Curriculum Vitae

Dr. Felix Frey

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Summary statement

I am a theoretical physicist by training and I work primarily in the area of biophysics and soft matter. In particular, I study self-assembly, transport and remodeling processes at biomembranes with the ambition to develop a comprehensive understanding of biological systems. I am trained in continuum modeling and I am working with particle-based mesoscale computer simulations in my current independent postdoc position. Therefore, I have acquired a unique skill-set that allows me to bridge scales.

Academic positions

2022 – present	Independent NOMIS Postdoctoral fellow at the Institute of Science and Technology Austria (ISTA) with Anđela Šarić and Martin Loose
2020 – 2022	Postdoc at the Department of Bionanoscience, Kavli Institute of Nanoscience, Delft University of Technology (TU Delft), in the group of Timon Idema
2019 – 2020	Postdoc at the Institute for Theoretical Physics, Heidelberg University, in the group of Ulrich Schwarz
2015 – 2019	PhD researcher at the Institute for Theoretical Physics, Heidelberg University, in the group of Ulrich Schwarz

Education

06/2019	PhD at the Institute for Theoretical Physics, Heidelberg University Thesis title: *Physical models for uptake processes at the cell membrane* (summa cum laude) Advisor: Ulrich Schwarz.
07/2015	Master of Science in Physics at Heidelberg University.
07/2012	Bachelor of Science in Physics at Heidelberg University.
06/2009	Abitur (A-level) at the Ludwig-Uhland-Gymnasium in Kirchheim unter Teck.

Fellowships and awards

2022	Independent NOMIS fellowship (fully funded independent 3-year Postdoc position, worth 242.000€)
2022	IST-BRIDGE fellowship (fully funded independent 2-year Postdoc position), funded from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No 101034413 (declined)
2021	Kavli Synergy Grant (worth 50.000€)
2020	Among the six best dissertations at the Heidelberger Wilhelm-und-Else Heraeus dissertation prize for physics and astronomy
2018	Travel grant for the Biophysical Society Annual Meeting in San Francisco funded through the Excellence Initiative at Heidelberg University
2015	Full 3-year PhD fellowship of the Heidelberg Graduate School for Physics (HGSFP)
2009	School award of the German Physical Society (DPG)

Talks and posters at international conferences and seminars

2024	Selected abstract for a talk at the *German Biophysical Society Meeting*, Leipzig
2024	Invitation for a talk at the *Young Investigator Mini Symposium at the Department of Biology at FAU*, Erlangen
2024	Selected abstract for a poster at the *EMBO | EMBL Symposium The mechanics of life: from development to disease*, Heidelberg
2024	Selected abstract for a talk at the *DPG Spring Meeting*, Berlin
2023	Invitation for a talk at the symposium *Septins: biology meets physics* at *TU Delft,* Delft
2023	Selected abstract for a poster at the *ISMC 2023| 7th International Soft Matter Conference*, Osaka
2023	Invitation for a talk at the *DGZ Focus Workshop: Workgroup Membrane Trafficking and Molecular Motors (online)*
2023	Invitation for a talk at the symposium *Theoretical Physics - Theory of Condensed Matter* at Johannes Gutenberg University, Mainz
2023	Invitation for a seminar talk at the *Max-Planck-Institute of Biophysics,* Frankfurt am Main
2023	Selected abstract for a talk at the *EMBO | EMBL Symposium Life at the periphery: mechanobiology of the cell surface*, Heidelberg
2023	Selected abstract for a talk at the *DPG Spring Meeting*, Dresden
2022	Poster at *The Vienna Soft Matter Day*, IST Austria, Klosterneuburg
2022	Talk at *Soft Hour seminar series*, IST Austria, Klosterneuburg
2022	Selected abstract for a talk at the *DPG Spring Meeting*, Regensburg
2022	Contributed flash talk at *Dutch Soft Matter Meeting*, Delft
2022	Selected abstract for a talk at *SynCell2022*, The Hague
2022	Invitation for a talk at the *Statistical Physics and low dimensional systems conference*, Pont-à-Mousson
2022	Selected abstract for a poster at the *Biophysical Society Annual Meeting*, San Francisco
2022	Talk at the *BN Forum*, seminar of the Department of Bionanoscience, TU Delft (online)
2022	Selected abstract for a poster at *NWO Physics@Veldhoven* (online)
2021	Selected abstracts for a talk and a poster at *Dutch Biophysics* (online)
2021	Selected abstract for a poster at *EMBO Workshop Molecular and Cell Biology of Septins*, Berlin
2021	Selected abstract for a poster at *EMBO Workshop Physics of living systems: From molecules to tissues* (online)
2021	Selected abstract for a poster at the *BaSyC (Building a Synthetic Cell) Spring Meeting* (online)
2021	Selected abstract for a poster at the *DPG Spring Meeting* (online)
2019	Selected abstracts for two talks at the *DPG Spring Meeting*, Regensburg
2018	Selected abstract for a poster at the *Venice Meeting on Fluctuations in Small Complex Systems IV*, Venice
2018	Talk at *BioQuant Internal Seminar*, Heidelberg University
2018	Selected abstract for a poster and flash talk at the *BDBDB4 Meeting*, Heidelberg
2018	Selected abstract for a talk at the *DPG Spring Meeting*, Berlin
2018	Selected abstract for a poster at the *Biophysical Society Annual Meeting*, San Francisco
2017	Selected abstract for a poster at the *DPG Spring Meeting*, Dresden

