



# Davide Torlo

## Curriculum Vitae

### Personal Information

Date of birth 7/12/1992  
Nationality Italian  
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### Education

- 2016–2020 **PhD in Mathematics**, *University of Zurich (UZH)*, Switzerland  
Supervisor: Prof. Rémi Abgrall.  
Thesis title: *Hyperbolic Problems: High Order Methods and Model Order Reduction*.
- 2014–2016 **M.Sc. in Mathematics 110 cum laude/110**, *Università degli Studi di Trieste & SISSA International School*, Italy  
Thesis title: *Stabilized reduced basis method for transport PDEs with random inputs*.  
Supervisor: Prof. Gianluigi Rozza.  
Awarded with the SISSA Scholarship for Master Degree.
- 2011–2014 **B.Sc. in Mathematics 110 cum laude/110**, *Università degli Studi di Milano–Bicocca*, Italy  
Thesis title: *Il Teorema di Fritz John: tre differenti approcci*.  
Supervisor: Prof.ssa Rita Pini.  
Awarded with the INDAM Scholarship for Bachelor Degree.

### Employment History

- 28/03/24 – **Assistant Professor (RTT)**, *Università di Roma La Sapienza, Italy*  
now Ricercatore in Tenure Track at Mathematics Department “Guido Castelnuovo” in Sapienza. Working on numerical analysis for hyperbolic problems, ODEs, model order reduction and scientific machine learning.
- 01/12/21 – **Postdoctoral fellow**, *SISSA, Trieste, Italy*  
27/03/24 Holder of a 3-years SISSA Mathematical Fellowship in SISSA mathLab group. Working on Model Order Reduction for advection dominated problems, high order methods and structure preserving schemes.
- 01/10/20 – **Postdoctoral position**, *INRIA Bordeaux, France*  
30/11/21 Under the supervision of Prof. Ricchiuto I have studied model order reduction techniques for dispersive waves models, stability of high order methods for hyperbolic problems and structure preserving schemes.
- 01/09/16 – **Research and teaching assistant**, *University of Zurich, Switzerland*  
31/08/20 I have been employed by University of Zurich, as a researcher and teaching assistant under the supervision of Prof. Abgrall.
- 01/09/15 – **Lecturer** of “Music and Mathematics” for High Schools, *Different high schools in Bergamo*  
01/06/16 I have studied and presented a popular science talk for High School students and a general audience on the influence of the Mathematics on the history of Musics, from the definition of octaves of Pitagora, to Bach structures, from the definitions of The Well–Tempered Clavier to Jazz tempos.
- 01/05/15 – **Theatrical technician**, at *TACT International Act Festival Trieste*, Teatro Stabile Sloveno  
30/06/16 Light designer and theatrical technician for 2 editions of TACT festival an international festival with 10 young theatrical groups coming from all over the world.
- 01/10/11 – **Educator**, at *Polo Civico* for the *Spazio Studio*  
01/06/13 Responsible of around 10 middle school students during the afternoon.

01/09/11 – **Theatrical technician**, at *Auditorium via Alberico da Rosciate, Bergamo*  
31/08/14 Technician and responsible of the Auditorium for local and national events and shows.

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## Habilitation

2023-2034 Italian Habilitation for Associate Professorship: *Abilitazione Scientifica Nazionale alle funzioni di professore universitario di Seconda Fascia nel Settore Concorsuale 01/A5 - Analisi Numerica*

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## Mentoring

2020-now **Co-supervising of students**

- Louis Petri (Master student at University of Mainz)
- Gaia Buccino (Master student at Politecnico di Milano)
- Ivan Prusak (PhD student at SISSA)
- Francesco Romor (PhD student at SISSA)
- Lorenzo Micalizzi (PhD student at UZH)
- Dr. Mirco Ciallella (former PhD student at Inria)
- Dr. Sixtine Michel (former PhD student at Inria)

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## Teaching Experience

2024-now **Instructor**, *I have been instructor of Numerical Analysis Courses (72 hours per year) to classes of Bachelor students from Mathematics and Mathematical Science for Artificial Intelligence*

