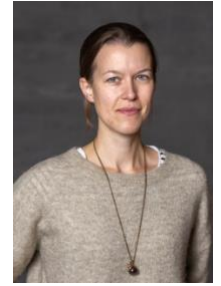


## Curriculum Vitae

Date: 10.11.2023

### Personal details

Name: Matilda Backholm, Assistant Professor  
 Identifiers: [I-6356-2013](#), [0000-0003-4501-8872](#), [Google Scholar](#)  
 Webpage: [aalto.fi/living-matter](http://aalto.fi/living-matter)



### Background

I am an ambitious and creative physicist exploring the effects of physical forces in soft and biological systems through meticulous experiments and theoretical modelling. I attained my BSc, MSc, and PhD degrees in three different countries and have extensive experience from working in different fields, cultures, and environments as well as from collaborating across national and continental borders. During my PhD, I developed a novel and highly sensitive micropipette force sensor to directly measure the viscoelastic material properties (*PNAS* 2013, *EPJE* 2015), microswimming (*PRE* 2014, *Phys. Fluids* 2014 & 2015) and crawling (*Biophys. J.* 2014) dynamics, as well as tangling interactions (*PRL* 2015) of the small nematode *C. elegans* – an important model organism in biology. My quantitative, force-based studies transformed our understanding of how this worm moves and adapts to environmental changes. During my Academy of Finland postdoc, I have further developed the micropipette technique (*Nature Protocols* 2019) to directly measure the miniscule friction of drops moving on superhydrophobic surfaces (*Commun. Mater.* 2020, *Adv. Mater.* 2021, *Nat. Chem.* 2023, *Nat. Mater.* 2023). During my career, I have also worked on capillary phenomena (*Soft Matter* 2014, *Langmuir* 2017, *Adv. Sci.* 2020, *Science Advances* 2020), as well as experimental and computational surface science (*Nanotechnology* 2012, *Appl. Surf. Sci.* 2013).

I started as an Assistant Professor in Soft Matter Physics at the Department of Applied Physics at Aalto University in September 2022. My Living Matter research group develops new experimental and analytical tools to probe the dynamics and flow in soft, living, and fluid materials. Right now, I am funded by an ERC StG, a Research Council of Finland Research Fellowship, as well as grants from the Erkko foundation and Finnish Academy of Science and Letters.

### Degrees

#### PhD in Physics, 2015

Department of Physics and Astronomy, McMaster University, Hamilton, ON, Canada  
 Thesis: *Biomechanics of C. elegans as probed by micropipette deflection*  
 Supervisor: Prof. Kari Dalnoki-Veress ([webpage](#))

#### MSc in Nanoscience with specialisation in Physics, 2011

The Interdisciplinary Nanoscience Center (iNANO), Aarhus University, Aarhus, Denmark  
 Thesis: *Glancing angle deposited titanium thin films – Structure and biological response*  
 Supervisor: Dr. Morten Foss ([webpage](#))

#### BSc in Physics, 2009 (Minors: Mathematics and Theoretical Physics)

Department of Physics, University of Helsinki, Helsinki, Finland  
 Thesis: *Ion-induced deformation of embedded nanoclusters*  
 Supervisor: Prof. Kai Nordlund ([webpage](#))

### Language skills

Swedish Native language  
 English Fluent  
 Finnish Fluent

### Current employment

**Tenure-track Assistant Professor**, Department of Applied Physics, Aalto University, Finland, 09.2022–08.2027  
 - Leader of Living Matter research group with a focus on the dynamics of mesoscale organisms and organs.

### Previous work experience

#### 09.2017 – 08.2022: Academy of Finland Postdoctoral Researcher

- Soft Matter and Wetting group of Prof. Robin Ras, Dept. of Applied Physics, Aalto University, Finland.

**08.2015 – 08.2017: Postdoctoral Researcher**

- Group of Prof. Robin Ras, Department of Applied Physics, Aalto University, Finland.

**09.2011 – 07.2015: Research and Teaching Assistant (Doctoral Student)**

- *Experiments in Soft and Living Matter* group of Prof. Kari Dalnoki-Veress, Department of Physics and Astronomy, McMaster University, Canada.

**2010 – 2011: Ethel Tybeck Foundation Research Assistant (MSc thesis researcher)**

- *Biomedical surface* group of Dr. Morten Foss, iNANO, Aarhus University, Denmark.

**2008 – 2009: Research Assistant (part-time)**

- Division of Materials Physics, University of Helsinki and Helsinki Institute of Physics, Finland.

