2018-00684 - Post-doc proposal: High-order polytopal discretization methods for electromagnetism (M/F)

**Contract type:** Public service fixed-term contract  
**Level of qualifications required:** PhD or equivalent  
**Fonction:** Post-Doctoral Research Visit  
**Level of experience:** Recently graduated

**About the research centre or Inria department**

The Inria Lille - Nord Europe Research Centre was founded in 2008 and employs a staff of 360, including 300 scientists working in sixteen research teams. Recognised for its outstanding contribution to the socio-economic development of the Nord - Pas-de-Calais Region, the Inria Lille - Nord Europe Research Centre undertakes research in the field of computer science in collaboration with a range of academic, institutional and industrial partners.

The strategy of the Centre is to develop an internationally renowned centre of excellence with a significant impact on the City of Lille and its surrounding area. It works to achieve this by pursuing a range of ambitious research projects in such fields of computer science as the intelligence of data and adaptive software systems. Building on the synergies between research and industry, Inria is a major contributor to skills and technology transfer in the field of computer science.

**Context**

The design of numerical methods that support general meshes has undergone vigorous developments in the past few years. These methods, referred to as polytopal discretization methods, can handle meshes with polygonal/polyhedral cells, and possibly including hanging nodes. In practice, the use of general meshes can bring major advantages, as it increases the flexibility in meshing complex geometries, and simplifies the refinement/coarsening procedures in adaptive simulations.

We are interested in polytopal discretization methods of arbitrary (and especially, high) order. High-order methods take advantage of the (local) regularity of the solution to improve the accuracy of the approximation. In terms of computational efficiency, order increasing (when possible) turns out to be much more interesting than mesh refinement. Classical arbitrary-order polytopal discretization methods include polygonal/polyhedral FEM, that typically use non-polynomial shape functions, and DG methods. More recently, new paradigms have emerged, that both (i) enable to stick to polynomial basis functions, and (ii) substantially reduce (with respect to DG methods) the number of globally coupled degrees of freedom. Virtual Element Methods (VEM) are one salient example of such methods. Our focus here is on Hybrid High-Order (HHO) methods [1], that have been introduced in 2014. HHO methods have some assets in comparison with VEM, like a dimension-independent construction, a reduced stencil, and local conservativity properties.

**Assignment**

HHO methods have already been analyzed for a wide variety of linear (e.g., advection-diffusion, linear elasticity) and nonlinear (e.g., Leray–Lions) problems, but no effort has been put yet into the design of HHO methods for models in electromagnetism [2]. This is the subject of this post-doc. The first step will be to design/analyze a HHO method for a 3D magnetostatic problem (in curl-curl formulation), and to implement/test it in a dedicated C++ platform [3]. In a second time, a (scalar) 2D Helmholtz-type problem will be considered, as a model for time-harmonic Maxwell's equations in domains that are invariant in one direction. In a last step, and if time allows, the (general) 3D time-harmonic Maxwell system will be tackled.

The project will be supervised by Simon Lemaire (CR Inria) and Emmanuel Creusé (Prof. Université de Lille).
Main activities
- devise and analyze advanced numerical methods on general meshes
- implement them in a C++ environment
- write research articles and present the results in international conferences

Skills
Technical requirements: The successful candidate will hold a PhD in applied mathematics (with emphasis on numerical analysis/scientific computing), and have a solid knowledge of C++.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
The gross monthly salary is 2653€.

General Information
- **Theme/Domain**: Numerical schemes and simulations
  Scientific computing (BAP E)
- **Town/city**: Villeneuve d'Ascq
- **Inria Center**: CRI Lille - Nord Europe
- **Starting date**: 2018-11-01
- **Duration of contract**: 1 year, 6 months
- **Deadline to apply**: 2018-07-31

Contacts
- **Inria Team**: RAPSODI
- **Recruiter**: Lemaire Simon / simon.lemaire@inria.fr

Conditions for application
Candidates will be treated firstly with a complete file: CV + list of publications + 2 representative publications + one or more letters of recommendation + prospects for professional integration after the post-doc.

Defence Security:
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.
Recruitment Policy:
As part of its diversity policy, all Inria positions are accessible to people with disabilities.

**Warning**: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.