2023 **Instructor of the Doctoral School of Mathematical Analysis, Modelling, and Applications and at SISSA**, *Course on "High order accurate time integration methods" (20 hours)*

2022 **Organizer and teacher**, *Summer School on Reduced Order Methods in Computational Fluid Dynamics, Trieste, Italy*

2021 **Instructor of the Doctoral School at University of Bordeaux**, *Course on "High order accurate time integration methods" (12 hours)*

2016-2020 **Teaching assistant for University of Zürich**, *I have taught every semester a course to classes of 20-80 Bachelor and Master students from Mathematics, Computer Science and Natural Science (300 hours)*

Contents taught: Numerical Methods for Informatics, Analysis 1, Numerical Analysis, Numerical Methods for Hyperbolic PDEs, High order methods for advection dominated problems

2018-2019 **Instructor**, *I have been instructor and organizer for 2 years of the course "Programming in MatLab" (120 hours)*

2017-2019 **Examiner**, *I have examined the exams of all the previous courses and of "Programming in Python", "Mathematics for Natural Science"*

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## Fields of interests

My academic interests focus on numerical methods for hyperbolic partial differential equations (PDEs). In particular, I work on high order explicit and implicit methods, structure preserving schemes and model order reduction (MOR) techniques for parametric hyperbolic PDEs. There are different techniques to approximate hyperbolic problems and resorting to arbitrary high order schemes allows to obtain very fine resolutions without extreme computational costs. According to the type of problem explicit or implicit schemes must be used to obtain reliable and stable solutions. I have also developed arbitrary high order time integration algorithms capable of preserving the positivity and the conservation of the physical quantities.

Another interesting topic I am working on are MOR methods. They are able to reduce computational costs for parametric PDE problems. After an *offline* phase, where expensive snapshots are computed, a cheap *online* phase allows to quickly obtain a solution for a given parameter. I am developing novel techniques in order to use the MOR on (hyperbolic) advection dominated problems, which suffer from a slow decay of the Kolmogorov  $n$ -width and, classically, are not suited for MOR.

I am also interested in computational statistics, machine learning and uncertainty quantification.

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## Publications and preprints

Thomas Izgin, Philipp Öffner, and Davide Torlo. A necessary condition for non-oscillatory and positivity preserving time-integration schemes. pages 121–131, 2024.

Monica Nonino and Davide Torlo. Calibration-Based ALE Model Order Reduction for Hyperbolic Problems with Self-Similar Travelling Discontinuities. *Journal of Scientific Computing*, 101(3):60, 2024. doi:10.1007/s10915-024-02694-z.

Ivan Prusak, Davide Torlo, Monica Nonino, and Gianluigi Rozza. An optimisation-based domain-decomposition reduced order model for parameter-dependent non-stationary fluid dynamics problems. *Computers & Mathematics with Applications*, 166:253–268, 2024.

Sajad Salavatidezfouli, Anna Nikishova, Davide Torlo, Martina Teruzzi, and Gianluigi Rozza. Computations for sustainability. In Cosimo Solidoro Marina Cobal Stefano Fantoni, Nicola Casagli, editor, *Quantitative Sustainability*, chapter 7, pages 91–110. Springer Cham, 2024. doi:10.1007/978-3-031-39311-2\_7.

Ivan Prusak, Monica Nonino, Davide Torlo, Francesco Ballarin, and Gianluigi Rozza. An optimisation-based domain-decomposition reduced order model for the incompressible Navier-Stokes equations. 151:172–189, 2023. doi:10.1016/j.camwa.2023.09.039.

Lorenzo Micalizzi and Davide Torlo. A new efficient explicit Deferred Correction framework: analysis and applications to hyperbolic PDEs and adaptivity. *Communications on Applied Mathematics and Computation*, 2023. doi:10.1007/s42967-023-00294-6.

Lorenzo Micalizzi, Davide Torlo, and Walter Boscheri. Efficient iterative arbitrary high order methods: an adaptive bridge between low and high order. *Communications on Applied Mathematics and Computation*, 2023. doi:10.1007/s42967-023-00290-w.

