

# Thibault Moli MAUREL OUIJA

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West Lafayette, IN, USA



## EDUCATION

Ph.D. in Applied Mathematics

Aix-Marseille University, France

Jan 2021–June 2024

**Thesis :** On the Particle Dynamics in Fully Developed Turbulence: Tessellation, Multiresolution and Machine Learning Methods

**Supervisor :** Prof. Kai Schneider and Dr. Keigo Matsuda

Master in Applied Mathematics

Aix-Marseille University, France

Sept 2018–June 2020

Bachelor in Mathematics

Aix-Marseille University, France

Sept 2015–June 2018

## EMPLOYMENT

Apollo 11 Postdoctoral Fellow

School of Aeronautics and Astronautics, Purdue University, IN, USA

July 2024–Present

West Lafayette, IN, USA

- Supervisor :** Prof. Kazuki Maeda
- Description :** Modeling, simulation and analysis of high-speed reacting flows with application to aerospace propulsion and energy systems.

Temporary Teaching and Research Associate (ATER)

Aix-Marseille University, France

Sept 2023–June 2024

Marseille, France

## RESEARCH EXPERIENCE

JSPS Short-term Fellowship 2023

JAMSTEC and Nagoya University, Japan

May 2023–Aug 2023

Yokohama and Nagoya, Japan

- Host :** Dr. Keigo Matsuda and Prof. Katsunori Yoshimatsu
- Project :** Development of parallelized tessellation-based divergence & rotation of particle laden turbulence

CTR Summer Program 2022

Stanford University, CA, USA

July 2022–Aug 2022

Palo Alto, CA, USA

- Collaborator :** Kai Schneider, Keigo Matsuda, Thibault Oujia, Jacob West, Suhas S. Jain and Kazuki Maeda
- Project :** Development of multiscale techniques for analyzing clustering in particle laden turbulence, including tools from machine learning.

## HONORS AND AWARDS

- Apollo 11 Postdoctoral Fellowship, Purdue University, 2024
- JSPS Short-Term Fellowship, Japan Society for the Promotion of Science, 2023
- CTR Summer Program, Center for Turbulence Research (CTR), Stanford University, 2022

## RESEARCH INTEREST

- Fluid Dynamics:** Particle-laden flows; turbulence; multiphase flows.
- Computational Analysis:** Tessellation techniques; multiresolution analysis.
- Combustion:** Reactive molecular dynamics; supersonic combustion; hypersonic applications; shock wave interactions.
- Machine Learning:** Predictive statistics; simulation acceleration.

# PUBLICATIONS

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## Journal Articles

- J. Bergmann, T. Maurel-Oujia, J.-C. Nave, K. Schneider, *et al.*, “Singularity formation of vortex sheets in 2D Euler equations using the characteristic mapping method,” *accepted in Physics of Fluids*, 2024.
- Z. Lin, T. Maurel-Oujia, S. Benkadda, and K. Schneider, “Tessellation-based analysis of impurity clustering in the edge plasma of tokamaks,” *Journal of Plasma Physics*, 2024.
- T. Maurel-Oujia, S. S. Jain, K. Matsuda, K. Schneider, J. R. West, and K. Maeda, “Neural network models for preferential concentration of particles in two-dimensional turbulence,” *Theoretical and Computational Fluid Dynamics*, 2024.
- J. R. West\*, T. Maurel-Oujia\*, K. Matsuda, K. Schneider, S. S. Jain, and K. Maeda, “Clustering, rotation, and swirl of inertial particles in turbulent channel flow,” *International Journal of Multiphase Flow*, p. 104 764, 2024, (\*Co-corresponding authors).
- Z. Lin, T. Maurel-Oujia, B. Kadoch, P. Krah, N. Saura, S. Benkadda, and K. Schneider, “Synthesizing impurity clustering in the edge plasma of tokamaks using neural networks,” *Physics of Plasmas*, vol. 31, no. 3, 2024.
- T. Maurel-Oujia, K. Matsuda, and K. Schneider, “Computing differential operators of the particle velocity in moving particle clouds using tessellations,” *Journal of Computational Physics*, vol. 498, p. 112 658, 2024.
- S. V. Apte, T. Oujia, K. Matsuda, B. Kadoch, X. He, and K. Schneider, “Clustering of inertial particles in turbulent flow through a porous unit cell,” *Journal of Fluid Mechanics*, vol. 937, 2022.
- T. Oujia, K. Matsuda, and K. Schneider, “Divergence and convergence of inertial particles in high-reynolds-number turbulence,” *Journal of Fluid Mechanics*, vol. 905, 2020.

