

# Giovanni Bordiga

## Curriculum Vitae

### Research interests

Mechanical intelligence · Inverse design · Differentiable physics · Optimization · Mechanical metamaterials · Material instabilities · Wave propagation · Homogenization theory

### Education

- Nov. 2016 – **PhD in Solid and Structural Mechanics**,  
Apr. 2020 *Doctoral School of Civil, Environmental, and Mechanical Engineering*,  
**University of Trento (Italy)**,  
Curriculum: Modeling and Simulation
- **PhD Thesis:** “Homogenization of periodic lattice materials for wave propagation, localization, and bifurcation”,  
**Advisors:** Andrea Piccolroaz and Davide Bigoni,  
**Evaluation Committee:** Basile Audoly and Pedro M. Reis,  
Final grade: *Cum Laude*.
- Sep. 2014 – **MSc in Civil Engineering**,  
Oct. 2016 *Department of Civil, Environmental, and Mechanical Engineering*,  
**University of Trento (Italy)**,  
Curriculum: Structures
- **MSc Thesis:** “Micromechanical modeling of masonry” (in Italian),  
**Advisor:** Davide Bigoni,  
Final grade: *110/110 Cum Laude*.
- Sep. 2011 – **BSc in Civil Engineering**,  
Sep. 2014 *Department of Civil, Environmental, and Mechanical Engineering*,  
**University of Trento (Italy)**
- **BSc Thesis:** “Non-uniform torsion of thin-walled open cross-section beams” (in Italian),  
**Advisor:** Massimiliano Gei,  
Final grade: *110/110 Cum Laude*.

### Research experience

- Sep. 2021 – **Postdoctoral Researcher**,  
Present *Harvard School of Engineering and Applied Sciences*,  
**Harvard University (US)**,  
**Advisors:** Katia Bertoldi
- Development of a differentiable simulation framework for automating the design of flexible mechanical metamaterials with target dynamic responses.
  - Inverse design of flexible mechanical metamaterials for shape morphing, nonlinear wave guiding, energy focusing, shock mitigation, and cloaking of nonlinear waves.
- May 2020 – **Postdoctoral Researcher**,  
Aug. 2021 *Department of Civil, Environmental, and Mechanical Engineering*,  
**University of Trento (Italy)**,  
**Advisors:** Andrea Piccolroaz and Davide Bigoni

- Homogenization of elastic lattices prestressed by circulatory (follower) forces demonstrating the existence of hypoelastic continuum materials displaying flutter instability at the macroscale.
- Analytical and numerical investigation of tensile buckling in periodic lattice materials endowed with sliding constraints.

Nov. 2016 – **PhD Student in Solid and Structural Mechanics,**  
 Apr. 2020 *Department of Civil, Environmental, and Mechanical Engineering,*  
**University of Trento (Italy),**  
**Advisors:** Andrea Piccolroaz and Davide Bigoni

- Analytical and numerical investigation of the free and forced dynamic response of Rayleigh-beam lattices leading to sharp frequency-dependent wave localization.
- Modeling and tuning of the prestress state in a lattice domain to realize dynamic interfaces designed for total reflection, negative refraction, and wave channeling.
- Development of static and dynamic homogenization methods for beam lattices prestressed by conservative and non-conservative positional forces.
- Analytical and numerical analysis of macroscopic and microscopic bifurcations in prestressed anisotropic lattices and their connection to shear bands formation and short-wavelength instabilities.