Maria Han Veiga, Lorenzo Micalizzi, and Davide Torlo. On improving the efficiency of ADER methods. *Applied Mathematics and Computation*, 466:128426, 2024. doi:10.1016/j.amc.2023.128426.

Mirco Ciallella, Davide Torlo, and Mario Ricchiuto. Arbitrary High Order WENO Finite Volume Scheme with Flux Globalization for Moving Equilibria Preservation. *Journal of Scientific Computing*, 96:53, 2023. doi:10.1007/s10915-023-02280-9.

Sixtine Michel, Davide Torlo, Mario Ricchiuto, and Rémi Abgrall. Spectral analysis of high order continuous FEM for hyperbolic PDEs on triangular meshes: influence of approximation, stabilization, and time-stepping. *Journal of Scientific Computing*, 94:49, 2023. doi:10.1007/s10915-022-02087-0.

Davide Torlo and Mario Ricchiuto. Model order reduction strategies for weakly dispersive waves. *Mathematics and Computers in Simulation*, 205:997–1028, 2023. doi:10.1016/j.matcom.2022.10.034.

Elena Gaburro, Philipp Öffner, Mario Ricchiuto, and Davide Torlo. High order entropy preserving ADER-DG scheme. *Applied Mathematics and Computation*, 440:127644, 2023. doi:10.1016/j.amc.2022.127644.

Davide Torlo, Maria Strazzullo, Francesco Ballarin, and Gianluigi Rozza. Weighted reduced order methods for uncertainty quantification. In Francesco Ballarin Gianluigi Rozza, Giovanni Stabile, editor, *Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics*, chapter 12, pages 251–264. Society for Industrial & Applied Mathematics, U.S., 2022. doi:10.1137/1.9781611977257.ch12.

Davide Torlo, Philipp Öffner, and Hendrik Ranocha. Issues with positivity-preserving Patankar-type schemes. *Applied Numerical Mathematics*, 182:117–147, 2022. doi:10.1016/j.apnum.2022.07.014.

Mirco Ciallella, Lorenzo Micalizzi, Philipp Öffner, and Davide Torlo. An arbitrary high order and positivity preserving method for the shallow water equations. *Computers & Fluids*, 247:105630, 2022. doi:10.1016/j.compfluid.2022.105630.

Rémi Abgrall and Davide Torlo. Some preliminary results on a high order asymptotic preserving computationally explicit kinetic scheme. *Communications in Mathematical Sciences*, 20(2):297–326, 2022. doi:10.4310/CMS.2022.v20.n2.a1.

Sixtine Michel, Davide Torlo, Mario Ricchiuto, and Rémi Abgrall. Spectral analysis of continuous FEM for hyperbolic PDEs: influence of approximation, stabilization, and time-stepping. *Journal of Scientific Computing*, 89(2):1–41, 2021. doi:10.1007/s10915-021-01632-7.

Rémi Abgrall, Élise Le Mélédo, Philipp Öffner, and Davide Torlo. Relaxation Deferred Correction Methods and their Applications to Residual Distribution Schemes. *The SMAI Journal of computational mathematics*, 8:125–160, 2022. doi:10.5802/smai-jcm.82.

Maria Han Veiga, Philipp Öffner, and Davide Torlo. Dec and Ader: similarities, differences and a unified framework. *Journal of Scientific Computing*, 87(1):1–35, 2021. doi:10.1007/s10915-020-01397-5.

Rémi Abgrall and Davide Torlo. High order asymptotic preserving deferred correction implicit-explicit schemes for kinetic models. *SIAM Journal on Scientific Computing*, 42(3):B816–B845, 2020. doi:10.1137/19M128973X.

Philipp Öffner and Davide Torlo. Arbitrary high-order, conservative and positivity preserving Patankar-type deferred correction schemes. *Applied Numerical Mathematics*, 153:15–34, 2020. doi:10.1016/j.apnum.2020.01.025.

