



TIMON EMKEN PhD

Theoretical Astroparticle Physicist

April 2023

UNIVERSITY CAREER

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|-------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 2021 – 2023 | Postdoctoral fellow | Stockholm University, Stockholm, Sweden Department: Group leader: Oskar Klein Centre, Department of Physics Prof. Jan Conrad |
| 2021 – 2023 | Guest researcher | Chalmers University of Technology, Göteborg, Sweden Department: Host: Department of Physics Theoretical Subatomic Physics group |
| 2019 – 2021 | Postdoctoral researcher | Chalmers University of Technology, Göteborg, Sweden Department: Group leader: Department of Physics Prof. Riccardo Catena |
| 2018 | Guest researcher | Stony Brook University, Stony Brook, NY, USA Department: Host: C.N. Yang Institute for Theoretical Physics Prof. Rouven Essig |

ACADEMIC EDUCATION

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|-------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2016 - 2019 | Ph.D. (Physics) | University of Southern Denmark, Odense, Denmark Specialization: Thesis: Department: Supervisor(s): Theoretical Astroparticle Physics <i>Dark Matter in the Earth and the Sun – Simulating underground scatterings for the direct detection of low-mass dark matter</i> Centre for Cosmology and Particle Physics Phenomenology (CP ³ -Origins) Prof. Chris Kouvaris |
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Results of the thesis were published in [2]-[6].

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| 2014 - 2015 | Ph.D. (discont.) | Julius-Maximilians-Universität, Würzburg, Germany Topic: Department: Supervisor(s): Astrophysical constraints on supersymmetric Pati-Salam models Faculty for Physics and Astronomy Prof. Werner Porod |
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| 2011 - 2013 | Master of Science | Georg August Universität, Göttingen, Germany Specialization: Thesis: Department: Supervisor(s): Theoretical Particle Physics <i>Supergravity & Supernovae – Gravitino Phenomenology in Astrophysics</i> Institute for Theoretical Physics Prof. Laura Covi |
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Results of the thesis were published in [1].

SUMMARY

- 18 scientific publications (2 single-authored)
- 10 published research software tools and libraries
- teaching assistant for 11 university courses
- co-supervisor of 3 master and 1 PhD student
- 23 scientific talks at seminars and conferences (7 invited)
- research featured in the public media

CONTACT & INFO


 Larssons Berg 8
SE-43166 Mölndal


 +46 (0) 76 325 97 87


 timon.emken@gmail.com


 15.03.1988
in Bochum, Germany


LINKS


 timonemken.com

 ORCID iD
0000-0002-4251-2229

 Twitter
@TimonEmken

 Github
temken

 inSPIRE-HEP
T.Emken.1

 Google Scholar
Timon Emken

COMMUNITY SERVICE

Referee activity

- Physical Review Letters (PRL)
- Physical Review D (PRD)
- Journal for Cosmology and Astroparticle Physics (JCAP)
- Journal for High Energy Physics (JHEP)
- European Physical Journal C (EPJC)
- Journal of Open Source Software (JOSS)
- Swiss National Supercomputing Centre (CSCS)

Memberships

- DarkNESS collaboration (since 2023)
- GAMBIT collaboration (since 2021)
- Svenska Fysikersamfundet (since 2021) incl. Kvinnor i fysik
- Deutsche Physikalische Gesellschaft (since 2007) incl. Working Group on Equal Opportunities (AKC)

Event organization

- 2019: Quantum Materials for Dark Matter Detection (QM4DM) (3-day workshop at Nordita)
- 2019: Bi-weekly QM4DM Journal Club
- 2017- 2018: Weekly CP³-Origins Journal Club

2010 **Research intern** German Aerospace Center, Köln, Germany
Department: Institute of Materials Physics in Space
Supervisor(s): Dr. Matthias Sperl

