Wissenschaftskolleg zu Berlin

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Born in 1953 in Paris

Studied Engineering at Stanford University, Physics at Université Paris VII, and Mathematics at Université Paris VI

PROJECT

Wavelets and Turbulence

I plan to complete the book entitled Wavelets and Turbulence that Cambridge University Press has asked me to write. Turbulence is an open problem for both mathematics and physics, having a lot of applications in engineering. Wavelet theory is a new branch of harmonic analysis that I use to analyze, compute and model turbulent flows.

Recommended Reading

Farge, Marie. 1986. "L'approche numérique en physique." Fundamenta Scientiae 7, 2: 155-175

Farge, Marie. 1992. "Wavelet transforms and their applications to turbulence." Ann. Rev. Fluid Mech. 24: 395-457.

Farge, Marie and Kai Schneider. 2006. "Wavelets: application to turbulence." Encyclopedia of Mathematical Physics, eds. J. P. Françoise, G. Naber and T. S. Tsun, 408-419. Oxford: Elsevier.

COLLOQUIUM, 16.02.2010

Can we predict turbulence?
In which sense and how?

Turbulence is a physical phenomenon that affects daily life in a wide variety of time and space scales (e.g., blood flow in the heart, cyclones in the atmosphere, magnetic fields of Earth and Sun). Turbulence is a state of flows that is characterized by a chaotic and intermittent behaviour. Although the fundamental equations of fluid dynamics were derived more than three hundred years ago by Leonhard Euler, after Frederic the Great seeked advice from him for the fountains of Sanssouci, it has not yet been proven that their solutions exist when the fluid flow becomes turbulent. This is one of the seven "Millenium Prize" problems of pure mathematics, which were announced in the year 2000 as a follow-up to the 23 problems that Hilbert proposed in 1900 for the twentieth century. The difficulty arises from the highly nonlinear behaviour of turbulent flows, that hinders predicting their evolution. Turbulence is still an open problem of classical mechanics that mathematicians, physicists and engineers tackle by performing both laboratory and numerical experiments. One performs experiments by directly solving the equations using supercomputers and looks for ways of solving them more efficiently. Among those the wavelet representation allows one to grasp at once all the scales where the nonlinear dynamics is active. Wavelets were invented in 1984 by Alex Grossmann (a theoretical physicist working on quantum mechanics) together with Jean Morlet (an engineer working for petroleum exploration). It is now a new branch of mathematics that has been developing very quickly and has already entered daily life (e.g., JPEG 2000 for image compression). This new multiscale viewpoint may offer a useful intellectual tool to study problems, even beyond natural sciences.

Farge, Marie (2020)

Farge, Marie (2017)

Scholarly publishing and peer-reviewing in open access

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=892666498

Farge, Marie (2012)

On helical multiscale characterization of homogeneous turbulence

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=766142779

Farge, Marie (2012)

Scale-wise coherent vorticity extraction for incomplete statistical modelling of homogeneous isotropic two-dimensional turbulence

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=766135446

Farge, Marie (2011)

Coherent vorticity simulation of three-dimensional forced homogeneous isotropic turbulence

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1029467951

Farge, Marie (2011)

Extraction of coherent geomagnetic structures in a geomagnetically induced current event using wavelets

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1029465126

Farge, Marie (2011)

On the role of vortical structures for turbulent mixing using direct numerical simulation and wavelet-based coherent vorticity extraction

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=766138739

Farge, Marie (2011)

The Lighthill - Weis-Fogh clap-fling-sweep mechanism revisited

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=766137449

Farge, Marie (Ridge, NY,2011)

Energy dissipating sturctures in the vanishing viscosity limit of 2D incompressible flows with boundaries

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=757645348

Farge, Marie (2011)

Coherent vorticity extraction in resistive drift-wave turbulence : comparison of orthogonal wavelets versus proper orthogonal decomposition

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=757644600