André Freitas

PhD Student · Physics

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Education

University of Rome "Tor Vergata" & Institut Polytechnique de Paris — *Rome, Italy & Paris, France*
PhD Physics — *11/2023 - present*

- Joint PhD funded by Marie Skłodowska-Curie Actions doctoral network.
- Advisors: Luca Biferale, Kiwon Um, Mathieu Desbrun
- Thesis title: *Large eddy simulation models in a deep machine learning loop*

Delft University of Technology — *Delft, the Netherlands*
MSc Aerospace Engineering — *08/2021 - 10/2023*

- Track: Aerodynamics, specialised in computational fluid dynamics and high performance computing.
- Advisors: Alexander van Zuijlen and Kevin Zwijsen.
- Thesis title: *Numerical study on turbulence induced vibrations of fuel rods using an Anisotropic Pressure Fluctuations Model*
- Thesis grade: 8.5/10
- Student Associations: Formula Student Team Delft

Instituto Superior Técnico — *Lisbon, Portugal*
BSc Aerospace Engineering — *09/2018 - 07/2021*

- Student associations: TLMoto (Moto Student team).

Professional Experience

09/2025 – 10/2025	**PhD intern**, NVIDIA	*Juelich, Germany*
05/2025 – 08/2025	**Visiting Graduate Student**, Los Alamos National Laboratory	*New Mexico, USA*
11/2022 – 09/2023	**Research Intern**, Nuclear Research & consultancy Group (NRG)	*Petten, the Netherlands*
08/2022 - 11/2022	**Aerodynamics Engineer Intern**, PLANA	*Suwon, South Korea*
01/2022 - 04/2022	**Teaching Assistant**, Dept. Aerospace Engineering, TU Delft	*Delft, the Netherlands*
03/2021 - 08/2021	**Undergraduate Research Assistant**, Instituto Superior Técnico	*Lisbon, Portugal*

Research Interests

My research focuses on turbulence modeling and control, with an emphasis on differentiable programming for physics-informed machine learning. I investigate *a posteriori* methodologies to enhance closure models or control agents in a complex flow, leveraging automatic differentiation to integrate numerical solvers with deep learning frameworks. My work involves developing high-performance computing (HPC) code optimized for large-scale GPU clusters to solve the Navier-Stokes equations or their reduced models, and integrate them with machine learning tools.

Main collaborations: Michele Buzzicotti, Federico Toschi, Xander de Wit, Alexei A. Mailybaev, Gregory Eyink, Alessandro Gabbana, Daniel Livescu.

Publications

Published

A. Freitas, K. Um, M. Desbrun, G. Eyink, A.A. Mailybaev, L. Biferale. On the importance of stochasticity in closures of turbulence. Europhysics letters (2026).

A. Freitas, K. Um, M. Desbrun, M. Buzzicotti, L. Biferale. A posteriori closure of turbulence models: are symmetries preserved?. European Journal of Mechanics - B/Fluids (2026)

X. de Wit, **A. Freitas**, F. Toschi. Dynamics of small bubbles in the non-dilute conditions. Physical Review Fluids (2026)

A. Freitas, K. Um, M. Desbrun, M. Buzzicotti, L. Biferale. Solver-in-the-loop approach to closure of shell models of turbulence. Physical Review Fluids (2025).

K. Zwijsen, **A. Freitas**, S. Tajfirooz, EMA Frederix, AH van Zuijlen. An optimized anisotropic pressure fluctuation model for the simulation of turbulence-induced vibrations. Physics of Fluids (2024)

In Review

A. Freitas, X. de Wit, Z. Wang, L. Biferale, F. Toschi. Statistical Properties of turbulence under a smart Lagrangian forcing (2025)

Awards, Fellowships, & Grants

2023 - 2026 **Marie Skłodowska-Curie Actions PhD Fellowship**, European Union

2021 **Research Initiation Grant**, Instituto Superior Técnico

Presentations

Invited Talks

Jan 2026. *Intermittency suppression via forced light particles*. Chiral particles and Odd fluids. Eindhoven (the Netherlands)

May 2025. *Eulerian and Lagrangian turbulence: closure and control problems*. 3rd Bilateral Smart-Turb Smart-Heart Workshop. Lecce (Italy)

Nov 2024. *Physics Based Deep Learning*. PhD Physics Journal Club UniTOV. Rome (Italy)

Mar 2024. *The Adjoint Method in Scientific Machine Learning*. Complex Flows and Complex Fluids seminar. Rome (Italy)

Contributed Presentations

A. Freitas, X. de Wit, Z. Wang, L. Biferale, F. Toschi. 2025. Statistical Properties of turbulence under a smart Lagrangian forcing. APS Division of Fluid Dynamics (DFD) Meeting, Houston, TX, USA.

A. Freitas, X. de Wit, Z. Wang, L. Biferale, F. Toschi. 2025. Statistical Properties of turbulence under a smart Lagrangian forcing. 2nd European Fluid Dynamics Conference (EFDC1), Dublin, Ireland.

A. Freitas, K. Um, M. Desbrun, M. Buzzicotti, L. Biferale. 2025. Differentiable LES of Rayleigh-Bénard convection. Euromech colloquium "Data-driven fluid mechanics", London, UK.

A. Freitas, K. Um, M. Desbrun, M. Buzzicotti, L. Biferale. 2024. Solver-in-the-loop approach to turbulence closure. 1st European Fluid Dynamics Conference (EFDC1), Aachen, Germany.

Schools

Data-Driven and Model-Based Tools for Complex Flows and Complex Fluid	*Rome, Italy*	*June 3-7 2024*
Quantum Computing and Tensor Networks	*University of Padova, Italy*	*May 6-24 2024*
Workshop on Machine Learning for Fluid Dynamics	*Paris, France*	*Mar 6-8 2024*
Machine Learning for Science and Engineering	*TU Berlin, Germany*	*Feb 12 - Mar 1 2024*
Exascale Computing and Scalable Algorithms	*KTH, Stockholm*	*Nov 27 - Dec 14 2023*

Date: April 17, 2026

Signature: