

Alessandro Lucantonio

Curriculum Vitae

The BioRobotics Institute
Scuola Superiore Sant'Anna
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Current position

April 2022– **Associate Professor in Solid and Structural Mechanics**, *The BioRobotics Institute*, Mathematical and Computational Modeling Area.

Research Experience

[Scuola Superiore Sant'Anna, Italy](#)

April 2019 – **Tenure-Track Assistant Professor in Solid and Structural Mechanics**, *The BioRobotics Institute*, Mathematical and Computational Modeling Area.

[SISSA - International School for Advanced Studies, Italy](#)

January 2014 **Postdoctoral Research Fellow**, *Mathematics Area*.

– March 2019 Working on the ERC Advanced Grant “MicroMotility” (P.I. Prof. A. DeSimone).

[Princeton University, USA](#)

April 2012 – **Visiting Student Research Collaborator**, *Complex Fluids Group*.

July 2012 Performing experiments and developing theoretical models of swelling-induced instabilities of thin elastic membranes, under the supervision of Prof. H. A. Stone.

Education

[Sapienza Università di Roma, Italy](#)

2010–2014 **Ph.D. in Theoretical and Applied Mechanics**, *Department of Mechanical and Aerospace Engineering*.

Topics: Solid and Structural Mechanics, Nonlinear Elasticity, Computational Mechanics, Finite Element Method, Swelling of polymer gels, Multiphysics Simulation. Dissertation: “Extreme mechanics of gels: large deformations and swelling-induced instabilities”.

2008–2010 **M.Sc. in Space Engineering**, *Department of Mechanical and Aerospace Engineering*.

Final mark: 110/110 *cum laude*. Thesis: “Non-linear modeling of electroactive polymers: theory and applications”.

2005–2008 **B.Sc. in Aerospace Engineering**, *Department of Mechanical and Aerospace Engineering*.

Final mark: 110/110 *cum laude*. Thesis: “Modeling nanocomposites with a non-uniform distribution of fibers”.

Research interests and early achievements track-record

My research interests lie at the intersection of several disciplines, including *non-linear elasticity*, *material science*, *structural mechanics*, *computational mechanics*, *differential geometry* and, recently, *machine learning*. In particular, I am studying a wide range of problems especially in the fields of **shape morphing** and **4D printing of active materials** (mainly hydrogels and bio-hybrid materials), **plant growth**, **multiphysics modeling of smart materials**, **modeling of soft robotic actuators** and **fracture of soft materials and biological tissues**, using a combination analytical, numerical and experimental methods. I am currently expanding my skills in *scientific computing*, through the development of a C++ software library for **high-performance physical simulation** and interactive visualization (*Neutrino*) based on the OpenCL/OpenGL frameworks.

Recently, I started a new research initiative to combine **machine learning** and **equation-based modeling** to build algorithms that will allow to automate the process of developing mathematical models for physical systems, while maintaining intelligibility of the models and improving their generalization capabilities with respect to purely

data-driven methods. Last year, I submitted a research proposal based on these ideas and in March 2022 I was awarded the **ERC Starting Grant 2021** with the project **ALPS - AI-based Learning for Physical Simulation** (funding: $\simeq 1.3$ M€ for 5 years).

I have published **25 articles in international peer-reviewed journals**, 13 of which as a first author, leading to **532 citations** in the period 2014–2021 and to an **h-index of 12** (source: [Google Scholar](#)). My publications appeared in journal belonging to diverse fields, including solid mechanics, computational mechanics, biology, physics, mathematics, biomechanical engineering, neuroscience, and materials science, which demonstrates the highly **interdisciplinary** character of my research.

I have participated to **20+ national and international conferences** and I have been invited to give 6 seminars and presentations at workshops. I am currently supervising **6 PhD students** (5 at SSSA and 1 at SISSA) and **1 postdoc** at SSSA. Since my PhD studies, I have been continuously involved in teaching undergraduate, graduate and post-graduate classes. Last year, I was awarded a **prize** from SSSA for the **outstanding graduate/postgraduate teaching**. I am currently the PI of my ERC project and I am participating to **2 H2020 projects** that I contributed to write.

