

Amaury HAYAT

Researcher in Mathematics

Research experience

- 2019 - pres. Ecole des Ponts Paristech - Professor (full since 2023, assist./associate. 2019-2023)**
> Deputy member of the University board for Education and Research (2022-pres)
> Main organizer of the seminar of applied mathematics (2020-2024)
> Faculty at CERMICS (Habilitation 02/23)
- Mar. - Apr. 2024 Peking University - Academic guest**
> Work on Fredholm backstepping
- 2019 - 2020 Rutgers University - Research associate (on leave)**
> Work on modeling and control of hyperbolic PDEs for traffic
(PI : Benedetto Piccoli)
- Sept. 2018 Tongji University – Academic guest**
> Work on density-velocity systems
- Mar. - Dec. 2017 ETH Zurich – Academic guest**
> Member of the institute for research in Mathematics (FIM)
- Avr.-Sep. 2014 Harvard University, Capasso Group - Research fellow**
> Work in optics at nanoscale.
> Work awarded by the French Academy of Sciences and Ecole Polytechnique.

Education

- 2016-2019 Sorbonne Université, LJLL – PhD candidate**
Dissert. title: Stabilization of 1D nonlinear hyperbolic systems by boundary controls
(Advisor : Jean-Michel Coron, co-advisor: Sébastien Boyaval)
- 2014-2016 Corps des Ponts, des Eaux et Forêts – Master of Public Policy in sustainable development.**
- 2014-2015 University of Cambridge, Queens’ College – MAST in applied mathematics**
(with First Class Degree and Foundation Scholarship award)
- 2011-2014 Ecole Polytechnique – Class X2011, Bsc. 2013, Eng. degree 2014, MSc. in applied physics. 2016.**
- 2009-2011 Lycée Sainte-Geneviève – High level undergraduate program in Mathematics, Physics and Chemistry**

Honors and awards

- 2021 Forbes 30 under 30 - Europe (in science and healthcare)
- 2020 Solemn Prize of the Chancellerie des Universités de Paris
- 2020 2019 PhD award of the European Embedded Control Institute
- 2014 Medal L.E. Rivot awarded by the French Academy of Sciences
- 2012 Medal of National Defense – awarded exceptionally
- 2008 Olympiades of geoscience – 1st Prize for Paris, Silver medal for France

Academic responsibilities

- 2022-pres. Deputy member (elected) of Ecole des Ponts Paristech's board for Education and Research
- 2020-2024 Main organizer of the seminar of applied mathematics, Ecole des Ponts Paristech.
- 2018-2019 Representative of PhD candidates at the board of Laboratoire Jacques Louis-Lions.
- 2016-2018 Organizer of the PhD students' seminar , Sorbonne University.
- 2014-2016 Representative of the IEPEF (senior civil servant trainees) class of 2016, board member of the UniPEF (a major senior civil servants' union)
- 2014-2015 Member of the student government (MCR first year rep.) – Queens' College Cambridge

Editorial activities

- 2024-pres Associate editor of Acta Applicandae Mathematicae
- 2022 Guest editor for Networks and Heterogeneous Media (one special issue)

Other professional experience

- Feb. - Jun. 2016 **Agence Française de Développement – Short term consulting**
> Work in the digital strategy team.
> Consultations, making and presenting the digital strategy.
> Prospective mission in Benin on digital technologies deployment.
- Sep. 2014 - Pres. **Corps des Ponts des Eaux et Forêts - IPEF (Senior civil servant)**
> Trainee 2014-2016 ; appointed permanently 2016
- Jul.-Aug. 2012 **SAFRAN Aircraft Engines, Progress strategy direction – Intern**
> Diffusion of the leadership model among young managers, under budget constraints.
- 2011-2012 **Gendarmerie Nationale, Commanding Group of Belfort – Officer**
> Coordinate actions of a 20 people team.
> Participate in patrols, support operations and investigations.