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## Referred Conference Proceedings

- T. Maurel-Oujia and K. Maeda, “Microscopic simulation and analysis of reactive shock wave in a  $H_2/O_2$  fuel mixture,” **12th International Conference on Multiphase Flow (ICMF)**.
- T. Maurel-Oujia, K. Matsuda, and K. Schneider, “Multiresolution analysis of convergence and divergence of inertial particle velocity in turbulence,” **13th Turbulence and Shear Flow Phenomena (TSFP13)**.
- T. Maurel-Oujia, S. S. Jain, K. Matsuda, K. Schneider, J. West, and K. Maeda, “Synthesis of preferential concentration of particles in isotropic turbulence using neural networks,” **18th European Turbulence Conference (ETC18)**.
- K. Matsuda, T. Maurel-Oujia, and K. Schneider, “Clustering formation of inertial particles in high reynolds number isotropic turbulence,” **18th European Turbulence Conference (ETC18)**.
- J. Bergmann, T. Maurel-Oujia, X. Y. Yin, J.-C. Nave, and K. Schneider, “On singularities in vortex sheets in 2D Euler flows using a high resolution characteristic mapping method,” **18th European Turbulence Conference (ETC18)**.
- T. Oujia, J. West, K. Matsuda, K. Schneider, S. S. Jain, and K. Maeda, “Divergence and rotation of inertial particles in a four-way coupled channel flow,” **11th International Conference on Multiphase Flow (ICMF)**.
- T. Oujia, K. Matsuda, and K. Schneider, “Extreme divergence and rotation values of the inertial particle velocity in high reynolds number turbulence using delaunay tessellation,” **12th Turbulence and Shear Flow Phenomena (TSFP12)**.

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## Technical Reports

- T. Oujia, S. S. Jain, K. Matsuda, K. Schneider, J. West, and K. Maeda, “Neural networks for synthesizing preferential concentration of particles,” in **Center for Turbulence Research (CTR), Proceedings of the Summer Program 2022**. 2022, Stanford University.
- J. West, T. Oujia, K. Matsuda, K. Schneider, S. S. Jain, and K. Maeda, “Divergence and curl of the inertial particle velocity in a four way coupled turbulent channel flow,” in **Center for Turbulence Research (CTR), Proceedings of the Summer Program 2022**. 2022, Stanford University.
- K. Matsuda, K. Schneider, T. Oujia, J. West, S. S. Jain, and K. Maeda, “Multiresolution analysis of inertial particle tessellations for clustering dynamics,” in **Center for Turbulence Research (CTR), Proceedings of the Summer Program 2022**. 2022, Stanford University.

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## Conference Abstracts

- T. Maurel-Oujia and K. Maeda, “Combined molecular dynamics simulations and regression analysis for high-speed reacting flows,” in, Salt Lake City, USA, **Bull. Amer. Phys. Soc.**, 2024.
- T. Maurel-Oujia, K. Matsuda, and K. Schneider, “Multiscale analysis of inertial particle dynamics in turbulent flows using a tessellation-based method,” in, Washington, USA, **Bull. Amer. Phys. Soc.**, 2023.
- T. Maurel-Oujia, S. Jain, K. Matsuda, K. Schneider, J. West, and K. Maeda, “Synthesizing inertial particle distribution in isotropic turbulence using neural networks,” in, Washington, USA, **Bull. Amer. Phys. Soc.**, 2023.
- L. Zetao, T. Maurel-Oujia, B. Kadoch, P. Krah, N. Saura, S. Benkadda, and K. Schneider, “Analysis of inertial impurity clustering in the edge plasma of tokamaks,” in, **EFTC 2023, 20th European Fusion Theory Conference**, 2023.