Publications

Journal Articles

- 2022 L. Lorenzon, **A. Lucantonio**, L. Costi, D. Zrincak, and M. Cianchetti. A novel soft pump based on mechanical instabilities and its application as an artificial ventricle simulator. *Submitted*, 2022.
- 2022 V. Damioli, E. Zorzin, A. DeSimone, G. Noselli, and **A. Lucantonio**. Transient shape morphing of active gel plates. *Submitted*, 2022.
- 2022 D. Andrini, G. Noselli, and **A. Lucantonio**. Optimal design of planar shapes with active materials. *Submitted*, 2022.
- 2021 J. Quaglierini, **A. Lucantonio**, and A. DeSimone. Mechanics of tubular helical assemblies: ensemble response to axial compression and extension. *Acta Mechanica Sinica*, volume 37, pages 173–186, 2021.
- 2021 S. Ciancia, **A. Lucantonio**, L. Vannozi, G. A. Pedrazzini, and L. Ricotti. Thermal analysis of paraffin-embedded tissue blocks for anatomic pathology processes. *Journal of Biomechanical Engineering*, volume 143(9), page 094501, 2021.
- 2021 D. Andrini, **A. Lucantonio**, and G. Noselli. A theoretical study on the transient morphing of linear poroelastic plates. *Journal of Applied Mechanics*, volume 88(3), page 031008, 2021.
- 2020 **A. Lucantonio** and A. DeSimone. Computational design of shape-programmable gel plates. *Mechanics of Materials*, volume 144, page 103313, 2020.
- 2020 R.M. McMeeking, **A. Lucantonio**, G. Noselli, and V. S. Deshpande. On polymer network rupture in gels in the limit of very slow straining or a very slow crack propagation rate. *Journal of the Mechanics and Physics of Solids*, volume 136, page 103754, 2020.
- 2020 I. Cesini, **A. Lucantonio**, M. Kowalczyk, G. D'Alesio, P. Kumar, D. Camboni, A. DeSimone, A.F. Morgera, and C.M. Oddo. Seedless hydrothermal growth of zno nanorods as a promising route for flexible tactile sensors. *Nanomaterials*, volume 10(5), page 977, 2020.
- 2020 D. Agostinelli, **A. Lucantonio**, G. Noselli, and A. DeSimone. Nutations in growing plant shoots: The role of elastic deformations due to gravity loading. *Journal of the Mechanics and Physics of Solids*, volume 136, page 103702, 2020.
- 2019 V. Agostiniani, **A. Lucantonio**, and D. Lučić. Heterogeneous elastic plates with in-plane modulation of the target curvature and applications to thin gel sheets. *ESAIM COCV*, volume 25(24), 2019.
- 2018 G. Fabris, **A. Lucantonio**, N. Hampe, E. Noetzel, B. Hoffmann, A. DeSimone, and R. Merkel. Nanoscale topography and poroelastic properties of model tissue breast gland basement membranes. *Biophysical Journal*, volume 115(9), pages 1770–1782, 2018.

