Wang Zewei **Marcus**

FLUID MECHANICS · AI FOR PHYSICS

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Summary

Physics and computational science researcher with an MSc in Fluid Mechanics from the Chinese Academy of Sciences (2024). I briefly pursued PhD studies at Zhejiang University, focusing on the theoretical foundations of ideal fluid mechanics, before joining a leading unicorn company in the semiconductor industry as a CFD Algorithm Development Engineer. There, I contributed to developing CFD solvers optimized for the company's chip architecture.

I have some experience in scientific computing using C++, with two peer-reviewed publications on large-eddy simulations of wind farms. I am also proficient in AI and quantum computing applications—using PyTorch for regression and control tasks, graph neural networks for anomaly detection.

My research interests lie in the intersection of computational mathematics and physics. I am driven to bridge theoretical physics with high-performance computation to uncover the mathematical structures underlying complex dynamical systems.

Skills

Core Knowledge	Fluid Mechanics, CFD, Analytical Mechanics, Quantum Mechanics, High-Performance Compute
Simulation Software	OpenFOAM, WRF (Weather Research & Forecasting)
Programming	Python, Matlab, C++, Linux, CUDA
Languages	Chinese (Native), English (Fluent)

Education

ZJU(Zhejiang University)
Hangzhou, Zhejiang Province, China

PHD STUDIES (BRIEFLY ATTENDED) — *September 2024 - March 2025*

- **Research Focus**: Theoretical studies on ideal fluids
- **Selected Courses and Grades**:
  1. Quantum Computing Software Systems: 89/100
  2. Artificial Intelligence Algorithms and Systems: 96/100
- **Reason for Leaving**: Developed a stronger interest in scientific computing, leading to a research shift.

CAS(Chinese Academy of Sciences)
Beijing, China

MASTER OF SCIENCE IN FLUID MECHANICS — *September 2021 - June 2024*

- **GPA**: 3.63/4.0
- **Core Focus**: Computational Fluid Dynamics (CFD) and Turbulence in Wind Farms
- **Selected Courses and Grades**:
  1. Dimensional Analysis: 94/100
  2. Hydrodynamics: 93/100
  3. Computational Fluid Dynamics: 88/100
  4. Continuity Mechanics (Fluid): 88/100
- **Project Involvement**: Research Participant in the Subproject of the National Natural Science Foundation (NSFC) project titled "Research on Multiscale Mechanical Problems in Nonlinear Mechanics"
- **Achievements**: Awarded the **Excellent Freshman Scholarship**, granted to the top 15% of incoming students.
- **Thesis**: "The Mechanisms and Models of Turbulent Wakes in Wind Farms" – Grade: Excellent.

SWJTU(Southwest Jiaotong University)
Chengdu, Sichuan Province, China

BACHELOR OF ENGINEERING IN ENGINEERING MECHANICS — *September 2017 - June 2021*

- **GPA**: 3.45/4.0 (Major GPA: 3.7/4.0) – **Ranked 1st** out of 14 in the program. The overall GPA includes both elective and required courses.
- **Selected Courses and Grades**:
  1. Engineering Numerical Analysis and Experiment: 99/100
  2. Computational Structural Dynamics: 98/100
  3. Material Mechanics: 98/100
  4. Computational Mechanics: 96/100
  5. Basic Mechanics Experiment: 97/100
  6. Elastic Mechanics: 94/100
  7. Methods of Mathematical Physics: 89/100
- **Awards and Achievements**:
  - **National Scholarship** (awarded by the Ministry of Education of China for top-performing undergraduate students)
  - Outstanding Graduate of Mao Yisheng College
  - Recommendation for Graduate School to the Chinese Academy of Sciences

Work Experience

Leading Chip Industry Unicorn (Confidential) *Shanghai, China*

CFD Algorithm Development Engineer *May 2025 - Present*

- Assisted in developing a CFD solver optimized for the company's chip architecture, implementing DNS explicit modules with HLLC, Roe, and dissipative flux schemes, as well as pre- and post-processing and Green-Gauss second-order reconstruction.
- Developed DNS and RANS implicit solver modules adapted to the same chip architecture, focusing on convective and diffusive flux Jacobians, matrix assembly, and linear solver implementation.