Luca Venturi, Davide Torlo, Francesco Ballarin, and Gianluigi Rozza. Weighted reduced order methods for parametrized partial differential equations with random inputs. In Flavio Canavero, editor, *Uncertainty Modeling for Engineering Applications*, chapter 2, pages 27–40. Springer International Publishing, 2019. doi:10.1007/978-3-030-04870-9\_2.

Davide Torlo, Francesco Ballarin, and Gianluigi Rozza. Stabilized weighted reduced basis methods for parametrized advection dominated problems with random inputs. *SIAM/ASA Journal on Uncertainty Quantification*, 6(4):1475–1502, 2018. doi:10.1137/17M1163517.

Roxana Crisovan, Davide Torlo, Rémi Abgrall, and Svetlana Tokareva. Model order reduction for parametrized nonlinear hyperbolic problems as an application to uncertainty quantification. *Journal of Computational and Applied Mathematics*, 348:466 – 489, 2019. doi:10.1016/j.cam.2018.09.018.

Philipp Öffner, Louis Petri, and Davide Torlo. Analysis for Implicit and Implicit-Explicit ADER and DeC Methods for Ordinary Differential Equations, Advection-Diffusion and Advection-Dispersion Equations. *arXiv preprint arXiv:2404.18626*, 2024.

Wasilij Barsukow, Mario Ricchiuto, and Davide Torlo. Structure preserving nodal continuous Finite Elements via Global Flux quadrature. *arXiv preprint arXiv:2407.10579*, 2024.

Mirco Ciallella, Lorenzo Micalizzi, Victor Michel-Dansac, Philipp Öffner, and Davide Torlo. A high-order, fully well-balanced, unconditionally positivity-preserving finite volume framework for flood simulations. *arXiv 2402.12248*, 2024.

Ivan Prusak, Davide Torlo, Monica Nonino, and Gianluigi Rozza. A time-adaptive algorithm for pressure dominated flows: a heuristic estimator. *arXiv preprint arXiv:2407.00428*, 2024.

Francesco Romor, Davide Torlo, and Gianluigi Rozza. Friedrichs' systems discretized with the Discontinuous Galerkin method: domain decomposable model order reduction and Graph Neural Networks approximating vanishing viscosity solutions. *arXiv preprint arXiv:2308.03378*, 2023.

Davide Torlo. Model reduction for advection dominated hyperbolic problems in an ALE framework: Offline and online phases. *arXiv preprint arXiv:2003.13735*, 2020.

Mario Ricchiuto and Davide Torlo. Analytical travelling vortex solutions of hyperbolic equations for validating very high order schemes. *arXiv preprint arXiv:2109.10183*, 2021.

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## International Talks

### Invited Talks

- Dec. 2024 **Numerical Aspects of Hyperbolic Balance Laws 2024**, *Ferrara, Italy*, presenting “How to preserve moving equilibria: Global Flux and analytical methods”
- Sept. 2024 **HONOM 2024**, *Chania, Greece*, presenting “Structure preserving methods via Global Flux quadrature: divergence-free preservation with continuous Finite Element”
- June 2024 **ECCOMAS 2024**, *Lisbon, Portugal*, presenting “Structure preserving methods via Global Flux quadrature: divergence-free preservation with continuous Finite Element”
- May 2024 **Shark 2024**, *Minho, Portugal*, presenting “Divergence-free Preserving Schemes: what’s wrong in SUPG and how to fix it”

