# ABOUT CONTINUOUS AND DISCRETE MARKERS FOR FREE SURFACE FLOWS

Burago N.G. (IPMech RAS, Moscow, RF)

Detailed history of marker techniques is highlighted in [1]. Here we share our own experience [2] in application of continuous and discrete marker techniques to modelling of fluid flows with moving free boundaries. The marker techniques are implemented on the basis of variational framework of 3D unsteady Navier-Stokes equations and finite element method.

In first approach the continuous marker-functions are used in order to track free boundaries motion. The marker-function is equal to unity for fluid and to zero for empty space. The marker-function is subjected to the transport equation. Isosurface with marker-function value of 0.5 represents moving free boundary. Advection velocity is detected by using its values in the eulerian grid nodes with marker-function values > 0.5. Boundary conditions at free moving boundaries are satisfied approximately and it results in violation of conservation laws for mass, momentum and energy. Therefore for restoration of mass conservation we use special correction procedure for marker-function in the vicinity of the free surface. This procedure produces also antidiffusion effect in order to avoid smearing of marker-function at free boundaries.

In second approach the moving free boundaries are tracked by discrete markers In order to simulate long time processes with open inflow and outflow boundaries the markers may be added and removed during calculation.

The following results are presented: 1) a drop falling into basin with water, 2) fluid flow from second to first floor through a hole; 3) water column destruction and water waves in closed basin; 4) Fountain and puddle from vertical jet; 5) horizontal jets falling into basin with water and others. The comparison with known results are also done.

The specific set of test problems for marker technique are discussed in addition to known tests for Navier-Stokes flows. For example, in addition we have checked the mass conservation in time for pots partly filled with water, for falling drops during long time and for some other cases. Such tests are not trivial and serve to effectively reject unsuitable algorithms.

## References

1. Burago N.G., Kukudzhanov V.N. A Review of Contact Algorithms. Mechanics of Solids. 2005. N. 1. P. 44-85. (draft: http://www.ipmnet.ru/~burago/papers/cont-e.pdf)

2. Burago N.G. Numerical solution of problems with moving interfaces. Dr. Sci. thesis. Moscow: IPMech RAS, 2003. 222 p. ( http://eqworld.ipmnet.ru/ru/library/books/dis_Burago_Doc2003.pdf)