Université Claude Bernard Lyon 1

HABILITATION A DIRIGER DES RECHERCHES

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Résumé

This habilitation thesis is devoted to the study of some partial differential equations, with a special emphasis on models arising in Fluid Mechanics. The general question we address here is about how and to which extent the presence of some heterogeneity (variations in density or temperature of the fluid, interaction with the boundary, anisotropy…) affects the dynamics of the fluid. Motivated by Physics, we perform our study in a low regularity framework.

The manuscript is composed of three main parts.

In the first one, we study linear hyperbolic operators having variable, low regularity coefficients. We prove several well-posedness results with and without loss of derivatives, for coefficients having lower regularity than the Lipschitz one.

In the second part, we focus on non-linear models related to fluid mechanics and address the question of their well-posedness. We deal with weak solutions, strong solutions at critical regularity and statistical solutions. We are interested in several questions, depending on the specific model under consideration: for instance, the description of the dynamics of interfaces, or questions linked with turbulence theory, or the attainment of suitable bounds on the lifespan of the solutions.

In the third and last part, we continue the study of models from fluid mechanics, but from the angle of singular perturbation problems. We focus on systems describing the dynamics of geophysical flows: our aim is to rigorously derive, by tools from asymptotic analysis, reduced models in some physically relevant regimes. We perform the low Rossby number (fast rotation) limit for nonhomogeneous (compressible and incompressible) fluid flows, for a wide range of the scaling parameters.