- Feb. 2024 **SIAM UQ 2024**, *Trieste, Italy*, presenting “Weighted Reduced Order Methods for Nonuniformly Distributed Parameters: a Collection of Methods”
- Feb. 2024 **INDAM Workshop “Inside”**, *Rome, Italy*, presenting “IMEX ADER and DeC: arbitrary high order schemes, stability and application to advection–diffusion–dispersion”
- Sept. 2023 **ENUMATH 2023**, *Lisbon, Portugal*, presenting “Arbitrary Lagrangian-Eulerian Model Reduction for Advection Dominated Problems and Some Graph Neural Network Ideas”
- May 2023 **Nottingham LMS Research School on Adaptive Methods and Model Order Reduction**, *Nottingham, UK*, presenting “Certified reduced basis methods for parametric PDEs: tutorials with RBniCS library”
- May 2023 **PDE Afternoon**, *Vienna University and TU Wien*, presenting “Model order reduction for advection dominated (hyperbolic) problems in an ALE framework”
- Oct. 2022 **Essentially hyperbolic problems: unconventional numerics, and applications**, *Ascona, Switzerland*, presenting “A new efficient explicit Deferred Correction framework: analysis and applications to hyperbolic PDEs and adaptivity”
- Jul. 2021 **Numhyp 2021**, *Trento, Italy*, presenting “Continuous Galerkin high order well-balanced discrete kinetic model for shallow water equations”
- Jul. 2021 **Icosahom 2020**, *Vienna, Austria*, presenting “On modified Patankar schemes and oscillations: towards new stability definitions”
- Mar. 2021 **Workshop on hyperbolic balance laws**, *Oberwolfach, Germany*, presenting “ADER and DeC: Arbitrarily High Order Explicit Methods for hyperbolic PDEs and ODEs”
- July 2020 **Icosahom online MS**, presenting “Arbitrary high-order, conservative and positive preserving Patankar-type deferred correction schemes”
- May 2020 **Analysis Junior Seminars**, *Trieste, Italy*, presenting “Model Reduction for Advection Dominated Hyperbolic Problems in an ALE Framework: Offline and Online Phases”
- Apr. 2020 **SAMinar**, *Zürich, Switzerland*, presenting “ADER and DeC: Arbitrarily High Order Explicit Time Integration Methods”
- Jul. 2019 **ICIAM 2019**, *Valencia, Spain*, presenting “Model order reduction for advection dominated problems”
- May 2019 **Seminar on Lattice Boltzmann methods**, *Henri Poincaré Institute, Paris, France*, “High order asymptotic preserving IMEX residual distribution scheme for kinetic model”

#### [Selected Contributions in Conferences](#)

- Sept. 2024 **HONOM 2024**, *Chania, Greece*, presenting “Structure preserving methods via Global Flux quadrature: divergence-free preservation with continuous Finite Element”
- June 2023 **Numhyp**, *Bordeaux, France*, presenting “Saving computational costs with efficient iterative ADER methods: p-adaptivity, accuracy results and structure preserving limiters”
- May 2023 **Shark-FV**, *Minho, Portugal*, presenting “Global flux WENO finite volume and other structure preserving schemes for water equations”
- Apr. 2023 **CFC23**, *Cannes, France*, presenting “Reduced Order Models on a Variational Multi-Scale Model of Navier–Stokes”
- Sept. 2022 **MORE 2022**, *Berlin, Germany*, presenting “Model order reduction for Friedrichs’ systems: a bridge between elliptic and hyperbolic problems”
- Apr. 2022 **HONOM 2022**, *Braga, Portugal*, presenting “Arbitrary High–Order Positivity–Preserving Finite–Volume Shallow–Water scheme without Restrictions on the CFL”
- Jul. 2021 **Numhyp 2021**, *Trento, Italy*, presenting “Continuous Galerkin high order well-balanced discrete kinetic model for shallow water equations”
- Jan. 2021 **WCCM-Eccomas 2020**, *Paris, France*, presenting “High Order Well-Balanced Discrete Kinetic Model for Shallow Water Equations”
- Sep. 2019 **MultiMat 2019**, *Trento, Italy*, Poster on “High order IMEX DeC RD for Baer–Nunziato 7 equations model”
- Apr. 2019 **Honom**, *Madrid, Spain*, presenting “High order residual distribution methods for stiff problems”
- Feb. 2019 **SIAM CSE19**, *Spokane, WA, USA*, presenting “Model order reduction for hyperbolic problems”
- Jun. 2018 **HYP2018**, *University Park, PA, USA*, presenting “Asymptotic Preserving relaxation method for RD schemes”

- Jun. 2018 **ECCM–ECFD**, *Glasgow, UK*, presenting “Asymptotic Preserving relaxation method for RD schemes”
- May 2017 **NumHyp 2017**, *Ascona, Switzerland*, presenting “Asymptotic Preserving Deferred Correction Residual Distribution schemes”