Teaching

- 2023-pres.** Theoretical and numerical analysis of hyperbolic systems, Sorbonne Université, graduate (M2), lectures.
- 2018-pres.** Control of dynamical systems and functional analysis, Ecole des Ponts Paristech, graduate (M1), practical exercises and tutoring (2018), lectures (2020-pres.).
- 2020-2023** Analysis and partial differential equations, Ecole des Ponts Paristech, senior undergrad (L3/1A), tutorials.
- 2021-2023** Completeness and Banach spaces, Ecole des Ponts Paristech, senior undergrad (L3/1A), lectures and tutorials
- 2021** Partial differential equations and finite elements, Ecole des Ponts Paristech, senior undergrad (L3/1A), lectures and tutorials.
- 2018-2020** Differential calculus and measure theory, Ecole des Ponts Paristech, senior undergrad (L3/1A), lectures and tutorials.
- 2017** Complex analysis, Sorbonne Université, senior undergrad (L3/1A), tutorials.

Student supervision

- 2023-pres.** Fabian Glöckle, PhD student (with Meta and Timothy Gowers)
- 2023-pres.** Yating Hu, visiting PhD student (advisor: Peipei Shang)
- 2022-pres.** Epiphane Loko, PhD student (with Antoine Chaillet)
- 2021-2024** Nathan Lichtlé, PhD student (with Alexandre Bayen), received the **UC Berkeley Fellowship**
- 2020-2023** Jean Cauvin-Vila, PhD student (with Virginie Erlacher)
- 2024** Gwenaëlle Léon, Master student
- 2023** Vincent Boulard, undergraduate researcher, received the **Junior Fermat Prize**
- 2022** Fabian Glöckle, research associate (with Timothée Lacroix)
- 2022** Tinhinane Mezair, Master thesis.
- 2021** Epiphane Loko, Master thesis.
- 2020** Nicolas Kardous, master student intern (with Alexandre Bayen and Alexandre Keimer)
- 2019-2020** Sydney Truong, undergraduate researcher (with Benedetto Piccoli), received the **Dean's Undergraduate Research Prize** and the **Mathematical Sciences Scholarship Award** “for best undergraduate research”

Talks in conferences

- 2024 [Mathematics for and by Large Language Models](#), IHES (invited speaker)
- 2023 [3rd Workshop on Mathematical reasoning and AI at NeurIPS](#), New Orleans (poster)
- 2023 [Control Methods in Hyperbolic Partial Differential Equations workshop](#), Oberwolfach (invited speaker)
- 2023 [International Congress on Industrial and Applied Mathematics](#), Tokyo (minisymposium)
- 2023 2nd CIRCLES Workshop on Traffic and Autonomy, Maiori (senior invited speaker)
- 2022 [Advances in Neural Information Processing Systems](#), New Orleans
- 2022 Formal Language and AI in Mathematics, IHP, Paris (invited speaker)
- 2022 [Congrès d'Analyse Numérique](#), Evian. (oral communication)
- 2021 Control Methods in Hyperbolic Differential Equations workshop (invited speaker)
- 2021 [International Conference on Learning Representations](#) (poster)
- 2019 [KI-net, Young Researchers Workshop: Kinetic descriptions in theory and applications](#), College Park, MA. (Invited speaker)
- 2019 [International Congress on Industrial and Applied Mathematics](#), Valencia. (oral communication)
- 2019 [Congrès SMAI](#), Guidel. (oral communication with financial support).
- 2018 [Analysis, Control and Inverse Problems for PDEs of French-German-Italian LIA](#), Napoli. (invited junior speaker)
- 2018 [International Congress of Mathematicians](#), Rio, August 2018. (oral communication)
- 2018 [First Franco-Moroccan Congress of Applied Mathematics](#), Marrakech. (oral communication)
- 2017 [Congrès SMAI](#), Ronces-les-bains. (oral communication)

Preprints :

