Offre n°2024-07649

**Post-Doctoral Research Visit F/M Campagne postdoc 2024 - Stellarator design: Foliations of toroidal domains by harmonic fields**

*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**

The posdoc will be co-supervised by Mario Sigalotti (Inria) and Ugo Boscain (CNRS)

**Mission confiée**

Nuclear fusion differs from conventional fission in that, instead of splitting large nuclei like Uranium and producing radioactive waste, it fuses light nuclei like Hydrogen isotopes. Its sole direct byproducts are Helium and neutrons. These reactions occur in relatively dense, very hot plasmas that are either compressed by powerful lasers (inertial confinement) or confined by strong magnetic fields. Magnetic confinement devices of the tokamak type have produced the largest amounts of fusion power to date, and a tokamak – the large ITER under construction in Provence – is projected to achieve net power for the first time in 2035. Tokamaks however, require an intense electrical current in the plasma. As a result, they are inherently pulsed and subject to instabilities called disruptions.

The stellarator is another magnetic confinement approach, alternative to the tokamak. It is naturally steady-state and immune from disruptions because it does not require a plasma current to confine the plasma: it obtains the same effect (helical fields) by means of specially deformed magnetic coils. The downside is the complexity of the coils’ shape. One could summarize by saying that tokamaks are relatively simple to build but difficult to operate, whereas stellarators are simple to operate but difficult to build. While today’s funding is mainly devoted to tokamak development, advances in 3D modeling and manufacturing have recently accelerated stellarator progress.

The stellarator design opens many technological and mathematical research challenges. The core issue considered by the proposed project is the design of coils generating a magnetic field in a toroidal domain (a domain diffeomorphic to a torus) whose integral lines are sufficiently twisted to allow the confinement and guarantee stability [1, 2]. Such twist is needed to counteract natural drifts of the particle trajectories towards the exterior of the stellarator. Our main objective consists in understanding the topological properties of phase portraits of magnetic fields in toroidal domains.


**Principales activités**

This main goal of the postdoc will consist in designing a foliation of a given toroidal domain in integral lines of a harmonic (divergence-free and curl-free) vector field with specific properties of twisting and density of the integral curves. Such properties are required to compensate the natural drift of the particle trajectories towards the exterior of the stellarator.

The main object to study is the shape of the integral lines of the magnetic field: the ideal situation is the one in which the toroidal domain is foliated by 2D topological tori, invariant for the flow of the magnetic field (a onion-like toroidal foliation). In this case on each 2D leaf the line field is either ergodic or contains periodic orbits. Another possibility is the presence of a discrete (finite or infinite) sequence of invariant 2D tori creating regions of confinement. We stress that this project focuses on the topological and Frobenius integrability properties of the phase portrait of the magnetic field and not on the plasma dynamics. When the case of harmonic vector fields is understood, we could consider as next step Beltrami vector fields, i.e., eigenvector fields of the curl operator. Harmonic fields describe magnetic
fields in the void, while Beltrami fields are stationary solutions of the equations of ideal magnetohydrodynamics in the context of a resting plasma and constant pressure.

Compétences

The candidate should have a strong mathematical background. Knowledge in nonlinear control theory, differential geometry, and geometric analysis will be highly appreciated.

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
- Flexible organization of working hours (after 12 months of employment)
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération

According to civil service salary scales

Informations générales

- Thème/Domaine : Optimisation et contrôle de systèmes dynamiques
- Ville : Paris
- Centre Inria : Centre Inria de Paris
- Date de prise de fonction souhaitée : 2024-11-01
- Durée de contrat : 1 an, 6 mois
- Date limite pour postuler : 2024-05-19

Contacts

- Équipe Inria : CAGE
- Recruteur : Sigalotti Mario / Mario.Sigalotti@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

There you can provide a "broad outline" of the collaborator you are looking for what you consider to be necessary and sufficient, and which may combine :

- tastes and appetencies,
- area of excellence,
- personality or character traits,
- cross-disciplinary knowledge and expertise...

This section enables the more formal list of skills to be completed and 'lightened' (reduced):

- "Essential qualities in order to fulfil this assignment are feeling at ease in an environment of scientific dynamics and wanting to learn and listen."
- "Passionate about innovation, with expertise in Ruby on Rails development and strong influencing skills. A thesis in the field of **** is a real asset."

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

The candidates must send a letter of motivation explaining how their scientific skills and profile match
the research proposal. Their application should also include
* a CV
* the list of publications
* the thesis reports (if the thesis has been already defended)
* Candidates who have not yet defended their thesis must provide a letter from their PhD adviser
certifying that the thesis is ready to be defended, giving a date of defense and the composition of the
defense committee.
* Recommendation letters (at least a letter from the PhD adviser)

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.