Research Experience

Research 1: Hamiltonian Mechanics for Fluid *09/2024 - 02/2025*

Preliminary results

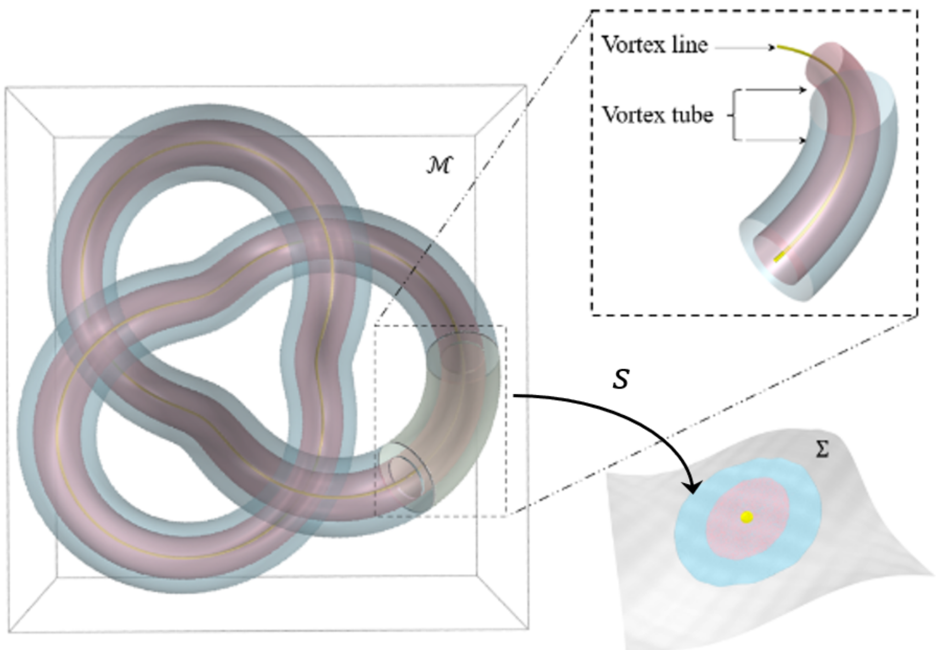
- **Research Overview:**

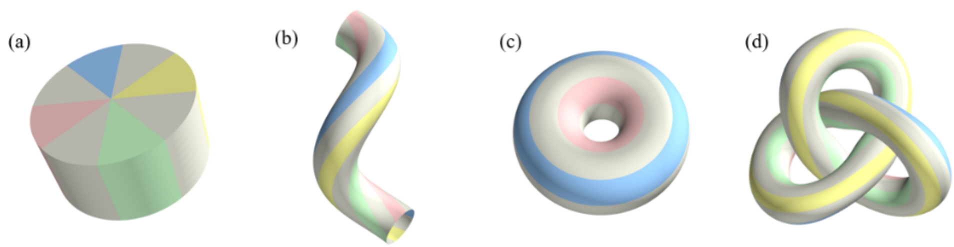
This study explores the Euler equations for ideal fluids using exterior differential geometry, focusing on their Hamiltonian structure. The velocity and vorticity fields are represented as 1-forms and 2-forms, respectively. A Clebsch mapping for vorticity is constructed, and the pullback operator is employed to map the area form on fluid surfaces to the vorticity field. This operator also helps establish the Hamiltonian phase space, allowing a symplectic interpretation of fluid dynamics. Variational analysis of the Hamiltonian reveals the equivalence of the symplectic structure in phase space and the momentum equations.

The study aims to generalize the ideal fluid equations to arbitrary surfaces and further explores the connection between symplectic structures and ideal fluid dynamics, offering a new mathematical perspective and a foundation for simulating fluids on arbitrary manifolds.