2008 - 2011 **Bachelor of Science** Georg August Universität, Göttingen, Germany
Thesis: *Static, axially symmetric Deformations of the Schwarzschild spacetime*
Department: Max Planck Institute for Dynamics and Self-Organization
Supervisor(s): Prof. Folkert Müller-Hoissen

TEACHING & SUPERVISION EXPERIENCE

Co-Supervisor

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|-------------|--------------------------------------------------|-------------|
| 2020 - 2022 | Einar Urdshals (PhD) | Chalmers |
| 2020 - 2021 | Jonas Frerick (Master) | RWTH Aachen |
| 2020 | Joakim Hagel (Master) Oskar Lindroos (Master) | Chalmers |
| 2020 | Bachelor Project | Chalmers |

Substitute lecturer

Department for Physics, Chemistry and Pharmacy, Odense, Denmark

2017 Advanced Quantum Mechanics,
Introduction to Astrophysics and Cosmology

This involved independent preparation and holding of lectures in advanced theoretical physics over a few weeks.

Teaching assistant

Department for Physics, Chemistry and Pharmacy, Odense, Denmark

2016-2017 General Relativity and Cosmology, Advanced Quantum Mechanics (2x), Physics A, Astrophysics and Cosmology

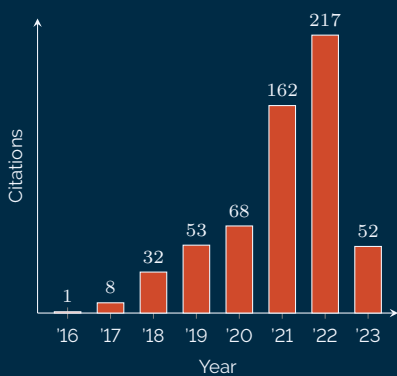
Faculty for Physics and Cosmology, Würzburg, Germany

2014 Theoretical Mechanics and Quantum Mechanics

Institute for Theoretical Physics, Göttingen, Germany

2011-2013 Classical Electrodynamics, Analytical Mechanics (2x), Mathematics for Physics I, Quantum Mechanics I

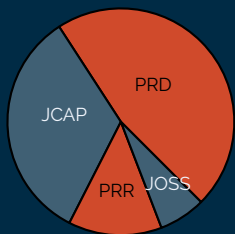
CITATIONS



(via Google Scholar, 03/23)

More citation statistics can be found on inSPIRE-HEP.

JOURNALS



OUTREACH

Social media outreach

Twitter account [↗](#) (>750 followers) dedicated to my work see e.g. [this thread](#) [↗](#).

Features in the media

Interviews & articles about my research, e.g. in [New Scientist](#) [↗](#).

Outreach article (2022)

"The dark side of the Sun" [↗](#) for department website of *Fysikum*.

Contributing author (2017)

Quantum Rascals web portal [Kvantebanditter](#) [↗](#)

Outreach article (2017)

"Detecting Dark Matter and Seeing the Invisible" [↗](#) for student newspaper *Hjerneblod*.

AWARDS & GRANTS

2023

MSCA - Seal of Excellence

Awarded for an outstanding project proposal under the Marie Skłodowska-Curie Actions (MSCA) of the European Union. (total score 87.2/100)

2022

SNIC Small Compute Grant

HPC Ressources (SNIC 2022/22-38, 60k core hours)

2007

DPG-Abiturpreis

Award by the German Physical Society (DPG) for outstanding achievements in Physics.