## Publications

### Peer-reviewed journals

- [9] C. Perez-Garcia, R. Zaera, J. Aranda-Ruiz, **G. Bordiga**, G. Risso, M. L. Lopez-Donaire, K. Bertoldi, D. Garcia-Gonzalez, “Reprogrammable Mechanical Metamaterials via Passive and Active Magnetic Interactions”. In: *Adv. Mater.* (2025), p. 2412353. DOI: [10.1002/adma.202412353](https://doi.org/10.1002/adma.202412353).
- [8] A. S. Meeussen, **G. Bordiga**, A. X. Chang, B. Spoettling, K. P. Becker, L. Mahadevan, K. Bertoldi, “Textile Hinges Enable Extreme Properties of Kirigami Metamaterials”. In: *Adv. Funct. Mater.* (2024), p. 2415986. DOI: [10.1002/adfm.202415986](https://doi.org/10.1002/adfm.202415986).
- [7] **G. Bordiga**, E. Medina, S. Jafarzadeh, C. Bösch, R. P. Adams, V. Tournat, K. Bertoldi, “Automated Discovery of Reprogrammable Nonlinear Dynamic Metamaterials”. In: *Nat. Mater.* 23.11 (2024), pp. 1486–1494. DOI: [10.1038/s41563-024-02008-6](https://doi.org/10.1038/s41563-024-02008-6).
- [6] A. Kotikian, A. A. Watkins, **G. Bordiga**, A. Spielberg, Z. S. Davidson, K. Bertoldi, J. A. Lewis, “Liquid Crystal Elastomer Lattices with Thermally Programmable Deformation via Multi-Material 3D Printing”. In: *Adv. Mater.* (2024), p. 2310743. DOI: [10.1002/adma.202310743](https://doi.org/10.1002/adma.202310743).
- [5] **G. Bordiga**, D. Bigoni, A. Piccolroaz, “Tensile Material Instabilities in Elastic Beam Lattices Lead to a Bounded Stability Domain”. In: *Philos. Trans. R. Soc. Math. Phys. Eng. Sci.* 380.2231 (2022), p. 20210388. DOI: [10.1098/rsta.2021.0388](https://doi.org/10.1098/rsta.2021.0388). (Cover article).
- [4] **G. Bordiga**, A. Piccolroaz, D. Bigoni, “A Way to Hypo-Elastic Artificial Materials without a Strain Potential and Displaying Flutter Instability”. In: *J. Mech. Phys. Solids* 158 (2022), p. 104665. DOI: [10.1016/j.jmps.2021.104665](https://doi.org/10.1016/j.jmps.2021.104665).
- [3] **G. Bordiga**, L. Cabras, A. Piccolroaz, D. Bigoni, “Dynamics of Prestressed Elastic Lattices: Homogenization, Instabilities, and Strain Localization”. In: *J. Mech. Phys. Solids* 146 (2021), p. 104198. DOI: [10.1016/j.jmps.2020.104198](https://doi.org/10.1016/j.jmps.2020.104198).
- [2] **G. Bordiga**, L. Cabras, D. Bigoni, A. Piccolroaz, “Free and Forced Wave Propagation in a Rayleigh-beam Grid: Flat Bands, Dirac Cones, and Vibration Localization vs Isotropization”. In: *Int. J. Solids Struct.* 161 (2019), pp. 64–81. DOI: [10.1016/j.ijsolstr.2018.11.007](https://doi.org/10.1016/j.ijsolstr.2018.11.007).
- [1] **G. Bordiga**, L. Cabras, A. Piccolroaz, D. Bigoni, “Prestress Tuning of Negative Refraction and Wave Channeling from Flexural Sources”. In: *Appl. Phys. Lett.* 114.4 (2019), p. 041901. DOI: [10.1063/1.5084258](https://doi.org/10.1063/1.5084258). (Editor’s Pick).

## In conference proceedings

- [3] **G. Bordiga**. “In-Plane Floquet-Bloch Waves in Elastic Grids and Prestress Tuning of Structured Interfaces”. In: *RAMSS2019 - Recent Advances in Mechanics of Solids and Structures*. Trento, 2019. URL: <http://rgdoi.net/10.13140/RG.2.2.15758.82244>.
- [2] **G. Bordiga**. “Free and Forced Wave Propagation in a Rayleigh-beam Grid: Flat Bands, Dirac Cones, and Vibration Localization vs Isotropization”. In: *ESMC2018 - 10th European Solid Mechanics Conference*. Bologna, 2018. URL: <http://rgdoi.net/10.13140/RG.2.2.24679.09126>.
- [1] **G. Bordiga**. “Micromechanical Modelling of Masonry”. In: *CERMODEL2017*. Trento, 2017.