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## Conference organization

- June 2024 **Scientific Machine Learning: Emerging Topics**, *SISSA, Trieste, Italy*

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## Workshops

- Nov. 2019 **High performance computing with Python**, *CSCS, Lugano, Switzerland*
- Jul. 2019 **Summer School on “Reduced order methods in computational fluid dynamics”**, *SISSA, Trieste, Italy*
- Feb. 2018 **Workshop on “Numerical and physical modelling in multiphase flows: a cross-fertilisation approach”**, *Paris, France*
- Mar. 2017 **Spring School on “Multiscale Modeling”**, *Aachen, Germany*
- Dec. 2016 **Workshop on “Modeling and Computation of Shocks and Interfaces”**, *Paris, France*

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## Research Visits

- Nov. 2024 **SISSA**, *Trieste, Italy*, hosted by dr. Federico Pichi  
Topic: Adaptive neural networks for model order reduction
- June 2024 **INRIA**, *Bordeaux, France*, hosted by prof. Mario Ricchiuto  
Topic: Divergence free methods
- Dec. 2023 **University of Zurich**, *Zurich, Switzerland*, hosted by prof. Remi Abgrall  
Topic: Adaptive high order methods
- Sept. 2023 **University of Cologne**, *Cologne, Germany*, hosted by Prof. Gregor Gassner  
Topic: Lattice Boltzmann methods for a fast and parallel implementation in `julia`
- May 2023 **University of Vienna**, *Vienna, Austria*, hosted by dr. Monica Nonino and prof. Ilaria Perugia  
Topic: Model order reduction for advection dominated problems
- Apr. 2023 **INRIA**, *Bordeaux, France*, hosted by prof. Mario Ricchiuto  
Topic: Divergence free methods
- Jul. 2022 **Gutenberg-University Mainz**, *Mainz, Germany*, hosted by dr. Philipp Öffner  
Topic: Modified Patankar schemes
- Feb. 2022 **INRIA**, *Bordeaux, France*, hosted by prof. Mario Ricchiuto  
Topic: Global Flux Problems
- Jun. 2019 **INRIA**, *Bordeaux, France*, hosted by prof. Mario Ricchiuto  
Topic: Kinetic schemes for shallow water equations
- Jun. 2018 **University of Catania**, *Italy*, hosted by prof. Giovanni Russo  
Topic: Implicit–Explicit Runge Kutta Deferred Correction algorithms

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## Awards, Scholarships and Competitions

- 2022 **Awards for the best contribution**, for the talk “A new efficient explicit Deferred Correction framework: analysis and applications to hyperbolic PDEs and adaptivity”, at Essentially hyperbolic problems: unconventional numerics, and applications, Ascona, Switzerland
- 2014–2016 **SISSA Scholarship for Master Degree**, *SISSA Scuola Internazionale Superiore di Studi Avanzati, Trieste*
- 2011–2014 **INDAM Scholarship for Bachelor Degree**, 5° national position
- 2011 **Premio Banca d'Italia per l'eccellenza negli studi matematici**
- 2008–2013 **Participant and winner of various mathematical games, both individually and as part of a team**, *Italian Mathematic Olympics Game, Kangaroo della Matematica, Gara di Matematica Applicata, Giochi Matematici Bocconi*

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## Extracurricular Experience

2017–now **Reviewer** for the *Journal of Computational Physics*, *Computer and Fluids*, *Mathematical Modelling and Numerical Analysis*, *Mathematics and Computers in Simulation*, *Applied Mathematics and Computation*, *Fluids*, *Advances in Computational Mathematics*, *Communications on Applied Mathematics and Computation*, *Journal of Scientific Computing*

2015–2016 **Lecturer of a seminar about "Music and Mathematics" for High Schools**

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## Skills

Programming Python (parallel computing, tensorflows, keras), Fortran, Matlab, Julia (parallel computing)  
Languages Italian (Native), English (C1 TOEFL 100/120), German B2