Nonlinear solution of magnetostrophic dynamo

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The fundamental dynamical state of the Earth's fluid outer core is believed to be magnetostrophic; that is, balance between the Coriolis force, the Lorentz force, the buoyancy force and the pressure gradient is nearly kept and the other inertial and viscous forces are negligible. This balance puts a constraint on the magnetic field structure inside the core known as the Taylor's constraint, which yields the axial torque exerted by the Lorentz force on the cylinder co-axial to the rotation axis is zero. Torsional oscillations about this Taylor state have been considered as a candidate for explaining decadal variations of the Earth's rotation. There may be two approaches to understand the fundamental state of the core. One is to solve the full equations numerically and simulate a state in which the inertial and viscous forces are negligibly small. This approach has been widely taken in recent large-scale computer simulations of the geodynamo. Another approach may be possible by solving a reduced equation of no viscosity and no inertia directly. In this case, nonlinear partial differential equations governing velocity and magnetic fields are solved by some iteration methods. Here I reconsider the latter problem and present some preliminary results. Efforts are made to seek a steady solution for a magnetostrophic dynamo operating in a rotating fluid box. I explain algorithms for solving nonlinear equations and discuss feasibility of this approach.