2020-02446 - PhD Position F/M Toward complex modeling and simulation of particle dynamics in turbulent flows

Type de contrat : CDD
Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria Sophia Antipolis - Méditerranée center counts 34 research teams as well as 8 support departments. The center's staff (about 500 people including 320 Inria employees) is made up of scientists of different nationalities (over 50 nationalities), engineers, technicians and administrative staff. 1/3 of the staff are civil servants, the others are contractual agents. The majority of the research teams are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Four teams are based in Montpellier and two teams are hosted in Bologna in Italy and Athens. The Center is a founding member of Université Côte d'Azur and partner of the I-site MUSE supported by the University of Montpellier.

Contexte et atouts du poste

The PhD position is offered within the Cálitate team, who invested and developed the topic of complex SDFs and stochastic particle modeling applied to single-phase and multiphase flows. This is done in collaborations with researchers that share interest in environmental applications (including meteorologists, hydro-physicists, physicists specialized in turbulence and two-phase flows modeling).

Mission confiée

PhD position 2020

Toward complex modeling and simulation of particle dynamics in turbulent flows

Scientific context of the subject

Particles are omnipresent in both environmental and industrial applications. Particle-laden flows indeed impact a large range of industrial processes, from energy production facilities (fouling of heat exchangers by iron oxides), to automotive (soot deposition in combustion engines) through oil transportation (use of polymers to modify the fluid rheology). Particles are also suspended in a number of environmental flows, including atmospheric flows (such as volcanic cloud and ash fallout, droplet growth in clouds or fog formation) and marine systems (e.g. silt deposition in delta rivers, plastic pollution in oceans and rivers, plankton sedimentation in oceans).

As transpires from these examples, the particles encountered are complex and driven by intricate mechanisms: particles are polydisperse, not exactly spherical but of any shape and deform (as bubbles and droplets); they can collide together in the fluid and form larger agglomerates; they have complex interactions with surfaces, on which they can deposit and later be resuspended again; they can even modify the very nature of the flow (i.e. polymeric flows). Particle-laden flows is thus a highly multi-disciplinary topic (with issues related to fluid mechanics, interface chemistry, surface and material science). Besides, it spans a wide range of temporal and spatial scales (from the nanometer scale up to geological scales). The challenge is thus to develop numerical models that capture all this rich and intricate phenomena to help in the design of optimal industrial processes or environmental solutions.

State of art on numerical simulations

These challenges represent critical technological locks and power companies are devoting significant design efforts to deal with these issues, increasingly relying on the use of macroscopic numerical models. This framework is broadly referred to as "Computational Fluid Dynamics" (CFD). However, such large-scale approaches cannot explicitly simulate small-scale particles, which limits their suitability and precision [1]. Particles encountered in industrial situations are generally difficult to model: They are polydisperse, not exactly spherical but of any shape and deform; They have complex interactions, collide and agglomerate; They usually deposit or stick to the walls and can even modify the very nature of the flow (i.e. polymeric flows). Extending present models to these complex situations is thus key to improve their applicability, fidelity, and performance.

Models operating in industry generally incorporate rather minimalistic descriptions of suspended inclusions. They rely on statistical closures for single-time, single-particle probability distributions. The underlying mean-field simplifications do not accurately reproduce complex features of the involved physics that require higher-order correlation descriptions and modeling. Indeed, predicting the orientation and deformation of particles requires suitable models of the fluid velocity gradient along their trajectories [2] while concentration fluctuations and clustering depend on relative particle dispersion. Estimates of collision and aggregation rates should also be fed by two-particle dynamics [3], while wall deposition and resuspension is highly affected by local flow structures [4, 5]. Significant improvement of existing approaches requires more accurate models.

Principales activités

Main objectives and activities

The aim of this doctoral research is to develop new models for the dynamics of clusters of particles (be it aggregates in the flow or complex deposits on the surface). For that purpose, the student will extend recent approaches that have been developed for small colloidal particles (i.e. smaller than a few microns). The doctoral student will participate to the development of state-of-the-art numerical tools, perform simulations, analyze and validate results.

For instance, in the case of particle resuspension, one will consider the resolved remobilization model as a starting point. This model, brought to fruition by C. Henry, already predicted accurately the remobilization rate of sub-millimeter particles in turbulent air flows [3]. Extension of the model may be key to improve their applicability, fidelity, and performance.

Informations générales

- Ville : Sophia Antipolis
- Centre Inria : CR Sophia Antipolis - Méditerranée
- Date de prise de fonction souhaitée : 2020-09-01
- Durée de contrat : 3 ans
- Date limite pour postuler : 2020-04-30

Contacts

- Équipe Inria : AT SOP AE
- Bossy Mireille / Bossy.Mireille@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 200 équipes projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3500 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 impacteront le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 180 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

When you apply, please send also an email to: christophe.henry@inria.fr and mireille.bossy@inria.fr.

Applications are required to send a cover letter to C D R and at least one recommendation letter to the above address.

Consignes pour postuler

Sécurité défense :
Ce poste est susceptible d’être affecté dans une zone à régime restrictif (ZRR) tel que défini 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.

Attention : Les candidatures doivent être dépoussées en ligne sur le site Inria. Le traitement des candidatures adressées par d’autres canaux n’est pas garanti.
address situation of neutrally buoyant particles in the millimeter range. Extension may also account the situation of remobilisation in multilayer beds by accounting for the bed morphology as well as inter-particle interactions. Systematic numerical simulations will be performed to support model developments and validation.

References


Compétences

- Candidates should have a solid background in one or more of the following topics: physics, applied mathematics, or mechanical engineering
- Strong competence and taste for code development. In particular knowledge of python/ C / C++ programming languages;
- Fluent in English

Optional competences

- Knowledge in fluid dynamics
- Knowledge in statistical physics
- Rigorous, autonomous and creative thinking
- Interest in environmental applications
- HPC skills will be 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 (after 6 months of employment) 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

Duration: 36 months
Location: Sophia Antipolis, France
Gross salary per month: 1982€ brut per month (year 1 & 2) and 2085€ brut/month (year 3)