Centre Inria d'Université Côte d'Azur
- **Date de prise de fonction souhaitée :** 2025-02-01
- **Durée de contrat :** 12 mois
- **Date limite pour postuler :** 2026-06-30

Contacts

- **Équipe Inria :** ATLANTIS
- **Recruteur :**
  Lanteri Stéphane / Stephane.Lanteri@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 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.

L'essentiel pour réussir

Applicants muat hold a Ph.D. in at least one the following disciplines: applied physics, electrical engineering, applied photonics, numerical mathematics and scientific computing.

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.

Consignes pour postuler

Applications must be submitted online on the Inria website. Collecting applications by other channels is not guaranteed.

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.