3MS: Mathematics of Multiscale Modeling and Simulation

Bernard Geurts Networking Day, 2024-09-16

Inspiration from Nature



Mathematics of Planet Earth MPE Virtual Physiological Human VPH

Energy transition Seasonal Storage

How does mathematics operate at 3MS? Goethe:

#324. It is not enough to know, we must also apply;

It is not enough to will, we must also do.

How does mathematics operate at 3MS? Goethe:

#324. It is not enough to know, we must also apply;

It is not enough to will, we must also do.



Applications

Focus on mathematics is illustrated with a variety of applications



VPH-Aneurysms

Radboud



NWO WAX+

TUE



PathFinder-ThermoDust

3D-printing - EU

3MS Team

- Lena Caban (UT/CUT)
- Paolo Cifani (now GSSI)
- Wouter Edeling (UT/CWI)
- Sagy Ephrati (now Chalmers)
- Arkadiusz Kuczaj (UT/PMI)
- Erwin Luesink (now UvA)
- Alexey Lyulin (UT/TUE)
- Wessel Wits (UT-fellow, NLR)

- Andrzej Boguslawski (CUT)
- Darryl Holm (ICL)
- Davoud Jafari (UT)
- Klas Modin (Chalmers)
- Mashabalesh Shettar (India)
- Artur Tyliszczak (CUT)

- Olena Bezdietko
- Viktoriia Bezugla
- Maarten Boomstra
- Arnout Franken
- Noortje van Goor
- Hyunjong Lee
- Kevin Redosado Leon
- Rensley Meulens
- Stijn de Wit

3MS is part of the SACS cluster at AM

Computational Engineering Mathematics (CEM)

3MS Research Areas

Numerical Mathematics

High-performance computing

Deterministic and stochastic PDE modeling

3MS Research Areas

Numerical MathematicsStructure-preserving discretisation
Geometric integration
Uncertainty quantificationHigh-performance computingAlgorithms - Neuromorphic
Quantum computing
OO - Reusability - eScience

Deterministic and stochastic PDE modeling Geometry, Symmetry, Reduction Coarsening nonlinearity Turbulence, Regularisation

3MS Research Areas

Numerical Mathematics

Structure-preserving discretisation Geometric integration Uncertainty quantification

High-performance computing

Algorithms - Neuromorphic Quantum computing OO - Reusability - eScience

Deterministic and stochastic PDE modeling Geometry, Symmetry, Reduction Coarsening nonlinearity **Turbulence, Regularisation**

Structure-preserving discretisation

Kraichnan hypothesis: Double cascade in 2D turbulence



NWO TOP1 – **SPRESTO** project

Structure-preserving discretisation

Single layer

Multiple layers



Quasi-geostrophic prediction of turbulent jets on a model planet – single and multiple layers

Zonal velocity field

NWO TOP1 – SPRESTO project

Algorithms

Fully resolved multiphase turbulence: Bubble dynamics



NWO OTP – Boiling project – Wim Nieuwpoort Prize

Turbulent Mixing Regularisation



3MS – Mathematics across disciplines



Mechanical/Chemical Engineering, (Geo-)Physics, Climate, Energy transition, Health, 3D Printing, ...