Résumé public du projet

Cette fiche permettra de présenter le projet et son avancement de façon très synthétique sur le site web de l'ANR. Les auteurs autorisent l'ANR à publier le contenu de ce résumé sur son site web ou sur d'autres supports.
Cette communication vise un public scientifique large, il faut donc privilégier une rédaction pédagogique et éviter les explications visant uniquement les spécialistes du domaine.
S'aider de l'exemple fourni.

Identification du projet

Acronyme	BECASIM
Titre	Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments
Programme – Edition	Numerical Models - 2012
Référence ANR	ANR-12-MONU-0007
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Date de début Date de fin	01/01/2013 31/12/2016
Pôles de compétitivité	-
Coût complet	889 848 euros
Aide ANR	787 346 euros
Site web	http://becasim.math.cnrs.fr/
Date de mise à jour de ce document	11/06/2013

Titre d'accroche du projet (1 ligne)

Developing high performance numerical tools to investigate the properties of condensed matter at very low temperatures

Sous-titre / Argument du projet (2 à 4 lignes)

Applications belonging to a future technological era are already foreseen by physicists working in the field of condensed matter. The purpose of our project is to develop robust and reliable numerical simulators, based upon new mathematically sound methods and modern high performance computing strategies, to numerically simulate real physical experiments and investigate new physics in superfluid systems (such as Bose-Einstein condensates).

Titre de la partie Enjeux & objectifs (1 ligne)

Provide a new state-of-the-art Numerical Methods and High Performance Computing software for the numerical simulation of Bose-Einstein condensates

Enjeux & objectifs (20 lignes max)

The goal of this project is to provide a new state-of-the-art Numerical Methods and High Performance Computing (HPC) software for the numerical simulation of Bose-Einstein condensates (BEC). This is a timely objective, since BEC physics is a very dynamic research field, with applications belonging to a future technological era. The project bridges a gap in this field, where modern, HPC numerical codes are nowadays absent. With the purpose to develop robust and reliable numerical simulators, based upon new mathematically sound methods and modern HPC strategies, this project has no worldwide equivalent and will strongly impact studies of BEC physics conducted in both mathematics and physics communities.

Titre de la partie Méthodes / Approches (1 ligne)

Mathematical models, numerical analysis, scientific parallel computing

Méthodes / Approches (20 lignes max)

The project combines mathematical modeling, numerical analysis and simulation in a coherent workflow that brings together 20 (permanent) mathematicians and computer scientists from 4 partners. This includes a solid task-force made of 5 research engineers, who will use their important experience in HPC to support coding effort. The project will also take benefit from the strong interaction with external collaborators, who are expert physicists in BEC systems.

Résultats (20 lignes max)

After 6 months of activity, we can consider that the project was settled down and the tasks assigned for the first year were tackled. Important progress has been already done in: (Task 1) the development and analysis of new numerical methods, (Task 2) the development of a first numerical code using parallel computing (OpenMP, MPI, CUDA). Concerning the scientific production during this period, we can mention two scientific papers accepted for publication, two others submitted and two papers in preparation. The web site of the project (in English) is now available.

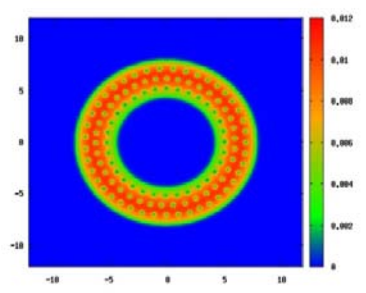
Perspectives (10 lignes max)

Continue the project with the same high rate of progress

Productions scientifiques et brevets (10 lignes max)

1)Computational methods for the dynamics of the nonlinear Schrödinger/Gross-Pitaevskii equations, X. Antoine, W. Bao, C. Besse, Computer Physics Communications, invited paper.
2)Particle-Based Anisotropic Surface Meshing, Z. Zhong, X. Guo, W. Wang, B. Lévy, F. Sun, Y. Liu and W. Mao, ACM Transactions on Graphics (special issue ACM SIGGRAPH 2013 conference proceedings), to appear.
3) Robust and efficient preconditioned Krylov spectral solvers for computing the ground states and dynamics of fast rotating and strongly interaction Bose-Einstein condensates, X. Antoine and R. Duboscq, submitted.
4) Analysis of time-splitting scheme for a class of random partial differential equations, R. Duboscq, R. Marty, submitted.

Illustration



Two-dimensional simulation of a fast-rotating Bose-Einstein condensate with formation of a giant vortex in the middle. A very first result using the new parallel code for solving the stationary Gross-Pitaevskii equation.
Credits : projet BECASIM.