| Aix*Marseille université | LAM LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE |
|---|---|
| www.univ-amu.fr | www.lam.fr |

# PhD Thesis

PhD thesis director name: Pierre BARGE
Email: pierre.barge@lam.fr
Phone number: +33 4 91 05 59 84

Co-director: ledizes@irphe.univ-mrs.fr

## PhD title: Vortices in self-gravitating protoplanetary disks

Subject description:
Gaseous vortices are believed to form in protoplanetary disks due, for example, to baroclinic or Rossby wave instabilities. Such vortices could change the global disk evolution and impact the mechanisms of planet formation by trapping large amount of solid particles in their cores. Dust trapping in vortices may be supported by recent observations of disk asymmetries around young stars with high resolution instrument like ALMA[9] and SPHERE[5]; it is also consistent with simulated observations[1].

The goal of the thesis is to study the evolution of giant vortices at the decoupling stage of planet formation and in regions of the disks where self-gravity can play a significant role. A first step will be to study the stability conditions and the evolution of self-gravitating vortices, a second one will be to include solid particles, coupled to the gas by aerodynamical forces, and to look at the possibility to form persistent clumps of solid material in spite of the complex evolution the dust-gas mixture[4,6].

Numerical simulations will be performed with a numerical code (ROSSBI), specifically developed and optimized to study the evolution of protoplanetary disks[2,3,7,8] . This code uses the finite volume method and can work in 2D or 3D; it solves the fully compressible inviscid Euler's equations for a perfect gas in non-homentropic conditions and for particles in a fluid approximation. The code is parallelized in OpenMP/MPI and can run on National computing resources. Theoretical work will be performed in collaboration with members of the team studying rotating fluids at IRPHE.

The applicant should be familiar with problems of fluid mechanics and have a sufficient skill in the use and management of numerical codes. He (she) will work at LAM with access to the local OpenMP/MPI cluster and the national computing resources allocated to the project.

References :

[1] Barge, P., Ricci, L., Carilli, C. & Previn, R. 2017, A&A 605, 122.
[2] Barge,P., Richard,S. & Le Dizes, S. 2016A&A...592A.136B
[3] Inaba, S. ; Barge,P. : Daniel,E. ; Guillard,H. 2005A&A...431..365I
[4] Johansen, A. et al. 2006ApJ...643.1219J
[5] Ligi, R. et al. 2018, MNRAS 473, 1774.
[6] Raettig, N., Klahr, H. & Lyra, W. 2015ApJ...804...35R
[7] Richard, S. ; Barge, P. and Le Dizès, S. 2013A&A...559A..30R
[8] Surville, C. and Barge, P. A&A 2015A&A...579A.100S
[9] Van der Marel, N. et al. 2013Sci...340.1199V