Teaching experience and supervision

2019, winter	Exercises in Electrodynamics (Bachelor course) at Heidelberg University
2019, summer	Lecture substitution (one lecture) at Heidelberg University in Theoretical Biophysics (Master course) for Prof. Ulrich Schwarz
2016, winter	Exercises in Stochastic Dynamics (Master course) at Heidelberg University
2016, winter	Exercises in Non-linear Dynamics (Master course) at Heidelberg University
2016, summer	Exercises in Theoretical Biophysics (Master course) at Heidelberg University
2015, winter	Exercises in Theoretical Statistical Physics (Master course) at Heidelberg University

2022 Co-supervision of two Bachelor End Projects at TU Delft
2018 Co-supervision of one Master thesis at Heidelberg University
2016-2018 Co-supervision of three Bachelor theses at Heidelberg University

Reviewing activities

Physical Review Letters (APS), PRX Life (APS), Physical Review E (APS), New Journal of Physics (IOPscience), The Journal of Applied Physics, The Journal of Chemical Physics, The Proceedings of the National Academy of Sciences (PNAS), eLife, Biology of the Cell, Nature Cell Biology, Nature Communications

Administration and organization

2022 Organization of the theory journal club of the Department of Bionanoscience at TU Delft
2022 Co-organization of the scientific retreat for the theory division of the Department of Bionanoscience at TU Delft involving the groups of three principal investigators
2021 Participation at the EMBO Lab Leadership course for postdocs (online)

List of publications

Summary of bibliometric information (Google Scholar, 08/2024): 390 citations, h-index: 10
§ Five most relevant publications

In preparation

18.§ F. Frey, M. Amaral, A. Šarić, *Decoding membrane designs – curvature sorting reveals how membranes remodel*, ***in preparation*** (2024).
Relevance: Computational work that uses particle-based mesoscale simulations to investigate how archaeal monolayer membranes made from bipolar and bilayer lipids microscopically respond to membrane bending. The study identifies key differences between eukaryotic and archaeal membranes with respect to membrane bending deformations.
Role: First and leading author.

17. M. Amaral*, **F. Frey***, X. Jiang, B. Baum, A. Šarić, *Modeling the reshaping of archaeal bolalipid membranes*, ***in preparation*** (2024). *Equal contributions.

16. G. Castro Linares*, **F. Frey***, D. de Ridder*, S. Reese, M. Mavrakis, R. P. Richter, T. Idema, and G. H. Koenderink, *Human septin binding and polymerization on lipid membranes depends on oligomer species, lipid composition and GTP*, ***in preparation*** (2024). *Equal contributions.

Submitted:

15.§ E. Weiner*, E. Berryman*, **F. Frey***, A. González Solís*, A. Leier, T. Marquez Lago, A. Šarić and M. S. Otegui, *Endosomal Membrane Budding Patterns in Plants*, ***in revision*** (2024). *Equal contributions.
Relevance: Combination of experiments and particle-based mesoscale simulations to investigate the morphology and formation pathways of concatenated intralumenal vesicles networks in multivesicular endosomes of plant cells. The study identifies possible conditions under which concatenated vesicles networks can arise.
Role: Co-first author. I developed the particle-based computer simulations.