**Publications**

A total of 27 publications listed in reverse chronological order. I have published 10 first and 5 corresponding (\*) author papers, and 18 papers without my PhD advisor. My h-index is 15 with ca 500 citations.

1. S. Lepikko, Y. M. Jaques, M. Junaid, **M. Backholm**, J. Lahtinen, J. Julin, V. Jokinen, T. Sajavaara, M. Sammalkorpi, A. S. Foster, and R. H. A. Ras, “Droplet slipperiness despite surface heterogeneity at molecular scale”, *Nature Chemistry* (2023), in press.
2. A. B. Tesler, S. Kolle, L. H. Prado, I. Thievensen, D. Böhringer, **M. Backholm**, B. Karunakaran, H. A. Nurmi, M. Latikka, L. Fischer, S. Stafslin, Z. M. Cenev, J. V. I. Timonen, M. Bruns, A. Mazare, U. Lohbauer, S. Virtanen, B. Fabry, P. Schmuki, R. H. A. Ras, J. Aizenberg, and W. H. Goldmann, “Long-term stability of aerophilic metallic surfaces underwater”, *Nature Materials* (2023), in press.
3. D. Daniel, M. Vuckovac, **M. Backholm**, M. Latikka, R. Karyappa, X. Q. Koh, J. V. I. Timonen, N. Tomczak, and R. H. A. Ras, “Probing surface wetting properties across multiple force, length and time scales”, *Communications Physics* **6**, 152 (2023).
4. M. Hokkanen, **M. Backholm**, M. Vuckovac, Q. Zhou, R.H.A Ras, “Force-based wetting characterization of stochastic superhydrophobic coatings at nanonewton sensitivity”, *Advanced Materials* **33**, 2105130 (2021).
5. M. Vuckovac, **M. Backholm**, J.V.I. Timonen, and R.H.A. Ras, “Viscosity-enhanced droplet motion in sealed superhydrophobic capillaries”, *Science Advances* **6**, eaba5197 (2020).  
Highlighted by 12 news outlets, such as Physics Today.
6. **M. Backholm\***, D. Molpeceres, M. Vuckovac, H. Nurmi, M. Hokkanen, V. Jokinen, J.V.I. Timonen, and R.H.A. Ras\*, “Water droplet friction and rolling dynamics on superhydrophobic surfaces”, *Communications Materials* **1**, 64 (2020).
7. M. Latikka, **M. Backholm**, A. Baidya, A. Ballesio, A. Serve, G. Beaune, J.V.I. Timonen, T. Pradeep, and R.H.A. Ras, “Ferrofluid microdroplet splitting for population-based microfluidics and interfacial tensiometry”, *Advanced Science* **7**, 2000359 (2020).
8. **M. Backholm\*** and O. Bäumchen, “Micropipette force sensors for in vivo force measurements on single cells and multicellular microorganisms”, *Nature Protocols* **14**, 594-615 (2019).  
Highlighted by 10 news outlets, including Pro-Physik, Göttinger Tageblatt, Science Daily, LongRoom, Phys.org, EurekAlert, JuraForum, Innovations Report.
9. S. Näkki, J.T.-W. Wang, J. Wu, F. Li, J. Rantanen, T. Nissinen, M. Kettunen, **M. Backholm**, R.H.A. Ras, K.T. Al-Jamal, V.-P. Lehto, and W. Xu, “Designed inorganic porous nanovector with controlled release and MRI features for safe administration of doxorubicin”, *Int. J. Pharm.* **554**, 327-336 (2019).
10. M. Latikka, **M. Backholm**, J.V.I. Timonen, and R.H.A. Ras, “Wetting of ferrofluids: phenomena and control”, *Curr. Opin. Colloid Interface Sci.* **36**, 118-129 (2018).  
Invited review article.
11. S. Zhang, O.H. Pakarinen, **M. Backholm**, F. Djurabekova, K. Nordlund, J. Keinonen, and T.S. Wang, “Absence of critical dose for the amorphization of quartz under ion irradiation”, *J. Phys.: Condens. Matter* **30**, 015403 (2018).
12. **M. Backholm\***, M. Vuckovac, J. Schreier, M. Latikka, M. Hummel, M.B. Linder, and R.H.A. Ras, “Oscillating ferrofluid droplet microrheology of liquid-immersed sessile droplets”, *Langmuir* **33**, 6300-6306 (2017).

