Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SIT03-20 Room:106 Time:May 26 10:15-10:30

On the origin of a stably stratified layer below the CMB inferred from dynamo models

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The geodynamo is powered by the two agents, thermal and compositional buoyancy. The former is fueled by secular cooling of the Earth and/or latent heat upon solidification of the inner core, while the latter is by release of the light elements at the inner core boundary with inner core growth. Since these two buoyancy sources should behave differently due to the vast difference of their diffusivity based on the molecular values, double diffusive convection would occur in the Earth's core.

Apart from double diffusive convection, it is inferred from seismic observations that there is a thin stably stratified layer of O(100) km below the core-mantle boundary. However, it is not well constrained whether the origin of stable stratification is thermal or compositional. Here we investigate effects of a stable layer on dynamo action driven by double diffusive convection. Stably stratified layer is imposed by giving a sub-adiabatic temperature gradient. Thickness of the stable layer is assumed to be 10 % of the core radius. It is found that strength of the dynamo-generated magnetic field is significantly reduced by the thin stable layer in case of dipolar dynamos. On the other hand, the magnetic field is strengthened with the stable layer in case of weak multi-polar dynamos, consistent with a previous study. We discuss mechanisms responsible for such a difference and implications for the origin of the stably stratified layer.

Keywords: dynamo, core, stable stratification, double diffusive convection