Offer #2024-07854

PhD Position F/M Passive imaging for terrestrial and solar seismology

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Context

We propose a three-years Ph.D. student position in passive imaging for terrestrial and solar seismology. This position is in the context of the ERC-StG project INCORWAVE (https://ffaucher.gitlab.io/erc-incorwave/) and takes place in the team Makutu, located at the University of Pau and Pays de l'Adour, in the Southwest of France.

Travel expenses for participation in conferences, workshops, and research stays are also covered within the project.

Assignment

The objective of the Ph.D. thesis is to investigate and develop accurate methods and software for passive imaging. In terrestrial and solar seismology, surface oscillations are measured and used to infer the inner structures. These oscillations relate to the propagation of waves through the medium, propagation that depends on the inner physical properties such as density, bulk modulus, meridional circulation, etc. Therefore, observing the waves allows us to reconstruct the properties we cannot access. In the problems we consider, the waves originate from natural/stochastic events in the interior, and to extract information from the oscillations, we work with the cross-correlation of signals. The cross-correlation can be related to deterministic Green's functions which are solutions to wave equations, [2,3,4], giving us the relation between the physical properties and the observations.

Main activities

The program will be divided into two main phases, with all software development and numerical implementation performed in the open-source code hawen developed in the team Makutu, https://ffaucher.gitlab.io/hawen-website/.

The first objective of the student is to understand the relation between the cross-correlation of signals and deterministic wave solutions. It implies the understanding of the wave equations in solar and terrestrial contexts.

- Derivation of the mathematical relations between the cross correlations and the Green's function depending on the wave equation considered and on the assumption regarding the stochastic nature of the source.
- Development and implementation of the numerical workflow in the open-source code hawen [1] developed in the team Makutu.
- Validation of the numerical simulations.

In the second phase, the inverse problem will be considered. The objective is here to reconstruct the internal structures of the medium from the measured oscillations. The reconstruction follows a nonlinear iterative minimization approach. The physical properties describing the system (such as the bulk modulus for the Earth, or the meridional circulation for the Sun) are iteratively updated to minimize a discrepancy criterion between the measurements and the numerical simulations.

- Formulation of the inverse workflow, in particular with the writing of the adjoint-state method for gradient computation in the context of cross-correlation data.
- Implementation in the open-source code hawen.
- Investigation of efficient inversion of the source covariance term.
  Investigation of efficient misfit criterion for inversion.

References

[1] F. Faucher, hawen: time-harmonic wave modeling and inversion using hybridizable discontinuous Galerkin discretization, Journal of Open Source Software, 6 (2021, https://ffaucher.gitlab.io/hawen-website/).
[2] L. Gizon and A. C. Birch, Local helioseismology, Living Reviews in Solar Physics, 2 (2005).
[3] N. M. Shapiro and M. Campillo, Emergence of broadband rayleigh waves from correlations of the ambient seismic noise, Geophysical Research Letters, 31 (2004).

[4] N. M. Shapiro, M. Campillo, L. Stehly, and M. H. Ritzwoller, High-resolution surface-wave tomography from ambient seismic noise, Science, 307 (2005), pp. 1615–1618.

Benefits package

- 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

Remuneration

2100€ / month (before taxs) during the first 2 years,
2190€ / month (before taxs) during the third year.

General Information

- **Theme/Domain :** Numerical schemes and simulations
  Scientific computing (BAP E)
- **Town/city :** Pau
- **Inria Center :** Centre Inria de l'université de Bordeaux
- **Starting date :** 2024-11-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-07-19

Contacts

- **Inria Team :** MAKUTU
- **PhD Supervisor :**
  Faucher Florian / florian.faucher@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

The applicant must have a solid background in applied mathematics, in particular in partial differential equations for wave propagation; knowledge in iterative optimization is also warmly recommended. It is necessary that the applicant is familiar with coding. In addition, the applicant is expected to review scientific bibliography and write reports/documentation for its progress, hence a good level in English for all aspects of communications is required.

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.

Instruction to apply

Thank you to send:
- CV
- Cover letter
- Master marks and ranking
- Support letter(s)

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.