- 2018 N. A. Caruso, A. Cvetković, **A. Lucantonio**, G. Noselli, and A. DeSimone. Spontaneous morphing of equibiaxially pre-stretched elastic bilayers: the role of sample geometry. *International Journal of Mechanical Sciences*, volume 149, pages 481–486, 2018.
- 2018 V. Agostiniani, A. DeSimone, **A. Lucantonio**, and D. Lučić. Foldable structures made of hydrogel bilayers. *Mathematics in Engineering*, volume 1(1), pages 204–223, 2018.
- 2017 **A. Lucantonio**, G. Tomassetti, and A. DeSimone. Large-strain poroelastic plate theory for polymer gels with applications to swelling-induced morphing of composite plates. *Composites Part B: Engineering*, volume 115, pages 330–340, 2017.
- 2017 **A. Lucantonio** and G. Noselli. Concurrent factors determine toughening in the hydraulic fracture of poroelastic composites. *Meccanica*, volume 52(14), pages 3489–3498, 2017.
- 2017 **A. Lucantonio** and A. DeSimone. Coupled swelling and nematic reordering in liquid crystal gels. *Soft Matter*, volume 13(43), pages 7907–7915, 2017.
- 2017 J. Rigosa, **A. Lucantonio**, G. Noselli, A. Fassihi, E. Zorzini, F. Manzano, F. Pulecchi, and M. E. Diamond. Dye-enhanced visualization of rat whiskers for behavioral studies. *eLife*, volume 6, page e25290, 2017.
- 2016 **A. Lucantonio**, L. Teresi, and A. DeSimone. Continuum theory of swelling material surfaces with applications to thermo-responsive gel membranes and surface mass transport. *Journal of the Mechanics and Physics of Solids*, volume 89, pages 96–109, 2016.
- 2016 G. Noselli, **A. Lucantonio**, R. M. McMeeking, and A. DeSimone. Poroelastic toughening in polymer gels: A theoretical and numerical study. *Journal of the Mechanics and Physics of Solids*, volume 94, pages 33–46, 2016.
- 2015 **A. Lucantonio**, G. Noselli, X. Trepas, A. DeSimone, and M. Arroyo. Hydraulic fracture and toughening of a brittle layer bonded to a hydrogel. *Physical Review Letters*, volume 115(18), page 188105, 2015.
- 2014 **A. Lucantonio**, M. Roché, P. Nardinocchi, and H. A. Stone. Buckling dynamics of a solvent-stimulated stretched elastomeric sheet. *Soft Matter*, volume 10(16), pages 2800–2804, 2014.
- 2014 **A. Lucantonio**, P. Nardinocchi, and L. Teresi. Multiphysics of bio-hybrid systems: shape control and electro-induced motion. *Smart Materials and Structures*, volume 23(4), page 045043, 2014.
- 2014 **A. Lucantonio**, P. Nardinocchi, and H. A. Stone. Swelling dynamics of a thin elastomeric sheet under uniaxial pre-stretch. *Journal of Applied Physics*, volume 115(8), page 083505, 2014.
- 2014 **A. Lucantonio**, P. Nardinocchi, and M. Pezulla. Swelling-induced and controlled curving in layered gel beams. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, volume 470(2171), page 20140467, 2014.
- 2013 **A. Lucantonio**, P. Nardinocchi, and L. Teresi. Transient analysis of swelling-induced large deformations in polymer gels. *Journal of the Mechanics and Physics of Solids*, volume 61(1), pages 205–218, 2013.
- 2013 S. Galante, **A. Lucantonio**, and P. Nardinocchi. The multiplicative decomposition of the deformation gradient in the multiphysics modeling of ionic polymers. *International Journal of Non-Linear Mechanics*, volume 51, pages 112–120, 2013.
- 2012 **A. Lucantonio** and P. Nardinocchi. Reduced models of swelling-induced bending of gel bars. *International Journal of Solids and Structures*, volume 49, pages 1399–1405, 2012.
- [In Conference Proceedings](#)
- 2012 **A. Lucantonio**, P. Nardinocchi, and L. Teresi. Multiphysics modeling of swelling gels. In *Proceedings of the 8th Annual COMSOL Conference*, 2012.

