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Computer modeling of astrophysical processes in three-dimensional statement of the very large resolution grids using GPU

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Computer simulation of gas-dynamic processes during the interaction of shock waves of great intensity, with different objects is the main objective of the study in this paper. Such problems arise when modeling engines for hypersonic aircraft, the study of their external aerodynamics, the study of the processes occurring during the collapse supernovae, the interaction of shock waves with the protoplanetary matter, etc. In astrophysics, major roles are played by different processes, which are very different in size and timeline, often the initial and boundary conditions are not well known. Therefore, it is very difficult to get a really realistic model that takes into account all the physical processes. A detailed study of such processes can only be performed on grids with a very large resolution and using differential methods of high resolution. In this work, computer modeling of gas-dynamic processes is carried out on a rectangular three-dimensional Eulerian grid very large resolution. The solution algorithm is based on the schemes of the high resolution type TVD and allows us to implement parallelization on multi-core processors and graphics accelerators Kepler and Maxwell. The results of modeling the interaction of shock waves of varying intensity with fragmented cloud of molecular gas are discussed. It is shown that the use of graphics accelerators can significantly speed up computations on grids with a resolution of more than 10^8 cells.

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A nozzle for vectorized thrust

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Air-jets, laterally injected into a high-speed flow through axisymmetric convergent–divergent nozzle are investigated to present the effects of the air thrust vectoring within the framework of an innovative propulsive system. The very complex 3D flow field parameters distribution and character aerodynamic features were studied. For the purposes of the numerical analysis, fluent code with additionally implemented user-defined file is applied. Different nozzle geometries, models with injected high-speed lateral streams are numerically simulated to determine how parameters and flow conditions affect the thrust vectoring. Valuable experimental data were compared with the results obtained from the numerical simulations. The laterally injected air-jets are an innovative concept for thrust vectoring that could has various applications in practice.

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