## Software

- [3] **G. Bordiga**. *DifFlexMM: Differentiable Flexible Mechanical Metamaterials*. Bertoldi Group, 2024. URL: <https://github.com/bertoldi-collab/DifFlexMM>.
- [2] **G. Bordiga**. *Simulation and Design of Shape-Morphing LCE Lattices*. Bertoldi Group, 2024. URL: <https://github.com/bertoldi-collab/morphing-lattices>.
- [1] **G. Bordiga**. *A Humble Image Tracking Code*. Bertoldi Group, 2023. URL: <https://github.com/bertoldi-collab/tracking-markers>.

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## Conference presentations

- Mar. 16–21, **APS2025**, Anaheim, CA (US),  
2025 *Nonlinear mechanical metamaterial cloaks*,  
**G. Bordiga**, J. Argaud, A. A. Watkins, V. Tournat, K. Bertoldi.
- Sep. 9–11, **SMASIS2024**, Atlanta, GA (US),  
2024 *Automated design of flexible mechanical metamaterials with reprogrammable wave functionalities*,  
**G. Bordiga**, E. Medina, S. Jafarzadeh, C. Bösch, V. Tournat, K. Bertoldi.
- Sep. 9–11, **SMASIS2024**, Atlanta, GA (US),  
2024 *Mechanical metamaterial ‘brain’ for fully analog control of a mobile robot*,  
C. Bösch, **G. Bordiga**, C. McCann, S. Jafarzadeh, J. Wilt, M. Yuen, Y. Jin, A. Fichtner, K. Bertoldi.
- Jul. 3–4, 2024 **DynaMetaFlex**, Workshop on “Nonlinear dynamics of flexible mechanical metamaterials”, Laboratoire d’Acoustique de l’Université du Mans, Institut d’Acoustique – Graduate School, CNRS, Le Mans Université, Le Mans, (France),  
*Teaching reprogrammable dynamics to material structures*,  
**G. Bordiga**, E. Medina, S. Jafarzadeh, C. Bösch, V. Tournat, K. Bertoldi.
- Oct. 8–11, **SES2023**, Minneapolis, MN (US),  
2023 *Inverse-design of nonlinear mechanical metamaterial cloaks*,  
**G. Bordiga**, J. Argaud, V. Tournat, K. Bertoldi.
- Mar. 5–10, **APS2023**, Las Vegas, NV (US),  
2023 *Manipulating energy flows with non-periodic mechanical metamaterials*,  
**G. Bordiga**, E. Medina, V. Tournat, K. Bertoldi.
- Oct. 16–19, **SES2022**, College Station, TX (US),  
2022 *Non-periodic design discovery for optimal dynamic responses in flexible mechanical metamaterials*,  
**G. Bordiga**, E. Medina, V. Tournat, K. Bertoldi.
- Jul. 4–8, 2022 **ESMC2022**, 11th European Solid Mechanics Conference, Galway (Ireland),  
*Non-hyper-elastic materials from follower prestress states reveal flutter instability in elastic lattices*  
(Invited talk),  
**G. Bordiga**, A. Piccolroaz, D. Bigoni.
- Mar. 14–18, **APS2022**, Chicago, IL (US),  
2022 *Architected metamaterials for routing nonlinear mechanical pulses*,  
**G. Bordiga**, E. Medina, V. Tournat, K. Bertoldi.

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## Invited talks & seminars

- Mar. 31, 2025 **Seminar**, *Center for Fluid Mechanics Seminar*, Brown University, Providence, RI (US),  
*Automating the discovery of nonlinear architected materials*,  
**G. Bordiga**.
- Jul. 25, 2024 **Seminar**, *Seismology and Wave Physics Lab*, ETH, Zürich (Switzerland),  
*Teaching reprogrammable dynamics to material structures*,  
**G. Bordiga**.
- Jun. 13, 2024 **Seminar**, *Laboratory for Intelligent Probabilistic Systems*, Princeton University, Princeton, NJ (US),  
*Teaching reprogrammable dynamics to material structures*,  
**G. Bordiga**.
- Jul. 4–8, 2022 **ESMC2022**, *11th European Solid Mechanics Conference*, Galway (Ireland),  
*Non-hyper-elastic materials from follower prestress states reveal flutter instability in elastic lattices*,  
**G. Bordiga**, A. Piccolroaz, D. Bigoni.

