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Numerical study of dynamo action generating equatorially asymmetric magnetic fields

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The geomagnetic field is apparently asymmetcic with respect to the equator. It is because that the geomagnetic field consists of the equatorially anti-symmetic and symmetric components. The anti-symmetic component is referred to as the dipole family, while the other is to the quadrupole family. Theoretically, the magnetic field of diffrent family is linealy independent if the velocity field consists solely of the equatorially symmetric conponent, which is supposed to be dominant in the Earth's core. On the other hand, a slight devition in the velocity field from the equatorial symmetry by superimposng the anti-symmetic component often results in a substantially asymmetic magnetic field due to non-linear coupling between the velocity and magnetic fields. It is still unclear how the asymmetic magnetic field is established by a dominantly symmetic velocity field with a slightly anti-symmetic component, and how it evolves with time.

Here, we use numerical dynamo modeling to examine effects of the non-linear coupling between the dipole and quadrupole families on the resultant magnetic field. For this purpose, we perform two dynamo runs at the same parameters, where the initial conditions are designed to yield a dynamo solution of the purely dipole family magnetic field, and that of the mixed-family magnetic field. Consequently it is found that the critical Rayleigh number for self-sustaining dynamo action is different for these solutions. Strength and morphology of the mangetic field are also different in some cases. Results of preliminary analysis will be discussed in this presentation.

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