The finite mass method

Harry Yserentant
Mathematisches Institut der Universität Tübingen
Auf der Morgenstelle 10, 72076 Tübingen, Germany
e–mail: `yserentant@na.uni-tuebingen.de`

The Lagrangian form of description of fluid flow can have many advantages. For example, there are no problems with free surfaces, and no convection terms arise. Such features make numerical methods based on the Lagrangian view especially attractive for free flows in unbounded space. In fact, some of the most popular methods of this type have its origins in astrophysics. In this talk, the finite mass method, a new Lagrangian method for the numerical simulation of gas flow and other problems of continuum mechanics, is presented and analyzed. In contrast to the finite volume and the finite element method, the finite mass method is founded on a discretization of mass, not of space. Mass is subdivided into small mass packets of finite extension each of which is equipped with finitely many internal degrees of freedom. These mass packets move under the influence of internal and external forces and the laws of thermodynamics and can undergo arbitrary linear deformations. Second order convergence has been proven for motions in external force and velocity fields and for the acoustic equations which result from a linearization of the Euler equations around a constant state. For the full Euler and Navier–Stokes equations, limits exist which satisfy the basic physical principles underlying these equations and can, in this sense, be regarded as solutions of these equations.