SCIENTIFIC PUBLICATIONS [\[inSPIRE-HEP profile ↗\]](#)

- [19] *Direct searches for general dark matter-electron interactions with graphene detectors: Part II. Sensitivity studies*
R. Catena, **Timon Emken**, M. Matas, N. Spaldin, E. Urdshals
Submitted to Physical Review Research (PRR). [\[arXiv:2303.15509\]](#)
- [18] *Direct searches for general dark matter-electron interactions with graphene detectors: Part I. Electronic structure calculations*
R. Catena, **Timon Emken**, M. Matas, N. Spaldin, E. Urdshals
Submitted to Physical Review Research (PRR). [\[arXiv:2303.15497\]](#)
- [17] *Dark matter - electron interactions in materials beyond the dark photon model*
R. Catena, D. Cole, **Timon Emken**, M. Matas, N. Spaldin, W. Tarantino, E. Urdshals
Journal for Cosmology and Astroparticle Physics 03 (2023) 052. [\[arXiv:2210.07305\]](#)
- [16] *A Next-Generation Liquid Xenon Observatory for Dark Matter and Neutrino Physics*
J. Aalbers et al. (incl. **Timon Emken**)
Journal of Physics G: Nuclear & Particle Physics 50 013001, 2023. [\[arXiv:2203.02309\]](#)
- [15] *Skipper CCDs for the search of a daily modulation of Dark Matter signal in the DM-SQUARE experiment (TAUP2021 Conference proceedings)*
N. Ávalos, H. Arnaldi, I. Artola, X. Bertou, E. Estrada, M. Gómez Berisso, M. B. Lovino, M. Mantiñan, M. Sofo Haro, J. Tiffenberg, J. Estrada, T.-T. Yu, R. Essig, **Timon Emken**
Journal of Physics: Conference Series, 2156 (2021), 012074.
- [14] *Electron recoils from terrestrial upscattering of inelastic dark matter*
Timon Emken, Jonas Frerick, Saniya Heeba, Felix Kahlhoefer
Physical Review D, 105(05):055023, 2022. [\[arXiv:2112.06930\]](#)
- [13] *obscura: A modular C++ tool and library for the direct detection of (sub-GeV) dark matter via nuclear and electron recoils*
Timon Emken
Journal of Open Source Software, 6(68), 3725, 2021. [\[arXiv:2112.01489\]](#)
- [12] *Crystal responses to general dark matter-electron interactions*
Riccardo Catena, **Timon Emken**, Marek Matas, Nicola A. Spaldin, Einar Urdshals
Physical Review Research, 3(3):033149, 2021. [\[arXiv:2105.02233\]](#)
- [11] *Solar reflection of light dark matter with heavy mediators*
Timon Emken
Physical Review D, 105(06):063020, 2022. [\[arXiv:2102.12483\]](#)
- [10] *Measuring the local Dark Matter density in the laboratory*
Bradley J. Kavanagh, **Timon Emken**, Riccardo Catena
Physical Review D, 104(08):083023, 2021. [\[arXiv:2004.01621\]](#)

CODING & COMPUTING SKILLS

Programming languages

| | |
|-------------|--------|
| C++ | 5+ yrs |
| Mathematica | 5+ yrs |
| LaTeX | 5+ yrs |
| Python | 3 yrs |

Software development

- Version control (git & svn)
- Build systems (make & CMake)
- Continuous Integration (CI)
- High-performance computing
- Parallelization (MPI & openMP)

High performance computing

- 2022-2023: Principal investigator of SNIC HPC project (SNIC 2022/22-38) 60000 core hrs on Tetralith.
- 2020-2023: User of Vera, C3SE Göteborg, Sweden
- 2019-2023: User of Tetralith, NSC Linköping, Sweden
- 2017-19: User of Abacus 2.0, DeiC National HPC Center, SDU, Odense, Denmark