Research grants

- 2022– **ERC Starting Grant 2021 project *ALPS -“AI-based Learning for Physical Simulation”***: I am the PI of this project, where I will develop new algorithms for the automatic construction of mathematical models for physical systems starting from data.
- Duration: 5 years
 - Total funding: ~ 1.3 M€
- 2021– **H2020 FET ICT project *SoftGrip***: within the Scuola Superiore Sant’Anna (coordinator institution) research unit, I am responsible of supervising and coordinating the activities of modeling and simulation of new soft grippers for the handling of fragile objects. *I supervise 1 postdoc and 1 PhD student and have direct responsibility on ~ 100 k€ of funding.*
- Duration: 3 years
 - Total funding: ~ 3 M€ (~ 800 k€ for Scuola Superiore Sant’Anna)
- 2021– **H2020 FET PROACTIVE project *I-Seed***: together with Prof. A. DeSimone, I am part of the core team at Scuola Superiore Sant’Anna (participating institution) which will develop new mathematical models to study and optimize the motility of robots inspired by plant seeds.
- Duration: 4 years
 - Total funding: ~ 4 M€ (~ 500 k€ for Scuola Superiore Sant’Anna)
- 2017 **Young Researchers Project 2017 *Evolution and shape control in active materials*** funded by Istituto Nazionale di Alta Matematica (INdAM). I was the P.I. of this project (3000 €), which allowed me and my colleagues to investigate some theoretical aspects of transient shape morphing in active materials.
- 2016 **Young Researchers Project 2016 *Fracture and instability in soft active materials*** funded by INdAM; P.I.: G. Noselli (SISSA). I contributed to write the proposal for this project, which then resulted in the paper “Poroelastic toughening in polymer gels: A theoretical and numerical study”, one of my major research contributions.
- 2014 **S.H.A.R.M. project *Mechanics of anisotropic polymer gels*** funded by Fondo Sociale Europeo (European Social Fund). I was the P.I. of this project that covered my research fellowship at SISSA for one year and led to the collaboration with a local company specialized in the production of gel-based biomaterials for cartilage replacement.
- 2011 **Young Researchers Project 2011 *Material remodelling in soft condensed matter*** funded by INdAM; P.I.: L. Teresi (Università Roma Tre). As a PhD student, I was part of the team at Sapienza Università di Roma developing theoretical and computational models for swelling polymer gels. The work for this project resulted in my most-cited publication: “Transient analysis of swelling-induced large deformations in polymer gels”.

Invited presentations

- 2021 **Prague, Czech Republic (online)**. I was invited to give a presentation at the workshop on Soft Robotics at the International Conference on Intelligent Robots and Systems (IROS). The title of the talk was “Modelling the dynamics of pneumatic robotic arms for model-based control”.
- 2021 **Cortona, Italy**. I was invited to give a talk at the workshop “Active Materials: from Mechanobiology to Smart Devices”. The title of the talk was “Two-dimensional shape control of active materials”.
- 2018 **Natal, Brasil**. I was an invited speaker at the workshop “Geometry of Soft Matter”. The title of my talk was “Computational design of non-Euclidean gel plates”.

- 2017 **Juelich, Germany.** I was invited at the Forschungszentrum Juelich - Institute of Complex Systems Biomechanics (ICS-7) by Prof. R. Merkel to give a talk on the fracture of polymer gels and tissues.
- 2016 **Amherst, Massachussets, USA.** I was invited to visit Prof. R. Hayward's research group in the Polymer Science and Engineering department at the University of Massachussets at Amherst.
- 2016 **Princeton, New Jersey, USA.** I was invited to visit Prof. H. A. Stone's group (Complex Fluids Group) at Princeton University and I gave a talk on the fracture of polymer gels and tissues.
- 2016 **Oaxaca, Mexico.** I was an invited speaker at Casa Matemática Oaxaca (Banff International Research Station), where the workshop "Mathematical Problems of Orientationally Ordered Soft Solids" was held. The title of my talk was "Challenges in the multiphysics modeling of polymer gels".
- 2015 **Barcelona, Spain.** I was invited by Prof. X. Trepat at Institute for Bioengineering of Catalonia (IBEC) and by Prof. M. Arroyo at Universitat Politècnica de Catalunya (UPC) to present my results about the fracture of polymer gels and tissues.
- 2015 **Oslo, Norway.** I was an invited speaker at the "Complex Materials Worskhop". The title of my talk was "A membrane theory for swelling polymer gels".
- 2013 **Cortona, Italy.** I was invited to give a talk at the workshop "The Mathematics of cells and tissues". The title of the talk was "Shape control of swellable elastomeric membranes".

