



**Offre n°2025-08639**

## **Internship : Deep Neural Networks for the design of nanophotonic devices**

**Type de contrat :** Internship agreement

**Niveau de diplôme exigé :** Graduate degree or equivalent

**Autre diplôme apprécié :** Master in applied mathematics or scientific computing

**Fonction :** Internship Research

### **A propos du centre ou de la direction fonctionnelle**

The Inria centre at Université Côte d'Azur includes 37 research teams and 8 support services. The centre'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**

Nanophotonics is the science that studies the interactions between light and matter at the nanoscale. Light is an electromagnetic wave whose wavelength is in the visible spectrum, i.e., between approximately 400 nm to 800 nm. In this context, one refers to as sub-wavelength structuring of matter. The structuring of matter at these scales allows these interactions to be shaped for a variety of technological and societal applications. Numerical modeling is extensively used for understanding the physical phenomena underlying light-matter interactions, but also for tailoring or harnessing these interactions guided by specific performance objectives. The first objective requires to numerically solve the system of time-domain or frequency-domain Maxwell equations coupled to differential equations modeling the behavior of propagation media at optical frequencies while the second goal is addressed by leveraging a numerical optimization algorithm in the framework of an inverse design workflow. For both objectives, the Atlantis team from the Inria Center at Université Côte d'Azur is developing the DIOGENeS

[<https://diogenes.inria.fr/>] software suite, which is dedicated to the numerical study of multiscale problems relevant to nanophotonics and nanoplasmonics. DIOGENeS implements several Discontinuous Galerkin (DG) type methods for which the team has developed a long-term expertise [1-3]. It also includes an inverse design component, which relies on statistical learning-based global optimization methods for single-objective, multi-objective and robust optimization [4-6]. Beside the above-mentioned high-fidelity DG-based electromagnetic solvers, since 2022 the team is also actively studying alternative modeling and design approaches leveraging Deep Neural Networks (DNNs) [7].

[1] J. Viquerat. *Simulation of electromagnetic waves propagation in nano-optics with a high-order discontinuous Galerkin time-domain method*. Ph.D. thesis, University of Nice-Sophia Antipolis, Dec 2015.

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

[3] E. Agullo, L. Giraud, A. Gobé, M. Kuhn, S. Lanteri and L. Moya. *High order HDG method and domain decomposition solvers for frequency-domain electromagnetics*. Int. J. Numer. Model. Electr. Netw. Dev. Fields, Vol. 33, No. 2 (2019)

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

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

[7] A. Clini de Souza, S. Lanteri, H.E. Hernandez-Figueroa, M. Abbarchi, D. Grosso, B. Kerzabi and M. Elsayy. *Back-propagation optimization and multi-valued artificial neural networks for highly vivid structural color filter metasurfaces*. Scientific Reports, Vol. 13, No. 1, pp. 21352 (2023)

## Mission confiée

This internship project is expected to be a first step toward a PhD project that will be concerned with the development of novel DNN-based approaches for the design of complex nanophotonic devices such as metasurfaces. The objective of the internship will be to propose, develop and assess different building block approaches relying on DNNs for designing a nanophotonic device. For this, the following steps will be considered: (1) Review of state-of-the art approaches in the bibliography on AI-based modeling for nanophotonics; (2) Formulation and coding of a few selected approaches; (3) Critical assessment and proposition of research directions for methods beyond the state-of-the art and taking into account the modeling challenges of complex nanophotonic devices; (4) Synthesis and publication of results.

## Compétences

Technical skills and level required :

- Master or engineering degree in numerical mathematics or scientific computing or data sciences
- Sound knowledge of numerical analysis for PDEs
- Basic knowledge of physics of electromagnetic wave propagation

Software development skills : Python and PyTorch

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

Other valued appreciated : good level of spoken and written english

## Informations générales

- **Thème/Domaine** : Numerical schemes and simulations  
Scientific computing (BAP E)
- **Ville** : Sophia Antipolis
- **Centre Inria** : [Centre Inria d'Université Côte d'Azur](#)
- **Date de prise de fonction souhaitée** : 2025-04-01
- **Durée de contrat** : 6 months
- **Date limite pour postuler** : 2025-12-31

## Contacts

- **Équipe Inria** : [ATLANTIS](#)
- **Recruteur** :  
Lanteri Stéphane / [Stephane.Lanteri@inria.fr](mailto: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.

**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

**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.