Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Wavelet-based regularization of the Galerkin truncated three-dimensional incompressible Euler equations[1] MARIE FARGE, CNRS-INSMI, LMD-IPSL, Ecole Normale Superieure-PSL, 24 rue Lhomond, NAOYA OKAMOTO, Center for Computational Science, Nagoya Univ. , KAI SCHNEIDER, I2M-CNRS, Centre de Mathematiques et d'Informatique, Aix-Marseille Univ. , KATSUNORI YOSHIMATSU, Institute of Materials and Systems for Sustainability, Nagoya Univ.

— We present numerical simulations of the three-dimensional Galerkin truncated incompressible Euler equations that we integrate in time while regularizing the solution by applying a wavelet-based denoising. For this, at each time step, the vorticity field is decomposed into wavelet coefficients, that are split into strong and weak coefficients, before reconstructing them in physical space to obtain the corresponding coherent and incoherent vorticities. Both components are multiscale and orthogonal to each other. Then, by using the Biot–Savart kernel, one obtains the coherent and incoherent velocities. Advancing the coherent flow in time, while filtering out the noise-like incoherent flow, models turbulent dissipation and corresponds to an adaptive regularization. In order to track the flow evolution in both space and scale, a safety zone is added in wavelet coefficient space to the coherent wavelet coefficients. It is shown that the coherent flow indeed exhibits an intermittent nonlinear dynamics and a $k^{-5/3}$ energy spectrum, where k is the wavenumber, characteristic of turbulent flows. Finally, we compare the dynamical and statistical properties of Euler flows subjected to dissipative, hyperdissipative, dispersive (Euler-Voigt) and wavelet-based regularizations.

[1]This work was partially supported by JSPS KAKENHI Grant Number (S)16H06339, (A)2524701 and (C)17K05139. MF and KS acknowledge support by the French Research Federation for Fusion Studies within the framework of the European Fusion Development Agreement.

Kai Schneider
Aix-Marseille Universite

Date submitted: 27 Jul 2017 Electronic form version 1.4