- L. Zetao, T. Maurel-Oujia, B. Kadoch, P. Krah, N. Saura, S. Benkadda, and K. Schneider, "Data-driven modeling of impurity transport in the edge plasma of tokamaks," in, **12th ITER International School**, 2023.
- T. Maurel-Oujia, K. Matsuda, and K. Schneider, "A tessellation-based approach to analyze elementary processes of inertial particles in turbulence," in, Kyoto, Japan, **RIMS workshop**, 2023.
- J. Bergmann, T. Oujia, X.-Y. B. Yin, J.-C. Nave, and K. Schneider, "High resolution vortex layer computations in 2D Euler flows using a characteristic mapping method," in, 67(19), Indianapolis, USA, **Bull. Amer. Phys. Soc.**, 2022.
- T. Oujia, S. Jain, K. Matsuda, K. Schneider, J. West, and K. Maeda, "Physics-informed neural networks for synthesizing preferential concentration of particles in turbulent flows," in, 67(19), Indianapolis, USA, **Bull. Amer. Phys. Soc.**, 2022.
- K. Schneider, T. Oujia, J. West, K. Matsuda, S. Jain, and K. Maeda, "On divergence, curl, and helicity of the inertial particle velocity in a 4-way coupled channel flow," in, Indianapolis, USA, **Bull. Amer. Phys. Soc.**, 2022.
- T. Oujia, K. Matsuda, and K. Schneider, "Quantifying divergence and rotation of the inertial particle velocity in high reynolds number turbulence using voronoi and delaunay tessellation," in, 66(17), Phoenix, USA, **Bull. Amer. Phys. Soc.**, 2021.
- T. Oujia, K. Matsuda, and K. Schneider, "Analysis of divergence and rotation of the inertial particle velocity in high reynolds number turbulence," in, 65(13), Chicago, USA, **Bull. Amer. Phys. Soc.**, 2020.
- X. He, T. Oujia, B. Kadoch, K. Matsuda, K. Schneider, and S. Apte, "Clustering of inertial particles in turbulent flow through a face-centered cubic cell," in, 65(13), Chicago, USA, **Bull. Amer. Phys. Soc.**, 2020.
- T. Oujia, K. Matsuda, and K. Schneider, "On the divergence of the inertial particle velocity in high reynolds number turbulence," in, 23-28 August 2020, Milano, Italy, **XXV ICTAM**, 2020.
- T. Oujia, K. Matsuda, and K. Schneider, "Divergence and convergence of inertial particles in high reynolds number turbulence," in, 64(13), 639, Seattle, USA, **Bull. Amer. Phys. Soc.**, 2019.
- S. Apte, T. Oujia, X. He, B. Kadoch, K. Matsuda, and K. Schneider, "Pore-scale investigation of clustering of inertial particles in turbulent flow through a porous medium," in, 64(13), 638, Seattle, USA, **Bull. Amer. Phys. Soc.**, 2019.

## INVITED TALKS

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- "Multiscale Dynamics of Inertial Particles in Turbulence: A Tessellation Technique Analysis", 2023, *AAE Special Seminar*, **Purdue University**, West Lafayette, IN, USA.
- "A Tessellation-based Approach for Multiscale Dynamics in Particle-Laden Turbulence", 2023, *CEIST Guest Seminar*, **JAMSTEC**, Yokohama, Japan.
- "A Tessellation-based Approach for Multiscale Dynamics in Particle-Laden Turbulence", 2023, *Fluid Mechanics Special Seminar*, **Nagoya Institute of Technology**, Nagoya, Japan.
- "A tessellation-based approach to study the dynamics of inertial particles in turbulence", 2023, *Onishi Lab. Seminar Series*, **Tokyo Institute of Technology**, Tokyo, Japan.
- "Physics-informed neural networks for synthesizing preferential concentration of particles in isotropic turbulence", 2022, *PiAI Seminar Series*, **Aix-Marseille University**, **Osaka University**, **Web Seminar**, Osaka, Japan.

## TEACHING EXPERIENCE

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### Research Mentoring

#### Purdue University, USA

- **Co-Supervisor**: Prof. Kazuki Maeda (Purdue University-USA)
- **Subject**: Scientific visualization of discrete field data
- 📅 Sept 2024—Present      **Student** : Eylul Ustaoglu (Purdue University-USA)

#### Aix-Marseille University, France

- **Co-Supervisor** : Prof. Kai Schneider (I2M-France)
- **Subject** : Two-dimensional Characteristic Mapping Method using CUDA
- 📅 Sept 2021—Mar 2022      **Student** : Julius Bergmann (TU Berlin-Germany)
- 📅 April 2021—Sept 2021      **Student** : Nicolas Saber (I2M-France)

### Course Instructor and Teaching Assistant

#### Aix-Marseille University, France

- **Analysis I** (Fall 2023, 50%): including continuity, differentiability, limits, derivatives, differential equations, corresponding theorems.
- **Analysis II** (Spring 2024, 100%): including integrals, directional derivatives, series expansion, topology, proofs of corresponding theorems.
- **Mathematical Tools** (Fall 2023, 25%): including trigonometry, geometry (e.g., equations of planes and lines), derivatives, integrals, limits.
- **Mathematical Tools for Life Sciences** (Fall 2023, 50%): including basic mathematics, differential equations, and calculus for biology students.
- **Mathematics Support Program** (Fall 2023, 100%): including assisted students resuming studies or needing extra help, foundational mathematics.