Highlight 1 **Exterior Differential Geometry Approach**

Highlight 2 **Symplectic Geometry and Hamiltonian Mechanics**





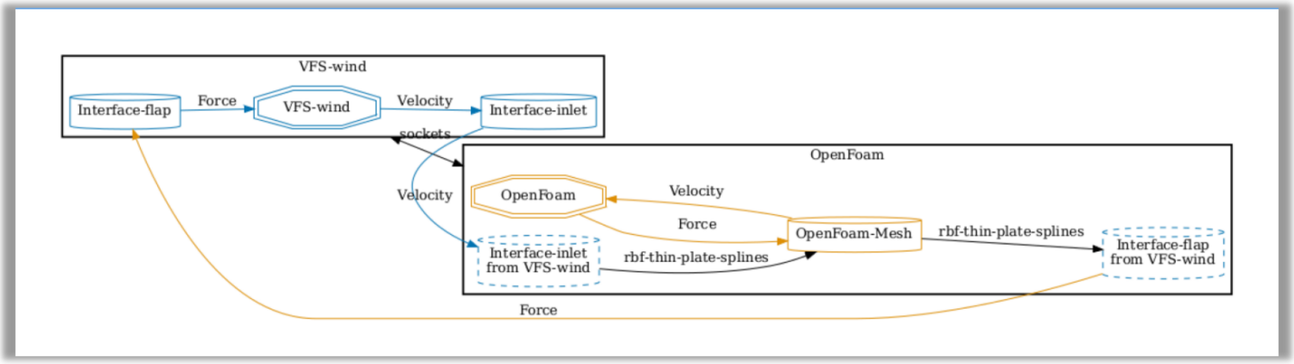
Research 2: Parallel Coupling Strategies for OpenFOAM and Finite Difference Solver *01/2024 - 06/2024*

Preliminary results: open Source soon

- **Research Overview:**

This study develops a parallel coupling framework between OpenFOAM and the high-fidelity finite difference solver VFS-Wind to resolve the aerodynamics of large-scale wind turbines without actuator models. OpenFOAM captures near-wall flow features with body-fitted unstructured grids, while VFS-Wind performs large-eddy simulations on structured grids. Stress fields computed in OpenFOAM are used to reconstruct velocity fields in VFS-Wind, enabling bidirectional data exchange via MPI, preCICE, and PETSc. This coupling strategy not only improves simulation accuracy but also provides insights for reinforcement learning-based FSI control.

Highlight 1 **High-Fidelity Coupling of OpenFOAM and VFS-Wind**
Highlight 2 **MPI-based Data Exchange with preCICE and PETSc**
Highlight 3 **Potential Applications in Reinforcement Learning for FSI**



Research 3: Upward Shift of Wind Turbine Wakes in Large Wind Farms

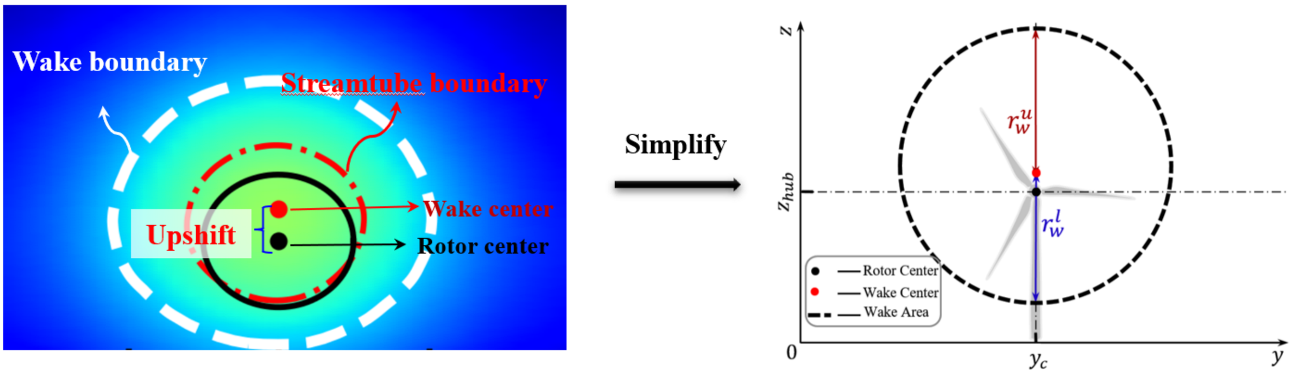
05/2024 - 12/2023

PUBLICATION: CLICK TO READ

- **Research Overview:**

This study examines the upward shift of wake centers in large wind farms using large-eddy simulations. Results show that downstream turbines experience greater wake elevation, especially with increased ground roughness and turbine rows. This shift is driven by turbulence entrainment and ground constraints. An improved analytical model, incorporating asymmetric wake expansion rates, enhances wake predictions by explicitly accounting for wake center displacement.