- G. Bastin, J-M. Coron, A. Hayat*, The usefulness of viscosity for the robustness of boundary feedback control of an unstable fluid flow system, 2023
- K. Agbo Bidi, J-M Coron, A. Hayat, N. Lichtlé*, A Novel Approach to Feedback Control with Deep Reinforcement Learning, 2023
- A. Hayat, A. Alanqary, R. Bhadani, C. Denaro, R. J. Weightman, S. Xiang et al, Traffic smoothing using explicit local controllers, 2023
- J.W. Lee*, H. Wang*, K. Jang*, A. Hayat*, M. Bunting*, et al. Traffic Control via Connected and Automated Vehicles, 2023
- A. Hayat, Y. Hu, P. Shang*, Boundary Stabilization of Star-Shaped Saint-Venant Networks with Combined Subcritical and Supercritical Channels, 2023
- A. Hayat, T. Liard, F. Marcellini, B. Piccoli*, A multiscale second order model for the interaction between AV and traffic flows: analysis and existence of solutions, preprint, 2021.
- F. Charton, A. Hayat, S. McQuade, N. Merrill, B. Piccoli*, A deep language model to predict metabolic network equilibria, preprint, 2021.

Published :

- L. Gagnon, A. Hayat, C. Zhang, S. Xiang*, Fredholm backstepping for critical operators and application to rapid stabilization for the linearized water waves, accepted in *Annales de l'institut Fourier*, 2023.
- A. Hayat, Y. Hu, P. Shang*, PI control for the cascade channels modeled by general Saint-Venant equations, *IEEE Transactions on Automatic Control*, 2022.
- A. Hayat, B. Piccoli, S. Truong*, Dissipation of traffic jams using a single autonomous vehicle on a ring road, *SIAM Journal on Applied Mathematics*, 2023.
- K. Agbo Bidi, J-M Coron, A. Hayat, N. Lichtlé*, Reinforcement Learning in Control Theory: A New Approach to Mathematical Problem Solving, *3rd Workshop on Math and AI at NeurIPS*, 2023
- F. Glöckle, B. Roziere, A. Hayat, G. Synnaeve, Temperature-scaled large language models for Lean proofstep prediction, *3rd Workshop on Math and AI at NeurIPS*, 2023.
- R. Bhadani, M. Bunting, M. Nice, F. Wu, A. Hayat, et al., Approaches for Synthesis and Deployment of Controller Models on Automated Vehicles for Car-following in Mixed Autonomy, *Proceedings of CPS-IoT*, 2023

*Authors in alphabetical order or co-first author

- J. Cauvin-Vila, V. Ehrlicher, A. Hayat*, Boundary stabilization of one-dimensional cross-diffusion systems in a moving domain, *Journal of Differential Equations*, 2022.
- G. Bastin, J-M. Coron, A. Hayat*, Diffusion and robustness of boundary feedback stabilization of hyperbolic systems, *Mathematics of Control, Signals, and Systems*, 2022.
- G. Lample, M.-A. Lachaux, T. Lavril, G. Ebner, A. Rodriguez, T. Lacroix, HyperTree Proof Search for Neural Theorem Proving, *Advances in neural information processing systems (NeurIPS)*, 2022
- A. Hayat, [PI Controller for the general Saint-Venant equations](#), *Journal de l'École Polytechnique*, 2022.
- L. Gagnon, A. Hayat, C. Zhang, S. Xiang*, Fredholm transformation on Laplacian and rapid stabilization for the heat equation, *Journal of Functional Analysis*, 2022.
- A. Hayat, B. Piccoli, S. Xiang*, Stability of multi-population traffic flows, accepted in *Networks and Heterogeneous Media*, 2022.
- J-M. Coron, A. Hayat, C. Zhang, S. Xiang*, Stabilization of the linearized water tank system. *Archive for Rational Mechanics and Analysis*, 2022.
- N. Kardous*, A. Hayat*, S. McQuade, X. Gong, S. Truong, P. Arnold, A. Bayen, B. Piccoli, A rigorous multi-population multi-lane hybrid traffic model and its mean-field limit for dissipation of waves via autonomous vehicles, *European Physical Journal - Special Topics*, 2022.
- A. Hayat, X. Gong, J. Lee et al., A holistic approach to the energy-efficient smoothing of traffic via autonomous vehicles, Book Chapter of *Intelligent Control and Smart Energy Management*, Springer, 2022
- S. Albeaik, A. Bayen, M-T. Chiri, X. Gong, A. Hayat, N. Kardous, A. Keimer, S. T. McQuade, B. Piccoli, Y. You*, Limitations and Improvements of the Intelligent Driver Model (IDM), *SIAM Journal on Applied Dynamical Systems*, 2021.
- A. Hayat, Boundary stabilization of 1D hyperbolic systems, *Annual Reviews in Control*, 2021.
- J. Lee, G. Gunter, R. Ramadan et al. Integrated Framework of Vehicle Dynamics, Instabilities, Energy Models, and Sparse Flow Smoothing Controllers, *Proceedings of the ACM 1st Workshop on Data-Driven and Intelligent Cyber-Physical Systems*, 2021
- A. Hayat, P. Shang*, [Exponential stability of density-velocity systems with boundary conditions and source term for the \$H^2\$ norm](#), *Journal de Mathématiques Pures et Appliquées*, 2021.
- F. Charton, A. Hayat, G. Lample*, [Learning advanced mathematical computations from examples](#), *International Conference of Learning and Representation (ICLR)*, 2021.

