

Solar energy transport with significantly suppressed velocity

*Shota Arai¹, Hideyuki Hotta¹

1.Astrophysics Laboratory , Department of Physics , Faculty of Science , Chiba University

We carry out a series of 2D convection calculations with highly suppressed velocity. Thermal convection in the solar interior is thought to maintain differential rotation and meridional circulation. Although the solar equator is rotating faster than polar region, recent high-resolution calculations with solar parameters accelerate the pole. This problem can be attributed to over-excited thermal convection in numerical calculations. Local helioseismology also supports this finding. Recent MHD simulations suggest that the small-scale Lorentz force is able to suppress the convection velocity, but the suppression is not enough and has not been numerical converged, i.e., higher resolution shows stronger suppression.

In this study, we assume that the Lorentz feedback in extremely high resolution, i.e., the sun, becomes stronger enough to explain equator acceleration and the result of the local helioseismology. In order to investigate this extreme condition, we carry out series of 2D hydrodynamics simulations with high viscosity mimicking the strong Lorentz force. The purpose of our research is to investigate energy flux transported by the thermal convection. Even if the velocity is reduced, convection needs to transport imposed energy flux at the bottom boundary. Generally it is expected that upflow and down flow become hotter and cooler, respectively than those without viscosity. We also find that the correlation becomes better with high viscosity with suppressing the small-scale chaotic motion.

Keywords: Sun, Thermal convection, Magnetic field