

Lorenzo Maria Perrone, PhD

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Computational scientist specializing in CFD, turbulence modelling, and scientific machine learning. After completing a PhD at the University of Cambridge (UK) I moved to Germany at the Leibniz-Institute for Astrophysics Potsdam, where I run massively-parallelized fluid simulations blending modern numerical methods with strong theoretical modelling.

Curious-minded and driven to apply scientific knowledge to real-world impact.

Skills

Computational Fluid Dynamics and HPC skills

- 8+ years experience in Computational Fluid Dynamics (CFD), successfully extracting effective models for turbulent transport from complex physical problems, including heat transfer, convection, particle transport, hydrodynamic instabilities.
- Proven expertise with established numerical methods (finite volume, spectral, and Lattice-Boltzmann), and industrial grade simulation software (OpenFoam, Paraview).
- Implemented new physics modules and numerical algorithms to reduce time-to-solution (e.g. super-time stepping, speeding up runs by x10-100) and thus perform large parameter surveys. Benchmarked and validated error scalings against analytical solutions.
- Led and contributed to large-scale simulation projects with unstructured moving-mesh code Arepo on some of the world's most powerful supercomputing facilities (20+ million core-hours on SuperMUC).
- Experienced in benchmarking HPC codes on multi-node clusters and kernel optimization (e.g., NVIDIA Nsight): I successfully identified and solved communication bottlenecks in code execution (runtimes were 2-3x slower than expected), I rewrote custom kernels to increase data alignment (30% speed-up).

Coding expertise

- I write and develop computational software in C++ and Python that is highly-scalable on modern architectures (GPUs, hybrid CPU+GPUs execution using MPI/OpenMP).
- I am the main author of the open source [turbocluster](#) library that uses GPUs to allow near real-time processing of large datasets (100+ GB per snapshot) of turbulent flows on unstructured meshes.
- Developed GPU-accelerated spectral code (C++ CUDA, [Spooky](#)) that matches performance of a 48-CPU server on a laptop GPU; contributor to open-source [Paicos](#) code for the analysis of astrophysics simulations (used at 3+ research institutions).
- Proficiency with modern code development techniques (applied to [Spooky](#) and [turbocluster](#)): continuous integration (CI/CD), containerization (Docker/Apptainer), automatic testing, version control (Git).

AI and Scientific Machine Learning

- Deep Learning and convolutional neural networks: I implemented an end-to-end pipeline to classify astronomical objects from high-dimensional and noisy astronomical surveys (100k samples), including pre-processing and data cleaning (F-score of 0.953).
- Physics-Informed Neural Networks (PINN) applied to computational fluid dynamics: I wrote a pipeline in Python and JAX to solve flows using PINNs and improved its performance reducing the error from 10% to 0.5% compared to analytical solution.

Analytical mindset

- Problem solving and creative thinking: break down complex problems into smaller parts, transfer knowledge from other fields (e.g. I successfully applied theories from atmospheric sciences to a new astrophysical instability).

- Physicists' approach to dealing with new situations: recognize what are the primary drivers, and what is less significant. Formulate effective models to describe physical systems; understand the validity and identify the limits of one's assumptions.

Collaboration and project leadership

- I lead a team of 4 people, setting the project direction and timeline. Able to combine goal-oriented work with creative exploration.
- I work in large, long-running collaborations with international teams of 10+ people spread over 3 countries (Germany, UK, Denmark).
- Manage 3-4 projects at the same time, allocate time and resources effectively. Supervision and mentoring of master students and undergraduates.
- Integrate in new teams quickly and successfully lead new projects to completion (e.g., I developed a promising model of magnetic field generation during a 6-months internship at Rutherford Appleton Laboratories, UK).

Effective communication skills

- 12+ first-authorship and co-authorship in peer-reviewed publications published in leading scientific journals, 50+ total citations.
- Invited speaker at leading international conferences (e.g. Harvard-Smithsonian, Oxford University), where I presented results of my research to general and specialist audiences.
- Involvement in the community: student secretary at Corpus Christi College in Cambridge (allocating budget of £20k for postgraduate society, meetings with multiple stakeholders), worked on sustainable conference planning at AIP (increased remote participation to 100+ researchers).

Work experience

- 10/2022 – ongoing: Research Scientist specialized in astrophysical turbulence. **Leibniz Institute for Astrophysics Potsdam (AIP), DE.**
- 01/2021 – 07/2021: Internship at the Rutherford Appleton Laboratories and Department of Atomic and Laser Physics, **University of Oxford, UK.**
- 07/2017 – 09/2017: Internship at the Swiss Plasma Center. **École polytechnique fédérale de Lausanne (EPFL), Switzerland.**

Education

- 10/2018 – 09/2022: PhD at the department of Applied Mathematics and Theoretical Physics (DAMTP). **University of Cambridge, UK.**
- 09/2016 – 07/2018: M.Sc. Physics, minor in Computational Science and Engineering. Master thesis carried out at the Swiss Plasma Center. **École polytechnique fédérale de Lausanne (EPFL), Switzerland.**
- 09/2013 – 07/2016: B.Sc. Physics cum laude (highest mark). **University of Pisa, Italy.**

Selected publications and talks

- "Characterizing turbulence in galaxy clusters: defining turbulent energies and assessing multi-scale versus fixed-scale filters", A&A, 2026 (in print, eprint: <https://arxiv.org/abs/2601.06250>)
- "Heat transport in the intra-cluster medium: the impact of microphysics on the large-scale dynamics in the periphery of galaxy clusters", JPP Frontiers of Plasma Physics Colloquium, 2025. DOI: 10.52843/cassyni.rccf5s
- "Thermal conductivity with bells and whistlers: Suppression of the magnetothermal instability in galaxy clusters", A&A, 2024. DOI: 10.1051/0004-6361/202449555

Certifications

- Node Level Performance Engineering, High-Performance Computing Center Stuttgart, June 2026
- Hybrid Programming in HPC – MPI+X, HLRS, Feb 2026
- Advanced Parallel Programming with MPI and OpenMP, Jülich Supercomputing Centre, Dec 2025
- Multi-GPU Programming, High-Performance Computing Center Stuttgart, May 2024

Languages: Italian (mother tongue), English (bilingual), German (B2 CEFR level), French (basic)

Personal interests: Hiking, maps, calendars.