## Mentoring

### At Bertoldi Lab, Harvard University

- Sep., 2024 – **Stijn de Bruin**, Master student, **TU Delft (Netherlands)**,  
Jun., 2025 Project: *Encoding dynamic bifurcations in mechanical metamaterials*.
- Sep., 2024 – **Antoine Fondeur**, Master student, **MINES Paris – PSL (France)**,  
Jan., 2025 Project: *Inverse design of magneto-mechanical metamaterials for reprogrammable static and dynamic responses*.
- Sep., 2024 – **Jian Zhimo**, PhD student, **Tsinghua University (China)**,  
Jan., 2025 Project: *Mechanical metamaterials for sensing and control*.
- Sep., 2023 – **Tom Vreugdenhil**, Master student, **TU Delft (Netherlands)**,  
Sep., 2024 Thesis: *Dynamic metamaterials for reprogrammable underactuated robotics*.
- Sep., 2023 – **Carlos Pérez García**, PhD student, **University Carlos III of Madrid (Spain)**,  
Dec., 2024 Project: *Magneto-mechanical metamaterials for reprogrammable stress-strain response and energy absorption*.
- Feb.–Sep., 2023 **Jean-Gabriel Argaud**, Master student, **MINES Paris – PSL (France)**,  
Project: *Cloaking in nonlinear mechanical metamaterials*.
- Jul.–Dec., 2022 **Cyrril Bösch**, PhD student, **ETH (Switzerland)**,  
Project: *Mechanical metamaterial ‘brain’ enables fully analog robotic control*.
- Sep., 2022–present **Audrey Watkins**, PhD student, **Harvard University (US)**,  
Project: *Nonlinear waves in multistable metamaterials for mechanical computing*.
- Feb.–Sep., 2022 **Ben Spoettling**, Master student, **ETH (Switzerland)**,  
Thesis: *Automated design and discovery of shape-morphing metamaterials*.

## Teaching experience

- 2018–2020 **Teaching assistant**,  
*Department of Civil, Environmental, and Mechanical Engineering*,  
**University of Trento (Italy)**,  
Course: *Structural Dynamics*
- 40+ students.
  - Material: Created interactive Mathematica notebooks to teach the dynamics of single and multi-degree-of-freedom systems, modal analysis, free and forced vibrations of elastic beams.
  - Graded: oral exams.

- 2019–2020 **Lecturer and tutor,**  
*Department of Civil, Environmental, and Mechanical Engineering,*  
**University of Trento (Italy),**  
 Course: *Solids and Structural Mechanics*
- 80+ students, 20 hours of lectures, and 5 hours of tutoring activities.
  - Taught: De Saint Venant theory and exercises, Principle of Virtual Work for statically indeterminate structures, structural symmetries, frame structures.
  - Graded: written and oral exams.
- 2018–2019 **Lecturer and tutor,**  
*Department of Civil, Environmental, and Mechanical Engineering,*  
**University of Trento (Italy),**  
 Course: *Solids and Structural Mechanics*
- 80+ students, 20 hours of lectures, and 20 hours of tutoring activities.
  - Taught: De Saint Venant theory and exercises, Principle of Virtual Work for statically indeterminate structures, Mohr's circles, elastic beam theory, frame structures.
  - Graded: written and oral exams.
- 2017–2018 **Lecturer and tutor,**  
*Department of Civil, Environmental, and Mechanical Engineering,*  
**University of Trento (Italy),**  
 Course: *Solids and Structural Mechanics*
- 80+ students, 30 hours of lectures, and 30 hours of tutoring activities.
  - Taught: De Saint Venant theory and exercises, Mohr's circles, failure and yield criteria (Von Mises, Tresca, Mohr-Coulomb, Rankine, Drucker-Prager), Principle of Virtual Work for statically indeterminate structures, elastic beam theory.
  - Graded: written and oral exams.