13. A. Khondker, A. Dhaliwal, R.J. Alsop, J. Tang, **M. Backholm**, A.-C. Shi, and M.C. Rheinstädter, “Partitioning of Caffeine in Lipid Bilayers Reduces Membrane Fluidity and Increases Membrane Thickness”, *Phys. Chem. Chem. Phys.* **19**, 7101 - 7111 (2017).
14. J. Tang, R.J. Alsop, **M. Backholm**, H. Dies, A.-C. Shi, and M.C. Rheinstädter, “Amyloid-b<sub>25-35</sub> peptides aggregate into cross- $\beta$  sheets in unsaturated anionic lipid membranes at high peptide concentrations”, *Soft Matter* **12**, 3165-3176 (2016).
15. S.A. Stewart, **M. Backholm**, N.A.D. Burke, and H.D.H. Stöver, “Crosslinked hydrogels formed through Diels-Alder coupling of Furan- and Maleimide-modified Poly(methyl vinyl ether-*alt*-maleic acid)”, *Langmuir* **32**, 1863-1870 (2016).
16. **M. Backholm**, A.K.S. Kasper, R.D. Schulman, W.S. Ryu, and K. Dalnoki-Veress, “The effects of viscosity on the undulatory swimming dynamics of *C. elegans*”, *Phys. Fluids* **27**, 091901 (2015).
17. **M. Backholm**, W.S. Ryu, and K. Dalnoki-Veress, “The nematode *C. elegans* as a complex viscoelastic fluid”, *Eur. Phys. J. E* **38**, 36 (2015).
18. R.D. Schulman, **M. Backholm**, W.S. Ryu, and K. Dalnoki-Veress, “Undulatory microswimming near solid boundaries”, *Phys. Fluids* **26**, 101902 (2014).  
Highlighted by Physics Today.
19. Y. Rabets, **M. Backholm**, K. Dalnoki-Veress, and W.S. Ryu, “Direct measurements of drag forces in *C. elegans* crawling locomotion”, *Biophys. J.* **107**, 1980-1987 (2014).
20. **M. Backholm**, R.D. Schulman, W.S. Ryu, and K. Dalnoki-Veress, “Tangling of tethered swimmers: Interactions between two nematodes”, *Phys. Rev. Lett.* **113**, 138101 (2014).  
Editor's Suggestion, Highlighted by PRL Editorial.
21. R.D. Schulman, **M. Backholm**, W.S. Ryu, and K. Dalnoki-Veress, “Dynamic force patterns of an undulatory microswimmer”, *Phys. Rev. E: Rapid Commun.* **89**, 050701 (2014).  
Highlight Article, Editor's Suggestion, Physics World “Image of The Day”.
22. **M. Backholm**, M. Benzaquen, T. Salez, E. Raphaël, and K. Dalnoki-Veress, “Capillary levelling of a cylindrical hole in a viscous film”, *Soft Matter* **10**, 2550-2558 (2014).
23. O. Bäümchen, M. Benzaquen, T. Salez, J.D. McGraw, **M. Backholm**, P. Fowler, E. Raphaël, and K. Dalnoki-Veress, “Relaxation and intermediate asymptotics of a rectangular trench in a viscous film”, *Phys. Rev. E* **88**, 035001 (2013).
24. **M. Backholm**, W.S. Ryu, and K. Dalnoki-Veress, “Viscoelastic properties of the nematode *Caenorhabditis elegans*, a self-similar, shear-thinning worm”, *Proc. Natl. Acad. Sci. USA (PNAS)* **110**, 4528-4533 (2013).
25. **M. Backholm\***, M. Foss, and K. Nordlund, “Roughness scaling in titanium thin films: A three-dimensional molecular dynamics study of rotational and static glancing angle deposition”, *Appl. Surf. Sci.* **268**, 270-273 (2013).
26. **M. Backholm\***, M. Foss, and K. Nordlund, “Roughness of glancing angle deposited titanium thin films: An experimental and computational study”, *Nanotechnology* **23**, 385708 (2012).
27. F. Djurabekova, **M. Backholm**, M. Backman, O.H. Pakarinen, J. Keinonen, K. Nordlund, T.-R. Shan, B.D. Devine, and S.B. Sinnott, “Amorphization of alpha-quartz and comparative study of defects in amorphized quartz and Si nanocrystals embedded in amorphous silica”, *Nucl. Instr. Meth. Phys. Res. B* **268**, 3095-3098 (2010).