14. F. Frey, U. S. Schwarz, *Coat stiffening explains the consensus pathway of clathrin-mediated endocytosis*, arXiv:2405.02820, ***preprint, in revision*** (2024).

13. L. Baldauf, **F. Frey**, M. Arribas Perez, M. Vladenov, M. Way, T. Idema, G. H. Koenderink, *Biomimetic actin cortices shape cell-sized lipid vesicles*, doi.org/10.1101/2023.01.15.524117, ***preprint, in revision*** (2023).

Published:

12. L. Baldauf*, **F. Frey***, M. Arribas Perez, T. Idema, G. H. Koenderink, *Branched actin cortices reconstituted in vesicles sense membrane curvature, **Biophys. J.** (2023).* *Equal contributions.

11.[§] M. Mund, A. Tschanz, Y.-L. Wu**, F. Frey,** J. L. Mehl, M. Kaksonen, O. Avinoam, U. S. Schwarz, and J. Ries, *Clathrin coats partially preassemble and subsequently bend during endocytosis*, ***J. Cell Biol.*** 222 (3): e202206038 (2023).
Relevance: Combination of experimental and theoretical work explaining how clathrin-coated membrane structures acquire curvature during endocytosis. The paper introduces the cooperative curvature model which is able to describe the average shape and invagination pathway of clathrin-coated membrane structures in different cell lines.
Role: Co-author. I developed the analytical model.

10. J. J. de Vries, D. M. Laan, **F. Frey**, G. H. Koenderink, M. P. M. de Maat, *A systematic review and comparison of automated tools for quantification of fibrous networks,* ***Acta Biomater.*** 157, 263-274 *(2022).*

9. **F. Frey**, and T. Idema, *Membrane area gain and loss during cytokinesis*, ***Phys. Rev. E*** 106, 024401 (2022).

8. **F. Frey**, and T. Idema, *More than just a barrier: using physical models to couple membrane shape to cell function*, ***Soft Matter***, 17, 3533 – 3549 (2021).

7. **F. Frey**, and U. S. Schwarz, *Competing pathways for the invagination of clathrin-coated membranes*, **Soft Matter** 16, 10723-10733 (2020).

6. **F. Frey**, D. Bucher, K. A. Sochacki, J. W. Taraska, S. Boulant, and U. S. Schwarz, *Eden growth models for flat clathrin lattices with vacancies*, ***New J. of Phys***. 22, 073043 (2020).

5. T. Wiegand, M. Fratini, **F. Frey**, K. Yserentant, Y. Liu, E. Weber, K. Galior, J. Ohmes, F. Braun, DP. Herten, S. Boulant, U. S. Schwarz, K. Salaita, E. A. Cavalcanti-Adam, and J. P. Spatz, *Forces during cellular uptake of viruses and nanoparticles at the ventral side*, ***Nat. Commun***. 11, 32 (2020).

4. **F. Frey**, F. Ziebert, and U. S. Schwarz, *Dynamics of particle uptake at cell membranes*, ***Phys. Rev. E*** 100, 052403 (2019).

3.[§] **F. Frey**, F. Ziebert, and U. S. Schwarz, *Stochastic dynamics of nanoparticle and virus uptake*, ***Phys. Rev. Lett.*** 122, 088102 (2019).
Relevance: Theoretical work using continuum and stochastic modeling to investigate the interplay between stochasticity and particle shape during virus or nanoparticle uptake. The paper shows that particle shape can significantly impact the dynamics of particle uptake**.**
Role: First author. I developed the analytical model.

2.[§] D. Bucher*, **F. Frey***, K. A. Sochacki, S. Kummer, JP. Bergeest, W. J. Godinez, HG. Kräusslich, K. Rohr, J. W. Taraska, U. S. Schwarz, and S. Boulant, *Clathrin-adaptor ratio and membrane tension regulate the flat-to-curved transition of the clathrin coat during endocytosis*, ***Nat. Commun***. 9, 1109 (2018). *Equal contributions.
Relevance: Combination of experiments and continuum modeling that suggests that clathrin coats undergo a flat-to-curved transition during clathrin-mediated endocytosis.
Role: Co-first author. I developed the computational model.

1. P. Kumberger, **F. Frey**, U. S. Schwarz, and F. Graw, *Multiscale modeling of virus replication and spread*, ***FEBS Lett***. 590, 1972-1986 (2016).