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非等方熱拡散の空間依存性とその地球コアダイナミクスへの影響
Spatial dependence of anisotropic thermal diffusivity and its influence on dynamics in the Earth's core

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Small-scale fluid motions in the Earth's core are likely to be highly anisotropic because of rapid rotation of the Earth and a strong magnetic field in the core. We have carried out direct numerical simulations of rotating magnetoconvection to investigate the effect of anisotropic diffusivity on dynamics in the Earth's core, as one of pilot studies. When a computational region is expressed in terms of a rectangular box with periodic boundaries in the three-directions, the prescribed anisotropic thermal diffusivities were found not to influence the character of rotating magnetoconvection, such as kinetic and magnetic energies averaged over the computational region. When a computational region is expressed in terms of a rectangular box with rigid boundary surfaces perpendicular to the gravitational direction, the prescribed anisotropic thermal diffusivities have a significant effect on the character of rotating magnetoconvection; that is, kinetic and magnetic energies can be increased even by a small anisotropy. The degree of increase depends on the direction of anisotropy and the direction of gravity corresponding to location of the computational region. These results suggest that anisotropic thermal diffusivity insignificantly influences dynamics in the bulk of the core, but that it should be effective near rigid boundary surfaces. Therefore, it is likely that anisotropic diffusivity has a more significant effect on MHD dynamos in rotating thin spherical shells. Such an implication can be examined through global numerical simulations of MHD dynamo models with anisotropic diffusivity being variable in the core.

Instead of such a study, we perform further direct numerical simulations of rotating magnetoconvection by prescribing anisotropic thermal diffusivities with spatial dependence; for example, in one case, anisotropic thermal diffusivities are presumed to be effective only near rigid boundary surfaces; in another case, anisotropic thermal diffusivities are presumed to be effective only far from rigid boundary surfaces. Hence this is another pilot study. Kinetic and magnetic energies in the former case seem to be larger than those in the latter case. The result is consistent with that obtained in our previous studies.

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