Teaching experience

- 2022– **Fracture Mechanics, Undergraduate program, Scuola Superiore Sant'Anna, Italy.**
- 2022– **Modelling of Multi-Physics Phenomena, M.Sc. in Bionics Engineering, Università di Pisa, Italy.**
- 2021– **Physics and Geometry of Active Materials and Structures, Undergraduate program, Scuola Superiore Sant'Anna, Italy.**
- 2021– **Physics and Geometry of Active Materials, M.Sc. in Physics of Complex Systems, Università di Pisa, Italy.**
- 2020– **Computational Modeling for Multiphysics, Ph.D. program in Biorobotics, Scuola Superiore Sant'Anna, Italy.**
- 2019–2020 **Mechanics of bio-robotic structures (co-lecturer), M.Sc. in Bionics Engineering, Università di Pisa, Italy.**
- 2019 **Soft and Smart Materials (co-lecturer), M.Sc. in Bionics Engineering, Università di Pisa, Italy.**
- 2015–2016 **Non-linear Mechanics of Soft Active Materials: Theory and Applications, Ph.D. program in Mathematical Analysis, Modelling and Application, SISSA - International School for Advanced Studies, Italy.**
- 2014–2015 **Mechanics of Polymer Gels, Ph.D. program in Mathematical Analysis, Modelling and Application, SISSA - International School for Advanced Studies, Italy.**
- 2012 **Mechanics of Materials and Structures (co-lecturer), M.Sc. in Engineering Sciences, Università di Roma "Tor Vergata", Italy.**
- 2010–2011 **Solid and Structural Mechanics (teaching assistant), B.Sc in Aerospace Engineering, Sapienza Università di Roma, Italy.**

Supervision of graduate students and postdoctoral fellows

- **5 Ph.D. students at Scuola Superiore Sant'Anna:** J. Quaglierini (topic: mechanics of bio-inspired helical structures - co-advised with A. DeSimone), S. Ciancia (topic: laboratory automation procedures – co-advised with L. Ricotti), L. Lorenzon (topic: modeling and experiments for artificial heart prototypes – co-advised with M. Cianchetti), R. Pathan (topic: embodied intelligence approaches in soft grippers for the manipulation of

fragile objects), C. Alessi (topic: modeling soft robotic actuators for model-based control - co-advised with E. Falotico)

- **1 postdoc at Scuola Superiore Sant'Anna:** V. Del Bono (topic: design, modeling and fabrication of a robotic wrist for a soft gripper)
- **2 Ph.D. students at SISSA – International School for Advanced Studies:** D. Andrini (topic: shape morphing with soft active materials – co-advised with G. Noselli), D. Lučić (topic: dimension reduction problems for polymer gel plates, co-advised with V. Agostiniani, now postdoc at University of Pisa)
- **2 M.Sc. students at Scuola Superiore Sant'Anna:** A. Castillo (bio-hybrid actuators: theory and experiments, co-advised with L. Ricotti, now Ph.D. student at Singapore University of Technology and Design), L. Costi (topic: modeling and experiments for artificial heart prototypes – co-advised with M. Cianchetti, now Ph.D. student at Cambridge University)

Position of responsibility

2020– **Member of the Faculty Board of the Ph.D. program in Biorobotics**, *Scuola Superiore Sant'Anna*, Italy.

2019– **Faculty Member**, *Scuola Superiore Sant'Anna*, Italy.

2016–2019 **Faculty Member**, *SISSA - International School for Advanced Studies*, Italy.

Editorial activity; organization of workshops and schools

2022 Co-organizer of the Advanced School “Mechanics of smart and bio-hybrid gels: experiments, theory, numerical simulation” at CISM (Italy).

2017 Guest Editor for the Special Issue “Active Behavior in Soft Matter and Mechanobiology” for the journal *Meccanica*.

2015, 2017 Co-organizer of the minisymposium “Soft Active Materials” at the AIMETA (Associazione Italiana Meccanica Teorica e Applicata) Congress.

Membership of scientific societies

Member of GNFM (Gruppo Nazionale per la Fisica Matematica) – INdAM (Istituto Nazionale di Alta Matematica).

Reviewing activity

Certified reviewer (Publons) for the following international scientific journals: *Journal of the Mechanics and Physics of Solids*, *Computer Methods in Applied Mechanics and Engineering*, *European Physical Journal E*, *Meccanica*, *PeerJ*, *Physical Review Letters*, *RSC Advances*, *Soft Matter*.

Language skills

Italian mothertongue.

English professional knowledge (C1 level) - Cambridge First Certificate in English (pass with grade A).

Technical skills

Programming Languages Python, C, C++, Golang.

Libraries OpenCL, OpenGL (basic), PyTorch, TensorFlow, numpy, scipy.

Operating systems Linux, Windows.

Scientific software COMSOL Multiphysics, ABAQUS, ANSYS; MATLAB, Mathematica, Maxima; gnuplot, L^AT_EX.