Astrophysical Dynamo Action

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Dynamo action describes the sustained conversion of kinetic energy into magnetic energy within the bulk of an electrically conducting fluid. It is commonly invoked to explain the origin of astrophysical magnetic fields.

Since its inception in the first half of the last century, dynamo theory – the mathematical description of dynamo action – has grown into a substantial body of work. In this talk, I shall review the present state of dynamo theory in astrophysics; the extent to which it succeeds in explaining the origin of cosmic magnetic fields, and what open issues remain.

I shall introduce several different dynamo scenarios that differ in underlying physics, and mathematical structure. In particular I shall discuss large- and small-scale dynamo action, fast and slow dynamos, and dynamos driven by both rough and smooth velocity fields.

In each case I will emphasize which issues arise from the linear (kinematic) part of the dynamo problem and which arise from the non-linear aspects of dynamo generation.