

Space Studies of the Earth-Moon System, Planets, and Small Bodies of the Solar System (B)
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INFLUENCE OF AN EXTERNAL FIELD ON A SELF-SUSTAINED DYNAMO: AN APPLICATION TO MERCURY

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Confirming measurements made by Mariner 10 more than thirty years ago, MESSENGER found a measurable internal magnetic field at Mercury that appears to be independent of the strong solar wind to which the planet is continuously subjected. This field may originate, as for other solar system planets and the Sun, by dynamo action in an electrically conductive fluid interior layer. Although a variety of explanations have been proposed for Mercury's weak dipole field strength – which cannot easily be explained with Earth-like dynamo models – the interaction of the planetary field with its own magnetosphere may play an important role in determining the magnetic field-generation regime. Recent studies, e.g., by Glassmeier and others, have explored the possibility of an external magnetic field interacting with the dynamo process, a process called a *feedback dynamo*. To study the dynamics of such a feedback dynamo, the algorithm of Wicht has been modified to include the diffusion of an external field through an electrically conductive core. Two situations are considered: first, a constant field aligned with the planetary angular momentum and opposing the direction of the averaged dipole moment; second, a field with the same direction as the first but with a magnitude proportional to the axisymmetric dipole energy at the outer boundary of the modeled dynamo. In the first case, with an external field 100 times smaller than the dynamo-generated field the dominant dipole reverses, resulting in an alignment of the dipole moment with the imposed field over approximately one magnetic diffusion time. In the second case, the imposed field reduces significantly the dipolar contribution, resulting in a highly multipolar surface field. The strength and overall character of dynamo-generated fields may thus be significantly affected by the influence of the imposed field, even one two orders of magnitude weaker than the dynamo-generated field. If convection in Mercury's outer core extends outward to the top of the core, the influence of an external field on Mercury's dynamo cannot be neglected.