Anomalous is normal in planetary dynamos: A case of Mercury

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Recent satellite missions to planets and moons have discovered huge diversity in planetary magnetic fields. In particular, Hermean magnetic field is unambiguously different from the geomagnetic field in many respects. The most striking feature of the Hermean magnetic field is the north-south asymmetric morphology discovered by the MESSENGER mission. Such an asymmetric field is expressed by an axial dipole offset from the center of the planet by 0.2 planet’ s radius, whereas the geomagnetic field at the Earth’ s surface is well approximated by the geocentric axial dipole. Since the planetary magnetic field is generated in the outer core, such a notable difference in morphology should be explained by that in the dynamo action.

Here we use numerical dynamo models to see why Mercury has such an anomalous magnetic field. In the model, convection is thermocompositionally-driven in the liquid core with a thermally stably stratified upper layer. The present models well produce the magnetic field similar to observations. The dynamo-generated magnetic fields force the flows via the Lorentz force to interact so as to break the equatorial symmetry. As a consequence, core flows have significantly north-south asymmetric helicity, resulting in the maintenance of the asymmetric magnetic field due to biased dynamo action. This symmetry breaking magnetic self-regulation causes the flow to generate and maintain the Mercury’ s axially offset dipolar field. The result indicates that the Mercury’ s anomalous magnetic field is a natural consequence of the dynamo mechanism in the core.

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