#### **Research supervision and leadership experience**

- Supervisor of 2 postdocs, 2 PhD students, 3 BSc thesis students, Aalto University, 2023 –
- Student co-supervisor for a total of 4 PhD, 6 MSc, and 8 BSc students at McMaster and Aalto University, 2012–2022.
- Mentor at the Graduate Women in Physics and Astronomy Society at McMaster University, 2013 – 2015.
- Mentor for new physics graduate students at McMaster University, 2012 – 2014.

#### **Teaching merits**

- Completed 2 courses (8 ECTS) in Pedagogy and Supervision at Aalto University (2023)
- Completed 5 courses (20 ECTS) in Pedagogy at the University of Helsinki (2007)
- **Lecturer** at Aalto University in *Soft Condensed Matter Physics* (4 courses).

- **Invited Guest Lecturer** at the University of Helsinki for *Presentation av de fysikaliska vetenskaperna* ('Introduction to Physical Sciences'), 10.2018, 11.2021, 11.2022; and *Naturvetenskap Nu* ('Natural Sciences Now'), 04.2017
- **Teaching Assistant (TA)**, McMaster University, 09.2011 - 08.2014
  - Head TA for the labs of *Modern Physics for Life Sciences* (8 courses in total): Responsible for the organisation of the first 3 weeks of teaching for the Winter of 2014 course, lecturer of 8 classes, in charge of organising labs and performing demos, involved with improving the "Magnetotactic bacteria in magnetic fields" lab focusing on modern biophysics research
  - Tutorial TA for *Physics of Living Systems* and *The Big Questions*: In-class teaching of the important concepts of the course and supervisor of student presentations.
  - Designed lab assignment with springs and lasers for the new *Explorations in Biophysics* course to mimic scattering experiments probing the helical structure of DNA.
- High School Lecturer (occasional substitute teacher)
  - Over 60 hours higher level mathematics and physics in Brändö Gymnasium (2006 - 2009)

### **Awards, Grants, and Honours**

- ERC StG (2023).
- Research Council of Finland Research Fellowship (2023).
- Grant from Jane and Aatos Erkko foundation (2023).
- Väisälä Starting Grant from the Finnish Academy of Science and Letters (2023).
- Aalto University School of Science Grant for Highly Ranked ERC applicants (2022).
- Hannu Koskinen's best presentation award, Finnish Physics Days (2019).
- Aalto University internal seed funding (2019)
- The Marie Skłodowska-Curie Actions *Seal of Excellence* (2017, call H2020-MSCA-IF-2016).
- Academy of Finland Postdoc Grant (2017)
- The Ruth and Nils-Erik Stenbäck prize for career accomplishments in science (2017).
- Nominated for the Mary Keyes Award for *Outstanding Leadership and Service* to McMaster Univ. (2014).
- The McMaster University School of Graduate Studies *International Excellence Award* (2012 and 2014).
- Selected as a McMaster Faculty of Science Delegate for the "Emerging Leaders global summit - *The next generation of women leaders creating the future*" (New York, 14.–16.1.2014).
- Students that I supervised awarded for talks at the Canadian Undergraduate Physics Conference: Sean Ridout, 2<sup>nd</sup> prize in the Biophysics/Soft Matter section (2013); Richard Parg, 1<sup>st</sup> prize in the Condensed Matter section (2012).
- Awarded for best Graduate Student Symposium Day talk, McMaster University (4.9.2012).
- The *ABB award in Physics* (2006) and the *Pro Mathematica Award* (2006).

### **Other key academic merits**

#### • **Memberships in scientific committees and societies**

- Young Academy Finland (**invited**), term of office 2019 – 2023. This is a multidisciplinary organization for promising early career researchers. We aim to promote research and strengthen the status of science and scholarship in society. All members are nominated by the Finnish Academy of Sciences and Letters.
- The European Physical Society, 2019 –
- The Finnish Physical Society, 2019 –
- *Founder* of the Graduate Women in Physics and Astronomy Society at McMaster University, 2013; Chair 2013 – 2014. Our main purpose was to create a support network for the women minority at our department. I applied for and received 2 000 CAD from the department for our activities.
- American Physical Society (APS), 2012 – 2015 and 2020 – 2022
- Canadian Association of Physicists (CAP), 2014 – 2015
- Liaison Committee (McMaster University), 2012 – 2014
- Fysikersamfundet i Finland (The Physical Society in Finland), 2009 –

