Developments of astrophysical simulation laboratory

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As a three-year project supported by research and developments applying advanced computational science and technology, Japan Science and Technology Corporation, we are developing a "Net-laboratory system for astro/space simulations". In this talk, we introduce the astrophysical simulation laboratory. One of the contents of this laboratory is the "Astrophysical Rotating Plasma Simulator" by which we can carry out three-dimensional global simulations of shear-rotating astrophysical plasmas. We are incorporating nested-grid schemes, adopted grid schemes, and general relativity into the simulator and developing modules which virtually "observe" the simulation results. We are also making a web page which introduces basic astrophysical simulations for beginners.

As a three-year project supported by research and developments applying advanced computational science and technology, Japan Science and Technology Corporation (ACT-JST), we are developing a "Net-laboratory system for astro/space simulations". The purpose of this project is to develop a virtual laboratory of astrophysical/space simulations. In this talk, we introduce the astrophysical simulation laboratory.

The astrophysical simulation laboratory consists of the simulation code library, graphical user interface to the simulator, data analysis tools of simulation results, and simulation result database. The platform of the simulation code is a three-dimensional magnetohydrodynamic code by explicit, finite differencing scheme. Various modules such as time advancement (simulation engine), initial conditions, boundary conditions, physical processes (e.g. magnetic diffusion, thermal conductivity, self-gravity) can be plugged-in to the platform. By using a web-based graphical user interface, we can input simulation parameters, select boundary conditions, and control simulations. Real-time monitoring of simulations is supported by using visualization softwares. Data analysis library includes time-sequence analysis of simulation results, spacial structure analysis, and radiative transfer modules to "observe" the simulation results. Simulation result database includes numerical data, information on simulation codes, manuals, and images and movies of simulation results. We are preparing tomake this database accessible through internet.

One of the contents of the astrophysical simulation laboratory is the Astrophysical Rotating Plasma Simulator (ARPS) by which we can carry out global three-dimensional magnetohydrodynamic simulations of shear-rotating astrophysical plasmas. In ARPS, in addition to the simulation engine based on the modified Lax-Wendroff scheme, we are installing new simulation engines based on CIP-MOCCT scheme and Roe scheme. We are incorporatingnested-grid schemes and adopted-grid schemes to the simulator. Based on the simulation code using generalized coordinates, general relativistic codes are now under construction.

We are also making a web page which introduces simulation methods, simulation codes and simulation results for basic astrophysical simulations such as one-dimensional shock propagation, one-dimensional dynamics of thermally conducting fluid, transonic flow, propagation of magnetohydrodynamical waves in gravitationally stratified atmosphere, contraction of self-gravitating interstellar clouds, and general relativisticaccretion flows.

We present simulation results obtained by using ARPS, web-based user interface, and the web page on the basic astrophysical simulations.