



Offre n°2024-07374

Post-Doctoral Research Visit F/M Virtual Element Methods for the cardiac EMI model (IDP 2024)

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

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

Contexte et atouts du poste

It has been recently recognized that the micrometric scale may play a crucial role to explain cardiac arrhythmia occurring at the organ scale \cite{jaeger2021frommillimetmicromet}. At this scale, the geometry of individual cells, and their spatial organization has to be taken into account, and a correct model is the extracellular, membrane, intracellular (EMI) model described in \cite{tveito2017cellbased}.

It is the aim of the MICROCARD project (ending in September 2024) to build an efficient high-performance computer software to solve the equations of the EMI model. To this aim, we are currently investigating the interest of finite volume methods, and have obtained some results for a standard scheme, adapted to the problem \cite{FVCA10.2023}. The methods studied up to now are restricted to triangular and tetrahedral mesh elements, and are low order approximations.

The variations of the electrical field may occur at a scale close to the cell length (see \cite{jaeger2021frommillimetmicromet}), meaning that the approximation may require mesh elements having the size of the cells. Anyway, the cells have complex geometries, which discretization needs smaller tetrahedrons. We want to investigate how recent virtual elements method \cite{antonietti2022virtualelementmethodapplicat} or polytopal discretizations \cite{dipietro2020hybridhighorder} may be used to discretize the EMI equations with less mesh elements (of more general shape), while retaining their precise geometry, and a good accuracy.

Mission confiée

The equations are Laplace equations within each cell, and the extracellular domain. They are coupled through time-dependent transmission conditions. These conditions involve additional state variables, that solve systems of nonlinear differential equations (ionic models). For this reason, the problem needs discretizing operators in the volume, but also integrals on the surface interfaces between subdomains. The discrete problem may be written in the complete volume (with a large sparse linear system) or on the interfaces only (with a smaller full linear system).

The postdoctoral researcher will have to complete a literature survey of possible polytopal methods, including the VEM and variants of FVM, like hybrid high-order finite volume (HHO) methods. He or she will propose some approaches to discretize the EMI model with such a method on general mesh elements. The objective is to define a method that can be used on very general meshes, with the fewer possible unknowns per cardiac cells. The researcher will have to assess the feasibility, and accuracy of such approaches, as well as to guarantee relative ease of implementation of the numerical scheme. For this reason a prototypal implementation will have to be programmed, and tested (test cases from the MICROCARD project may be used to this aim). In addition, the mathematical soundness of the method may be studied. Depending on the difficulty of the problem, it may include proving existence of the discrete solution, uniqueness, and understanding its theoretical convergence if possible. This may be difficult because the regularity of solutions has not been studied.

Principales activités

Main activities:

- Survey of the literature, propose a solution to the discretization of the EMI model in the above context
- Assess the accuracy and convergence of the method, numerically or by analysis
- Implementation in a software code, run and analyse numerical test cases

- Write scientific article, present the work at conferences

Compétences

Academic background:

- Ph.D. in Applied mathematics.

Required skills:

- Strong knowledge of methods for elliptic PDE discretization (finite elements or finite volumes), in theory and in practice,
- Scientific computing, strong coding abilities (C, C++, or Fortan) and knowledge of scientific libraries
- Candidates are expected to write scientific journal papers in autonomy and to communicate their results in conferences.

Relational skills:

- Candidates will be asked to work in collaboration in a research team,
- Good abilities to communicate and manage project in a team are required.

Language:

- Spoken and written English.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- 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
- Social security coverage

Rémunération

2788€ / month (before taxes)

Informations générales

- **Thème/Domaine** : Modélisation et commande pour le vivant
Calcul Scientifique (BAP E)
- **Ville** : Talence
- **Centre Inria** : [Centre Inria de l'université de Bordeaux](#)
- **Date de prise de fonction souhaitée** : 2024-10-01
- **Durée de contrat** : 2 ans
- **Date limite pour postuler** : 2024-05-03

Contacts

- **Équipe Inria** : [CARMEN](#)
- **Recruteur** :
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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

Thank you to send:

- CV
- Cover letter
- Support letters (mandatory)
- List of publication

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.