Research program:
"Algebraic and geometrical methods for the study of fluids"

Annex C

Department of Department of Management Engineering, information and production

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Description

In the study of stratified fluids one has to face various problems related to the presence of nonlinear phenomena and dispersive terms in the equations of motion. If the fluid is constrained to move in a channel and the density is variable on the lower or on the upper lid, further complications arise. For example, additional terms appear in the evolution laws of total momentum and total vorticity. In this research project we plan to study another interesting consequence of the variability of the density on the lids, namely the need to modify the Hamiltonian structures of the system. The candidate will start to analyze the long-wave approximation, which consists in ignoring the dispersive terms. The equations obtained in this case admit, in general, well-known Hamiltonian structures, called "structures of hydrodynamic type", and closely related to geometric objects known as "Frobenius varieties". A first target will be to use these geometric structures to obtain information on the dynamics of stratified fluids. A second objective will be to determine the properties of the complete – dispersive – system from the Frobenius variety associated to the long-wave approximation. This analysis involves, in particular, the study of deformations of the Hamiltonian structures of hydrodynamic type in new Hamiltonian structures, containing dispersive terms and thus potentially useful in the study of fluids with variable density. The important class of systems associated with affine Lie algebras will be considered as a guiding example.