Analysis on generation and maintenance mechanisms of the magnetic field in case 1 of the numerical dynamo benchmark

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We will present some results of analyses about the generation and maintenance mechanisms of the magnetic fields under the condition of case 1 of the numerical dynamo benchmark defined by Christensen et al. (2001).

In recent years, three-dimensional simulations of MHD dynamo in rotating spherical shells have been carried out vigorously. For the purpose of performance comparison and verification among the numerical codes, a set of reference solutions are presented as the numerical dynamo benchmark (Christensen et al., 2001, hereafter referred to as the benchmark).

However, it seems that detailed analyses on the generation and maintenance mechanisms of the magnetic fields of the reference solutions presented in the benchmark have not been well performed. Kageyama and Sato (1997) and Olson et al. (1999), for instance, argue on the generation and maintenance mechanisms of the magnetic fields and on the equilibrium states. However, the reference solutions of the benchmark are different from those discussed by those papers in the sense of spatial structures and temporal variations. Most of the numerical calculations of the more recent studies have been performed with the parameter values which give the solutions of the larger temporal variabilities. It is even more difficult to obtain an intuitive understanding on the generation and maintenance mechanisms of the magnetic fields.

On the other hand, the reference solutions of the benchmark are quasi-steady. It is convincing to expect that the details of the dynamical structure of the solutions can be pursued. Moreover, understanding of the quasi-steady solutions may be useful in recognizing more unsteady solutions obtained by other numerical simulations.

We carry out numerical simulations under the benchmark configuration by the use of our own numerical model. We present some results of analyses on the structures of solutions, especially, generation and maintenance mechanisms of the magnetic fields.

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