Post-doctoral position (18 months) in applied mathematics (PDE, numerical analysis)

Analysis and simulation of models of gas-particle mixtures : from the mesoscopic to the macroscopic scale

Scientific context

The scientific objective of the project is to study, from a mathematical and/or numerical perspective, models of partial differential equations describing aerosols (mixtures consisting of a particle phase—such as solid impurities or droplets—suspended in a gas). These models are based on kinetic theory, which describes systems consisting of a large number of elementary particles at the mesoscopic scale (between the microscopic and macroscopic scales) in terms of their density function in phase space. By letting various small physical parameters (the Knudsen number, the mass ratio between a gas molecule and a particle, the Mac number, etc.) toward 0, we can obtain various asymptotic models, such as the Euler-Vlasov model [2] (fluid-kinetic) or the Maxwell-Stefan model [3] (diffusive asymptotic), which describe the evolution of macroscopic variables: density, macroscopic velocity, and temperature. Fluid-kinetic or Maxwell-Stefan models, which are less refined, are, however, less expensive to simulate numerically than a kinetic model.

Mission

Depending on the postdoctoral fellow's background, the work will focus on numerical and/or more theoretical aspects, such as:

- ▷ development and implementation of numerical schemes that preserve asymptotic behavior (see, for example, [1], [4], [5]) between the two scales of description of the mixture, starting with the asymptotic limit of a coupled system of two kinetic-collisional PDEs toward a coupling between a collision equation and a Vlasov equation, and then considering fluid or diffusive asymptotics.
- ▷ analysis of the introduced schemes (proof of convergence),
- ▷ analysis of the well-posedness of the equations and justification of the asymptotic results.

Qualifications

Ph.D. in mathematics, with expertise in partial differential equations (theoretical and/or numerical aspects), preferably in the field of kinetic theory of gases or fluid mechanics. The skills expected of the postdoctoral researcher are as follows: scientific curiosity, rigor, the ability to read scientific documents in English, the ability to compile a bibliography, the ability to write a scientific paper in English, the ability to work independently and interact with supervisors, ...

Work Environment and Supervision

The LJK is a laboratory for applied mathematics and computer science at the University of Grenoble Alpes (UGA) with a staff of 300, including researchers, faculty members, and engineers.

Under the supervision of Frédérique Charles, professor at UGA, and Clément Jourdana, maître de conférences at UGA, you will join the EDP team in the AMAC department at LJK, which consists of 14 tenured faculty members, 10 doctoral students, and 3 postdoctoral researchers.

Practical Details

Salary : based on the UGA pay scale (starting at €2,900 gross per month, depending on experience).
Duration : 18 months.
Contract start date : between October 1 and December 31, 2026.

Application

Contact Frédérique Charles (frederique.charles@univ-grenoble-alpes.fr) and Clément Jourdana (clement.jourdana@univ-grenoble-alpes.fr).

References

[1] D. Caparello, L. Pareschi, T. Rey. High-Order Asymptotic-Preserving IMEX schemes for an ES-BGK model for Gas Mixtures. Preprint, 2026. https://arxiv.org/abs/2511.22304

[2] F. Charles, L. Desvillettes. From collisional kinetic models to sprays: internal energy exchanges. Communications in Mathematical Sciences, 23:173–193, 2025. https://dx.doi.org/10.4310/CMS.241217081314

[3] F. Charles, A. Massimini and F. Salvarani. Diffusion asymptotics of a kinetic model for gas-particle mixtures with energy exchanges. Communications in Mathematical Sciences, 24: 797–844, 2026. https://dx.doi.org/10.4310/CMS.260210003838

[4] A. Crestetto, N. Crouseilles, M. Lemou. Kinetic/fluid micro-macro numerical schemes for Vlasov-Poisson-BGK equation using particles. Kinetic and Related Models, 2012, 5(4): 787-816. https://dx.doi.org/10.3934/krm.2012.5.787

[5] T. Laidin. Hybrid kinetic/fluid numerical method for the Vlasov-BGK equation in the diffusive scaling. Kinetic and Related Models, 2023, 16(6): 913-947. https://dx.doi.org/10.3934/krm.2023013