Highlight 1 **Discovery of Upward Wake Shift**
Highlight 2 **Enhanced Analytical Wake Model**



Research 4: Statistics of wind farm wakes for different layouts and ground roughness

07/2022 - 05/2023

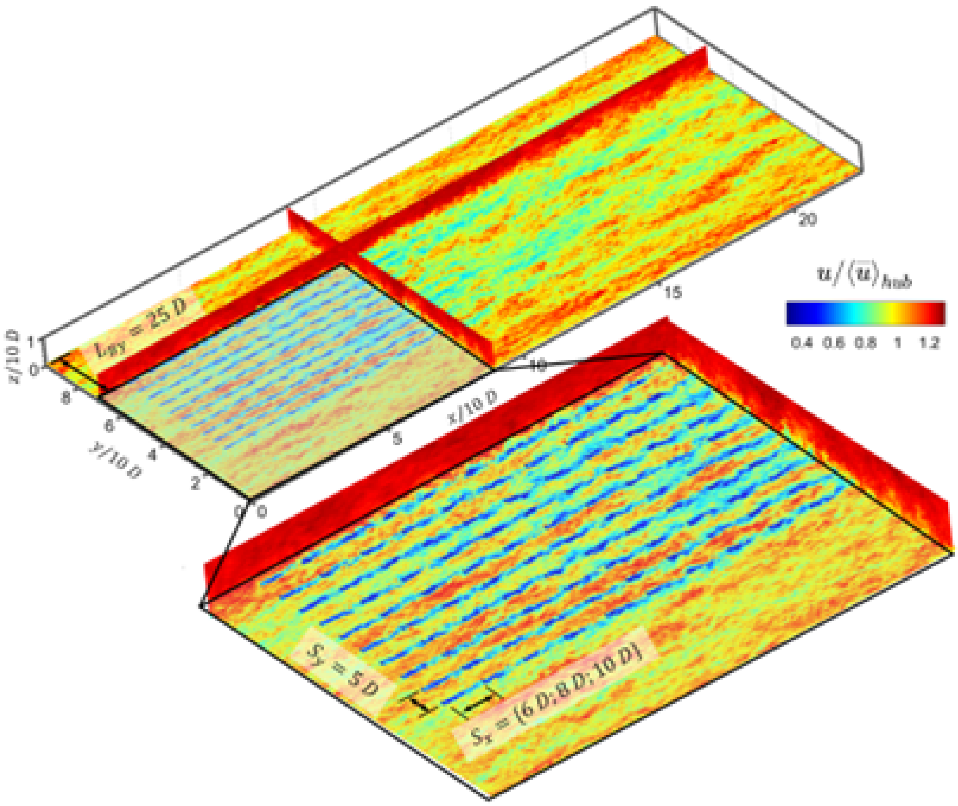
PUBLICATION: CLICK TO READ

- **Research Overview:**

This study investigates wind farm wakes using large-eddy simulation (LES) with an actuator disk model for turbines. The effects of streamwise turbine spacing (S_x), number of turbine rows, and surface roughness on wake characteristics are examined. The results show that smaller values of S_x lead to higher turbulence intensity in the near wake (within 20 rotor diameters), while in the far wake (beyond 90 rotor diameters), the velocity deficit and Reynolds stresses converge across different S_x cases.

Additionally, cases with more turbine rows and higher surface roughness show faster velocity recovery and higher turbulence intensity. The analysis of the mean kinetic energy (MKE) budget reveals that vertical MKE transport through convection plays a dominant role in wake recovery, contrasting with the streamwise MKE flux in the wind farm region. An improved analytical model for velocity deficit, based on the Emeis model, provides better predictions, though it requires specifying the velocity deficit at a downstream location.

Highlight 1 **Exploring Key Factors Affecting Wind Farm Wake Recovery**
Highlight 2 **Understanding the Physical Mechanisms of Wake Recovery**
Highlight 3 **Proposing an Analytical Model for Wind Farm Wake**



Publications

2023 **Wang, Z., et al.,** Statistics of wind farm wakes for different layouts and ground roughness. *Boundary-Layer Meteorology*

2023 **Wang, Z. and Yang, X.,** Upward Shift of Wind Turbine Wakes in Large Wind Farms. *Energies*

Honors & Awards

International

Asia **First Prize,** Individual Competition, Asian Region of the International Student Engineering Mechanics Competition *2020*

Asia **Second Prize,** Team Competition, Asian Region of the International Student Engineering Mechanics Competition *2020*

Domestic

China **National Scholarship,** Ministry of Education of China *2019*

China **Provincial First Prize,** "Higher Education Cup" Mathematical Modeling Competition (National Competition) *2019*

China **Excellent Freshman Scholarship,** Chinese Academy of Sciences (CAS) *2021*

China **Outstanding Graduate,** Mao Yisheng College, Southwest Jiaotong University *2021*