MHD Relaxation with Flow in a unit Sphere

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We investigate a relaxation process in a unit sphere of an electrically conducting fluid by computer simulation. We solve the magnetohydrodynamics(MHD) equations in a full sphere, including the origin at the radius r = 0, with a newly developed spherical grid system, Yin-Yang-Zhong grid (Hayashi and Kageyama, J.Comput.Phys., 2016). In the classical theory of the MHD relaxation by Woltjer and Taylor, flow in a relaxed state is supposed to be absent. On the other hand, we study relaxed states with flow. The boundary is a perfectly conducting, stress-free, and thermally insulating spherical wall. Under these conditions, the angular momentum is conserved as well as the total energy. Starting from a simple and symmetric state in which a ring-shaped magnetic flux without flow, a dynamical relaxation process of the magnetic energy is numerically integrated. The relaxed state has a characteristic structure of the flow field with four vortices. The Reynolds number Re and the magnetic Reynolds number Rm is the same: Re = Rm = 8600.

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