

# Re-examination of dynamo action by fluid motion with two-dimensional periodicity

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Recently many MHD dynamo simulations have exhibited, and some of them has shown virtual magnetic fields similar to real Earth's one. The simulated results, however, are not interpreted sufficiently. One of reasons is insufficient understanding of kinematic dynamo problems. We consider that 'insufficient understanding' derives from understanding relied on only the alpha-effect in past kinematic studies. Ordinary alpha-effect is a concept explaining in the case of small  $Rm$ , where  $Rm$  is magnetic Reynolds number, so it is not clear whether alpha-effect is also appropriate for large  $Rm$  which is important case because  $Rm$  is  $O(10^2)$  in Earth's outer core.

The purpose of our study is to re-examine kinematic problems from a view point whether interpretation by alpha-effect is appropriate or not.

We re-examine a kinematic dynamo problem by fluid motion with two-dimensional periodicity, which is first considered by G.O. Roberts (1970, 1972). The motion is a motion simplifying the columnar convection in the Earth's outer-core (c.g. Busse, 1970). G.O. Roberts showed the flow on infinite plane has an effective dynamo action even though it is very simple. He, however, showed only that a part of solutions for small  $Rm$  was understood by the alpha-effect, and he has not touched solutions for large  $Rm$  which case is close to outer core.

We attempt an examination whether the interpretation by alpha-effect is appropriate, based on the mean-field theory which defines alpha-effect. The result is that it is not appropriate that solutions are understood in terms of alpha-effect, since in large  $Rm$  the mean-field theory does not define alpha-effect.