- Spektrum rf (Student Society), 2006 – 2009, Member of Program Committee 2008

• **Scholarly activities and outreach**

- Referee for *Nat. Commun.*, *J. Colloid Interface Sci.*, *J. R. Soc. Interface*, *Langmuir*, *Nanotechnology*, *Nanoscale Res. Lett.*, *Text. Res. J.*, and *Int. J. Nanomedicine*.
- Chairperson at *Challenges in the Physics of Active and Biological Matter Workshop*, Espoo, Finland, 08.2023.
- Reviewer of research proposal for Deutsche Forschungsgemeinschaft (German Research Foundation), 2023.
- Invited Keynote speaker at the *MATRENA* Doctoral programme in Materials research and Nanoscience Seminar Event, University of Helsinki, 12.2022.
- Member of PHYS Diversity Team, Aalto University, 2022 –
- Co-chair of PHYS Pizza seminars, 2022 –
- Invited chair for the *Soft Matter Sector* at the Finnish Physics Days 2021, Jyväskylä, 03.2021. I was in charge of accepting all soft matter abstracts as well as chairing the soft matter session.
- Invited *Studia Generalia* lecture about physics research, Brändö Gymnasium (~200 students), 2019.
- Invited to speak about soft matter physics to high school teachers at the *Finland Swedish Physics and Chemistry Days* (2015 & 2019).
- Chairperson at the *Soft Matter and Biophysics I* session at Physics Days 2017, Helsinki 22.3.2017.
- Co-chair of the Soft Condensed Matter and Biophysics Journal Club (McMaster University), 2014.
- Co-organiser of the Girls in Science Day at McMaster University, 05.2014: an event created by the Graduate Women in Physics and Astronomy Society to motivate girls to pursue a scientific career. The event was very popular and is still organized annually.
- Tens of soft matter demos for visiting high school students, McMaster University, 2013 – 2014.
- Judge at the Canadian Undergraduate Physics Conference, McMaster University, 10.2013.
- Judge at the Engineering and Science Olympics, McMaster University, 10.2013.
- Representing McMaster University at the Graduate Fair of the Canadian Undergraduate Physics Conference, University of British Columbia, Vancouver, BC, 11.2012.
- Volunteer at the International Congress of Quantum Chemistry, Helsinki, Finland, 2009.

• **Invited seminars & conference presentations**

I have given more than 20 contributed talks at established conferences and have been invited to give presentations at tens of internationally established conferences and international advanced schools, including:

- **Kumpula Physics Colloquium**, University of Helsinki, Finland (3.11.2023): *How to swim at the mesoscale*.
- **Nanoscience Days** (keynote), Jyväskylä, Finland (10.10.2023): *Forces and flow in soft and living materials*.
- **Challenges in the Physics of Active and Biological Matter Workshop**, Espoo, Finland (16.8.2023): *How to measure swimming forces of living micro- to meso-organisms*.
- **APS March Meeting**, Chicago, USA (14.3.2022, held virtually due to pandemic): *Friction of sparkling water drops on superhydrophobic surfaces*.
- **Biological Soft Matter virtual seminar series** (hosted by Dr. Daniel Frankel, 20.4.2021): *Exploring living systems with micropipette force sensors* ([link to YouTube video](#)).
- **Physics of Fluids, University of Twente**, Netherlands (17.3.2021, held virtually due to pandemic): *Viscosity-enhanced drop motion in sealed superhydrophobic capillaries*.
- **PMMH, ESPCI**, France (12.2.2021, held virtually due to pandemic): *Viscosity-enhanced drop motion in sealed superhydrophobic capillaries*.
- **Gulliver, ESPCI**, France (8.2.2021, held virtually due to pandemic): *Viscosity-enhanced drop motion in sealed superhydrophobic capillaries*.
- **MPI of Dynamics and Self-Organization (DS)**, Göttingen, Germany (5.2.2021, held virtually due to pandemic): *Viscosity-enhanced drop motion in sealed superhydrophobic capillaries*.

- **4<sup>th</sup> International Conference on Manipulation, Automation and Robotics at Small Scales**, Helsinki, Finland (1.-5.7.2019): *Magnetocapillary dynamics of magnetic droplets.*
- **MPI-DS**, Göttingen, Germany (22.4.2016): *Dynamics of microswimming in different environments.*
- **Department of Mathematics and Statistics, University of Helsinki**, Finland (10.2.2016): *Active worm tangles.*
- **Gulliver, ESPCI**, Paris, France (12.9.2013): *The material properties and propulsion dynamics of the microswimmer *C. elegans*.*
- **University of Toronto**, Canada (27.8.2012): *Mechanical properties of *C. elegans*.*