Journée Calcul Scientifique et Modélisation Mathématique

Rapport sur les contributions

https://indico.math.cnrs.fr/e/9293

ID de Contribution: **1** Type: **Non spécifié**

Olivier Bodart - Modélisation et contrôle optimal en volcanologie. Applications à des éruptions réelles

jeudi 8 juin 2023 10:00 (1 heure)

Je vais présenter le travail que j'ai effectué en collaboration avec des volcanologues du Laboratoire Magmas et Volcans de Clermont-Ferrand. Le point de départ sera la réalisation d'un code de calcul efficace pour la modélisation de la déformation d'édifices volcaniques. Ces derniers sont gouvernés par les lois de l'élasticité linéaire, mais la présence de fractures rend les champs de déformations sont discontinus. Cela nous a motivé à développer une méthode de type XFEM. Je parlerai ensuite du problème inverse qui consiste à déterminer les efforts appliqués sur une fracture de manière à rendre compte de déplacements mesurés en surface. Je présenterai quelques applications et évoquerai la méthodologie de travail des géophysiciens dans ce contexte, assez inhabituelle pour un(e) mathématicien(ne). Je terminerai par quelques perspectives".

ID de Contribution: **2** Type: **Non spécifié**

Philippe Helluy - Solveurs Galerkin discontinus quasi-explicites et inconditionnellement stables pour les lois de conservation.

jeudi 8 juin 2023 11:00 (1 heure)

Solveurs Galerkin discontinus quasi-explicites et inconditionnellement stables pour les lois de conservation.

Nous décrivons un schéma cinétique parallèle et quasi-explicite de type Discontinuous Galerkin (DG) pour résoudre des systèmes hyperboliques de lois de conservation. Le solveur est inconditionnellement stable (c'est-à-dire que le nombre de CFL peut être arbitraire), a la complexité d'un schéma explicite. Dans ce travail, nous évaluons la performance du schéma dans le cas particulier des équations de Maxwell. Nous mesurons l'avantage de la stabilité inconditionnelle en réalisant des expériences avec de très grands nombres de CFL. En outre, les possibilités parallèles de la méthode sont étudiées.

Quasi-explicit, unconditionally stable, Discontinuous Galerkin solvers for conservation laws.

We describe a parallel and quasi-explicit Discontinuous Galerkin (DG) kinetic scheme for solving hyperbolic systems of conservation laws. The solver is unconditionally stable (i.e., the CFL number can be arbitrary), has the complexity of an explicit scheme. The time integration can be fully time reversible. It can be applied to any hyperbolic system of balance laws. In this work, we assess the performance of the scheme in the particular cases of the Maxwell's equations. We measure the benefit of the unconditional stability by performing experiments with very large CFL numbers. In addition, the parallel possibilities of the method are investigated.

ID de Contribution: **3** Type: **Non spécifié**

Diane Peurichard - Mathematical modeling of tissue morphogenesis and regeneration

jeudi 8 juin 2023 14:00 (1 heure)

In this talk, we investigate the mechanisms by which organs acquire their functional structure, realize its maintenance over time and rebuild their architecture after injury. We do this by means of two-dimensional Individual Based Models (IBM) of interacting cells and extra-cellular-matrix fiber elements. The mechanical model first shows that the emergence of organized structures could be explained by simple mechanical interactions between the cells and the collagen fibers. Our assumption is that the fiber network resists the pressure induced by the growing cells and forces them to regroup into clusters. Reciprocally, cell clusters force the fibers to merge into a well-organized network. When applied to adipose tissues, the model produces structures that compare quantitatively well to the experimental observations and seems to indicate that cell clusters could spontaneously emerge as a result of simple mechanical interactions between cells and fibers and surprisingly, vasculature is not directly needed for these structures to emerge. In the second part of the talk, we extend this model to account for mechanisms of tissue repair after injury, and use it to explore the mechanisms responsible for adipose tissue regeneration. The model successfully generates regeneration or scar formation as functions of few key parameters, and seems to indicate that the fate of injury outcome could be mainly due to extra-cellular (ECM) matrix rigidity. Altogether, these studies point to the essential role of mechanics in tissue structuring and regeneration, and bring a comprehensive view on the role of ECM crosslinking on tissue architecture emergence and reconstruction.

ID de Contribution: **4** Type: **Non spécifié**

Stéphane Randoux - From wave turbulence to integrable turbulence and soliton gases

jeudi 8 juin 2023 15:00 (1 heure)

The nonlinear propagation of random dispersive waves has been an active research topic in nonlinear physics since the 1960s. Historically, a very important part of the work on this subject has been focused on weak wave turbulence. Wave turbulence theory deals with the non-equilibrium statistics of incoherent and weakly nonlinear dispersive waves in non-integrable systems. On the other hand, many physical systems are described at leading order by partial differential equations (such as the nonlinear 1D Schrodinger equation) that are integrable in the sense that they can be solved using the inverse scattering transform (IST) method. Nowadays, the theoretical description of nonlinear random wave fields in integrable systems is addressed in the framework of so-called "integrable turbulence", a research area introduced by Zakharov in 2009. In this talk, I will review experimental and numerical developments on the subject of integrable turbulence with a focus on the topic of soliton gas.