Title: "Initial conditions, chaotic branching and feeback-stabilization in numerical dynamos"

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Abstract:

Due to its weak dipole field, Mercury exhibits a close magnetopause and is thus subject to strong magnetospheric fields caused by the magnetopause currents. At the surface, such fields have a magnitude comparable to that of the planetary internal field. It has been suggested that the behavior of planetary dynamos in the presence of external magnetic field sources may differ from the solutions found for isolated dynamos. Therefore, Mercury's dynamo is likely to be affected by the field at the core-mantle boundary (CMB) by the magnetospheric currents.

We present results from a numerical study, that shows how initial conditions and external field sources (i.e., a magnetospheric feedback) affect the stability of dynamo solutions. For the initialization of the magnetic field, we use a seed-field with toroidal and poloidal components. For weak convective forcing (slightly supercritical Rayleigh numbers) and moderate magnetic diffusivities (viscous to magnetic diffusivities ratio of Pm=2/3), the dynamo reaches a saturation of magnetic field (a strong field solution) for strong seed-field values. However, it may also reach a weaker stable solution (a weak field solution) when weak seed-fields are used. In general, the magnetic energy of the weak seed-field is at least one order of magnitude lower than the energy of the strong-field branch.

The magnetospheric feedback is such that magnetopause currents induce an axisymmetric dipole at the CMB that is always anti-parallel to the internal dipole providing a negative feedback on the dynamo, which we use for our implementation. We found that external fields can significantly modify the evolution of the weak seed-field dynamos. In contrast, solutions with strong seed-fields are not significantly affected by the external sources.

We have found that a magnetospheric feedback may be important for dynamos with weak dipole fields and weak convection strength. Such weakened dipole fields may be found for example at dipole polarity reversals. Alternatively, the weak dipole field may have occurred at the initiation of the dynamo (e.g. a non-dipolar seed field). Dynamos of planets with short orbital distances are subject to intense solar winds, and thus they are susceptible to a control of the dynamo field by the magnetospheric feedback.