SUMMARY OF Ph.D. DISSERTATION

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Title

Initial-Boundary Value Problems for Motion of Inhomogeneous Incompressible Fluid-like Bodies

In this dissertation, initial-boundary value problems for the motion of inhomogeneous incompressible fluid-like bodies (IIFB) are studied.

In order to describe a dense and slow flow of granular materials, the IIFB model has been introduced by the use of continuum approximation, which is considered to be physically plausible. Their motion is determined by the basic conservation laws of mass, linear momentum and angular momentum under the isochoric process. In addition to them the constitutive equations that the stress depends also on the gradient of the density are adopted. This dependence implies a quite important property of the granular matter due to the material inhomogeneity unlike the classical Navier-Stokes fluids.

The model equation under consideration is the coupled system of the first- and the second-order partial differential equations with respect to the density, the pressure and the velocity vector field of the body. In virtue of its incompressibility, the transformation from the original problem in Eulerian coordinate system to the problem in Lagrangian coordinate system is effective. From this transformation the system of the first- and the second-order quasi-linear partial differential equations with respect to the pressure and the velocity field is deduced.

Here, we are concerned with the initial-boundary value problems of the system of equations mentioned above. Concerning the boundary conditions we assign both the usual adherence condition and the generalized Navier's slip boundary condition. It should be remarked that the slip phenomena are quite important for the granular flows.

For such problems mentioned above the unique time-local solvability is proved in Sobolev-Slobodetskii spaces. First, the existence theorems for their linearized problems with constant coefficients are proved and the norm estimates are derived in weighted Sobolev-Slobodetskii spaces in both the half space and the whole space by the use of Fourier-Laplace transformation. Second, applying the regularizer method, we generalize the results to the linearized problems in a bounded domain. Then, by using these estimates, the time-local existence theorems of the quasi-linear problems are established by the successive approximation method.