Correct reproduction of solar differential rotation in high-resolution simulation with Fugaku

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We carry out high-resolution simulations in supercomputer Fugaku to understand the generation mechanism of the solar differential rotation.
The sun is rotating differentially with the slow pole and the fast equator. While the observation for the solar differential rotation has a long history from the 1600s, we still do not understand the maintenance mechanism of the solar differential rotation. The anisotropic turbulence in the solar convection zone is thought to generate the differential rotation. Recent high-resolution simulations fall into the anti-solar differential rotation regime, i.e., the fast pole and the slow equator. The reason why we cannot reproduce the solar differential rotation is that the numerical simulation tends to show fast convection.
In order to deal with this problem, we carry unprecedentedly high-resolution simulations with supercomputer Fugaku. We optimize our R2D2 code especially for Fugaku to obtain the best performance in the supercomputer. Using the optimized code, we carry out the high-resolution simulation with more than 5 billion grid points and we for the first time reproduce the solar differential rotation without using any artificial technique. In the simulation, the magnetic field becomes unexpectedly strong and suppresses the convection. As a result, the convection generates the solar differential rotation correctly. The new simulation totally changes our view of the solar convection zone.

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