Workshop contributions – *Wednesday, August 23, 2023*

Tobias Barker *– University of Bath, United Kingdom*

Dynamics of the Navier-Stokes equations from 'geometrically constrained' initial data

Motivated by an open question posed by Chemin, Zhang and Zhang, I will discuss the dynamics of the 3D incompressible Navier-Stokes equations from 'geometrically constrained' initial data.
 – Joint work with Christophe Prange (Cergy) and Jin Tan (Cergy).

Denis Bonheure *– Université Libre de Bruxelles, Belgium*

Global weak solutions to a time-periodic body-liquid interaction problem

We prove existence of time-periodic weak solutions to the coupled liquid-solid problem constituted by an incompressible Navier-Stokes fluid interacting with a rigid body of finite size, subject to a linear restoring force. The fluid flow is generated by a uniform, time-periodic velocity field ***V*** far from the body. We emphasize that our result is global, in the sense that no restriction is imposed on the magnitude of ***V***. Moreover, and remarkably, the frequency of ***V*** is arbitrary. Thus, in particular, it can coincide with any multiple of a natural frequency of vibration of the body so that, with this model, resonance cannot occur. Although being based on the classical "invading domains" technique, our approach requires several new ideas. The fixed point of the Poincaré map has to be found in a class of weak solutions, and therefore in the infinite-dimensional framework due to the lack of sufficient dissipation.
 – This is joint work with G.P. Galdi.

Jan Dušek *– Université de Strasbourg, France*

Direct computation of correlations of the solution of a linear and non-linear stochastic equation. Application to an excited hot jet

Philippe Fraunié *– Université de Toulon, France*

Simultaneous perturbations stochastic approximation method applied to the turbulent Ekman marine layer

Giovanni Paolo Galdi *– University of Pittsburgh, USA*

Hopf bifurcation and resonance in a fluid-structure problem

The flow of viscous fluid around structures is a fundamental problem that lies at the heart of the broad research area of Fluid-Solid Interaction. A main feature of this problem regards the study of the oscillations (vibrations) produced by the fluid on the structure and generated by Hopf bifurcation from the equilibrium (steady state) configuration. Of particular significance is the phenomenon of forced oscillation of suspension bridges. When the frequency of the oscillation induced by the fluid approaches the natural structural frequency of the bridge, a resonant phenomenon may occur that could culminate into structural failure. In this presentation we will provide a mathematical analysis of flow-induced oscillations due to Hopf bifurcation, on classical models proposed by the current engineering literature. However, this analysis shows that, at least for the commonly adopted models, a dramatic structural failure cannot be ascribed to Hopf bifurcation only

Julien Guillod *– Laboratoire Jacques-Louis Lions of Sorbonne Université, France*

Sedimentation in buoyancy-driven flow

It seems intuitively obvious that a fluid of variable density will eventually rearrange itself over time towards a density profile where the heaviest fluid is at the bottom. However, this phenomenon is difficult to analyze mathematically. The aim of this talk is to present results along these lines for the system coupling the transport equation for density to the Stokes equation for velocity. Perspectives and numerical simulations will also be presented.
 – Joint work with Antoine Leblond and Anne-Laure Dalibard.

Paolo Maremonti – *Università degli Studi della Campania "Luigi Vanvitelli", Italy*

The Navier-Stokes equations: an estimate of a possible gap related to the energy equality of a suitable weak solution

It is well known that a weak solution *a priori* enjoys an energy inequality. We investigate the existence of a weak Leray-Hopf solution enjoying the energy equality. We are unable to fully prove the result. However, we prove that if there is a possible gap for the energy equality, then the gap can be represented by means of a suitable additional dissipation. This result is an existence result, we do not achieve the result for any Leray-Hopf weak solution.

Andrzej Nowakowski – *University of Sheffield, United Kingdom*

Calculation of pressure and forces in stochastic vortex methods

Ana Radošević – *University of Zagreb, Croatia*

Uniqueness and regularity results for incompressible fluid-rigid body interaction problem

We study a nonlinear moving boundary fluid-structure interaction problem where the fluid flow is governed by 3D incompressible Navier-Stokes equations, while the structure is a rigid body described by a system of ordinary differential equations that capture the conservation of linear and angular momentum. More precisely, we focus on the situation where a rigid body moves within a 3D incompressible Newtonian fluid that is contained in a bounded domain. We prove a generalization of the well-known weak-strong uniqueness and regularity result for the Navier-Stokes equations to the fluid-rigid body system.

– This is a joint work with Boris Muha and Šárka Nečasová.

Gianmarco Sperone – *Politecnico di Milano, Italy*

Homogenization of the steady-state Navier Stokes equations with prescribed flux rate or pressure drop in a perforated pipe

The steady motion of a viscous incompressible fluid in a pipe (perforated with a large number of small holes, which may have different shapes and a non-periodic spatial distribution) is modeled through the Navier-Stokes equations with mixed boundary conditions involving the Bernoulli pressure and the tangential velocity on the inlet and outlet of the tube, while either the transversal flux rate or the pressure drop is prescribed along the pipe. Applying the classical energy method in homogenization theory, we study the asymptotic behavior of the solutions to these systems, without any restriction on the magnitude of the data, as the size of the perforations goes to zero and show that the effective equations remain unmodified in the limit. The main novelty of the present work lies in the obtainment of the required uniform bounds, which are achieved (in the case of the prescribed flux problem) by a contradiction argument based on Bernoulli's law for solutions of the stationary Euler equations.

Tong Tang – *Yang Zhou University, China*

Energy equality for the compressible Primitive Equations with vacuum

We study the energy conservation for the weak solutions to the compressible Primitive Equations (CPE) system with degenerate viscosity. We give sufficient conditions on the regularity of weak solutions for the energy equality to hold, even for solutions that may include vacuum. In this paper, we give two theorems, the first one gives regularity in the classical isotropic Sobolev and Besov spaces. The second one state result in the anisotropic spaces. We get new regularity results in the second theorem because of the special structure of CPE system, which are in contrast to compressible Navier-Stokes equations.