Offer #2025-09157

Post-Doctoral Research Visit F/M A Well-Balanced Approximate Riemann Solver for Depth-Averaged Coulomb-type Model of Granular Flows with Dilatancy Effects (H/F)

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

Context

In natural environments, granular flows play a crucial role in sediment transport and landscape evolution, manifesting in a wide range of geophysical phenomena such as: landslides and debris avalanches.
Given the potential hazards these flows may present to both infrastructure and human populations, the modeling and the forecast of their dynamics are essential for effective risk mitigation (Neri et al.,2015).
Gravity-driven dry granular flows are strongly influenced by the underlying topography (Iverson and Denlinger, 2001; Pudasaini and Hutter, 2007; Chassignet et al., 2012). To address the challenges of modeling large scale granular flows over complex topographies, depth-averaged equations have emerged as a prevalent approach.

The simplest depth-averaged model was derived by Savage and Hutter (1989) in which a Coulomb-type friction term is used.

To simulate granular flows modelled by Savage and Hutter (1989), several finite volume schemes have been proposed (Mangeney-Castelnau et al., 2005; Mangeney et al., 2007; Kelfoun and Druitt, 2005; Patra et al., 2005; Christen et al., 2010; De' Michieli Vitturi et al., 2019; De' Michieli Vitturi et al., 2023; Mergili et al., 2016; Kaland and Struckmeier, 2008).

To handle the Coulomb-type friction term, all the scheme above use a fractional-step, except Mangeney-Castelnau et al. (2005) and Mangeney et al. (2007) where a Riemann solver based on an apparent topography and a hydrostatic reconstruction allows one to discretize all the source terms at the same time and therefore provide a well-balanced

scheme.

Recall that well-balanced scheme have the desired property of exactly maintaining steady states solutions, like the state at rest of a granular mass.

Recently, the seminal model Savage and Hutter (1989) could be extended Bouchut et al. (2021) in order to account for dilatancy effects. The hydrostatic reconstruction approach has been applied for numerical simulations with a finite volume scheme in Mangeney-Castelnau et al. (2005) and Mangeney et al. (2007). However, in that work, the dilatancy source term is discretized after splitting, so the scheme is not actually well-balanced.

As highlighted by the authors, such splitting numerical method induces some numerical difficulties close to the so-called dry/wet transition (between $h > 0$ and $h = 0$).

Assignment

We aim at developping in this project a well-balanced finite volume scheme that includes the dilatancy source term. Our approach is to extend a new well-balanced scheme recently developed for the Savage-Hutter model in the PhD thesis of Geddo (2025).

Main activities

Construction of a numerical scheme, implementation and test

Writing of a manuscript for publication in a peer-reviewed journal

Skills

Compétences techniques et niveau requis :

Langues :

Compétences relationnelles :

Compétences additionnelles appréciées :

Benefits package

- Subsidised catering
- Partially reimbursed public transport
- Leave: 7 weeks' annual leave + 10 days' RTT (full-time basis) + possibility of exceptional leave (e.g. sick children, moving house)
- Possibility of teleworking and reorganisation of working hours
- Professional equipment available (videoconferencing, loan of IT equipment, etc.)

- Social, cultural and sporting benefits (Association de gestion des œuvres sociales d'Inria)
- Access to professional training
- Social security

General Information

- **Theme/Domain :** Numerical schemes and simulations
  Scientific computing (BAP E)
- **Town/city :** Chatou
- **Inria Center :** Centre Inria de Paris
- **Starting date :** 2025-09-01
- **Duration of contract :** 4 months
- **Deadline to apply :** 2025-08-14

Contacts

- **Inria Team :** MATHERIALS
- **Recruiter :**
  Boyaval SÉbastien / Sebastien.Boyaval@inria.fr

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Vous pouvez donner là, un portrait à "gros traits" du (de la) collaborateur(trice) attendu(e) : ce que vous voyez comme nécessaire et suffisant et qui peut associer :

- goûts et appétences,
- domaine d'excellence,
- éléments de personnalité ou de caractère,
- savoir et savoir faire transversaux...

Cette rubrique permet de compléter et alléger (réduire) la liste plus formelle des compétences :

- "Se sentir à l'aise dans un environnement de dynamique scientifique, aimer apprendre et écouter sont des qualités essentielles pour réussir cette mission."
- " Passionné(e) par l'innovation, avec une expertise dans le développement Ruby on Rail et une grande capacité de conviction. Une thèse dans le

domaine *** constitue un réel atout."

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Instruction to apply

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