- G. Bastin, J-M. Coron, A. Hayat*, [Input-to-State Stability in sup norms for hyperbolic systems with boundary disturbances](#), *Nonlinear Analysis*, 2021.
- A. Hayat, [Global exponential stability and Input-to-State Stability of semilinear hyperbolic systems for the \$L^2\$ norm](#), accepted in *Syst. Contr. Lett.*, 2020.
- G. Bastin, J-M. Coron, A. Hayat*, [Feedforward boundary control of \$2 \times 2\$ nonlinear hyperbolic systems with application to Saint Venant equations](#), accepted in *European Journal of Control* 2020.
- Z. An, N. J. Merrill, K. Lee, R. Robin, A. Hayat, O. Zapfe, B. Piccoli, A Two-Step Model of Human Entrainment: A Quantitative Study of Circadian Period and Phase of Entrainment, accepted in *Bulletin of Mathematical Biology*, 2020.
- J-M. Coron et A. Hayat*, [PI controllers for 1D nonlinear transport equation](#), 2019, *IEEE Trans. Automat. Contr.*, vol. 64, no 11, p. 4570-4582.
- G. Bastin, J-M. Coron, A. Hayat, P. Shang*, [Boundary feedback stabilization of hydraulic jumps](#), 2019, *IFAC J. of Systems and Control*, vol. 7, p. 100026.
- G. Bastin, J-M. Coron, A. Hayat, P. Shang*, [Exponential boundary feedback stabilization of a shock steady state for the inviscid Burgers equation](#), 2019, *Math. Models Meth. Appl. Sci.*, vol. 29, no 2, p. 271-316.
- A. Hayat, [On boundary stability of inhomogeneous \$2 \times 2\$ 1-D hyperbolic systems for the \$C^1\$ norm](#), 2019, *ESAIM: Cont. Optim. Calc. Var.*, vol. 25, p. 82.
- A. Hayat, [Exponential stability of general 1-D quasilinear systems with source terms for the \$C^1\$ norm under boundary conditions](#), 2019, *SIAM J. Control Optim.*, vol. 57, no 6, p. 3603-3638.
- A. Hayat et P. Shang*, [A quadratic Lyapunov function for Saint-Venant equations with arbitrary friction and space-varying slope](#), 2019, *Automatica*, Vol. 100, p. 52-60.
- A. Hayat, A.J. Hackett-Pain, H. Pretzsch, T.T. Rademacher, A.D. Friend, [Modelling tree growth taking into account source and sink limitations](#), 2017, *Front. Plant Sci.* 8:182. doi: 10.3389/fpls.2017.00182.
- A. Hayat*, J.P.B. Mueller*, F. Capasso, [Lateral chirality sorting optical forces](#), 2015, *PNAS*, vol.112no.43, 13190-13194