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## Peer reviews

- [Journal of the Mechanics and Physics of Solids](#)
- [Science Advances](#)
- [Advanced Engineering Materials](#)
- [International Journal of Solids and Structures](#)
- [European Journal of Mechanics - A/Solids](#)
- [Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences](#)
- [Computer Methods in Applied Mechanics and Engineering](#)
- [Journal of Elasticity](#)
- [Mechanics of Materials](#)
- [Journal of Sound and Vibration](#)
- [Meccanica](#)
- [Journal of Mechanics of Materials and Structures](#)

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## Events & Conferences service

- Sep. 9–11, 2024 **SMASIS2024, Special Symposium: Embodying Physical Computing and Mechano-Intelligence**, Atlanta, GA (US)  
*Served as:* Session chair.
- Jul. 22, 2024 **Git + GitHub Workshop: Version control for scientists**, Harvard SEAS, Cambridge, MA (US)  
*Served as:* Organizer and presenter.

- Jul. 29, 2022 **Git + GitHub Workshop: Version control for scientists**, Harvard SEAS, Cambridge, MA (US)  
Served as: Organizer.
- Sep. 27, 2019 **Researchers' night**, Trento (Italy)  
Served as: Co-organizer and presenter for the Solid and Structural Mechanics exhibition stand.
- Jun. 6–7, 2019 **RAMSS2019 — Recent Advances in Mechanics of Solids and Structures**, Trento (Italy)  
Served as: Conference assistant.
- Sep. 28, 2018 **Researchers' night**, Trento (Italy)  
Served as: Co-organizer and presenter for the Solid and Structural Mechanics exhibition stand.
- Jul. 2–6, 2018 **ESMC2018 — 10<sup>th</sup> European Solid Mechanics Conference**, Bologna (Italy)  
Served as: Co-organizer for conference program.
- Sep. 29, 2017 **Researchers' night**, Trento (Italy)  
Served as: Co-organizer and presenter for the Solid and Structural Mechanics exhibition stand.

## Awards & Honors

- 2017 Graduation Award for Merit, University of Trento (Italy)
- 2016 University Scholarship for Merit, Italian government, INPS
- 2015 University Scholarship for Merit, Italian government, INPS
- 2015 Graduation Award for Merit, University of Trento (Italy)
- 2014 University Scholarship for Merit, Italian government, INPS
- 2013 University Scholarship for Merit, Italian government, INPS
- 2012 University Scholarship for Merit, Italian government, INPS

## Entrepreneurial experience

- Apr.–May, 2024 **Blueprint**, By *The Engine Tough Tech startup accelerator*, Cambridge, MA (US)  
Startup: [SoftPulse](#). Turning metafluids into a passive pressure-regulating device for drug-resistant hypertension treatment.  
Team: Adel Djellouli, Giovanni Bordiga, and Katia Bertoldi.

## Community activities

- Jun.–Aug., 2024 **Beach volleyball tournament**, *Harvard Rhino League*, Cambridge, MA (US)  
Role: Team captain for the Bertoldi Lab (Championship winner).
- Jun.–Aug., 2023 **Beach volleyball tournament**, *Harvard Rhino League*, Cambridge, MA (US)  
Role: Team captain for the Bertoldi Lab (Championship winner).

## Skills

### Programming

Scientific computing	Wolfram Language	Highly specialized	Python	Highly specialized
	MATLAB	Advanced	R	Intermediate
Markup	L <sup>A</sup> T <sub>E</sub> X	Highly specialized	Markdown	Advanced
	HTML/CSS	Basic		
Others	Java	Advanced	C/C++	Intermediate
	Javascript	Advanced	Bash	Intermediate
	Android	Basic	SQLite	Basic

### Application software

Modeling & Simulation	Mathematica	Highly specialized	COMSOL	Advanced
	ABAQUS	Intermediate	SAP2000	Intermediate
CAD	AutoCAD	Highly specialized	SketchUp	Advanced

<b>IDE</b>	VSCode	<i>Highly specialized</i>	IntelliJ IDEA	<i>Advanced</i>
	Android Studio	<i>Intermediate</i>		
<b>Graphics</b>	Inkscape	<i>Advanced</i>	GIMP	<i>Intermediate</i>
<b>Others</b>	Git	<i>Advanced</i>	GitHub	<i>Advanced</i>
	Zotero	<i>Advanced</i>		
<b>Operating systems</b>				
	Linux	<i>Highly specialized</i>	Windows	<i>Advanced</i>
	Android	<i>Advanced</i>	MacOS	<i>Intermediate</i>

## Languages

- **Italian:** Native language
- **Chinese:** Duolingo
- **English:** Professional proficiency