CSPH&VD$^3$: The massive-parallel load balancing code for smooth-particle-hydrodynamic modeling of materials in extremes

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Application of well-known parallel algorithms for Lagrangian methods like SPH based on static computational area decomposition leads to weak computational resources balance as the algorithms ignore spatial medium redistribution in problems with free surfaces, continuity losses, and high energy density media flows. To overcome the limitation we developed a high-effective parallel program complex CSPH&VD$^3$ (Voronoi dynamical domain decomposition), which uses dynamic decomposition of modeled samples among computational units (CU) according to distribution of the Voronoi diagram cells built upon the samples [1].

Modeling example of a problem with significant surface shape dynamics and highly inhomogeneous spatial density distribution shows a highly effective resources utilization comparing to static domain decomposition. Tests are provided which prove convergence of VD$^3$ algorithm for systems with initial load imbalance with number of particles up to $10^8$ distributed among up to $10^3$ CU. Almost perfect linear scalability of VD$^3$ is demonstrated.