- [9] *Rejecting the Majorana nature of dark matter with electron scattering experiments*
Riccardo Catena, **Timon Emken**, Julia Ravanis
Journal for Cosmology and Astroparticle Physics., 2020(06):056, 2020. [[arXiv:2003.04039](#)]
- [8] *Projected sensitivity to sub-GeV dark matter of next-generation semiconductor detectors*
Erik Andersson, Alex Bökmark, Riccardo Catena, **Timon Emken**, Henrik Klein Moberg, Emil Åstrand.
Journal for Cosmology and Astroparticle Physics, 2020(05):036, 2020. [[arXiv:2001.08910](#)]
- [7] *Atomic responses to general dark matter- electron interactions*
Riccardo Catena, **Timon Emken**, Nicola Spaldin, Walter Tarantino
Physical Review Research, 2:033195, 2020. [[arXiv:1912.08204](#)]
- [6] *Direct Detection of Strongly Interacting Sub-GeV Dark Matter via Electron Recoils*
Timon Emken, Rouven Essig, Chris Kouvaris, Mukul Sholapurkar
Journal for Cosmology and Astroparticle Physics, 1909(09):070, 2019. [[arXiv:1905.06348](#)]
- [5] *How blind are underground and surface detectors to strongly interacting Dark Matter?*
Timon Emken, Chris Kouvaris
Physical Review D, 97(11):115047, 2018. [[arXiv:1802.04764](#)]
- [4] *The Sun as a sub-GeV Dark Matter Accelerator*
Timon Emken, Chris Kouvaris, Niklas Grønlund Nielsen
Physical Review D, 97(6):063007, 2018. [[arXiv:1709.06573](#)]
- [3] *DaMaSCUS: The Impact of Underground Scatterings on Direct Detection of Light Dark Matter*
Timon Emken, Chris Kouvaris
Journal for Cosmology and Astroparticle Physics, 1710(10):031, 2017. [[arXiv:1706.02249](#)]
- [2] *Terrestrial effects on dark matter-electron scattering experiments*
Timon Emken, Chris Kouvaris, Ian M. Shoemaker
Physical Review D, 96(1):015018, 2017. [[arXiv:1702.07750](#)]
- [1] *Model independent limits on an ultralight gravitino from supernovae*
Riccardo Catena, Laura Covi, **Timon Emken**
Physical Review D, 91:123524, 2015. [[arXiv:1410.0314](#)]

PUBLISHED RESEARCH SOFTWARE ([Link to website](#))

- (10) Darphene (2023) – General dark matter-electron interactions in graphene
Timon Emken
[Code, v0.1.0], [DOI:10.5281/zenodo.7774374],
- (9) DarkART (2021) – Dark Atomic Response Tabulator - C++ tool to supersede and improve the python tool DarkARC.
Timon Emken
[Code, v0.1.0], [DOI:10.5281/zenodo.6046224],
- (8) obscura (2021) – A C++ library for dark matter detection computations
Timon Emken
[Code, v1.0.0], [DOI:10.5281/zenodo.5665890],
- (7) DaMaSCUS-SUN (2021) – Dark Matter Simulation Code for Underground Scatterings - Sun edition
Timon Emken
[Code, v0.1.0], [DOI:10.5281/zenodo.4559874], [ascl:2102.018]
- (6) libphysica (2021) – Static C++ library collecting functions, variables, and classes for application in sci- entific codes
Timon Emken
[Code, v0.1.1], [DOI:10.5281/zenodo.4557118],

LANGUAGE SKILLS

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| German | native |
| English | fluent |
| Danish | proficient |
| Swedish | basic |

LEAVES

Parental leave

2020 - 2022: 6 months in total

- (5) [comparXiv](#) (2020) – CLI tool to compare two versions of an arXiv preprint
Timon Emken
[Code, v0.1.8], ,
- (4) [Dirac-vs-Majorana](#) (2020) – Statistical discrimination of sub-GeV Majorana and Dirac dark matter
Timon Emken
[Code, v1.0], [DOI:10.5281/zenodo.3701262],
- (3) [DarkARC](#) (2019) – Dark Matter-induced Atomic Response Code
Timon Emken
[Code, v1.0], [DOI:10.5281/zenodo.3581334],
- (2) [DaMaSCUS-CRUST](#) (2018) – Dark Matter Simulation Code for Underground Scatterings - Crust edition
Timon Emken, Chris Kouvaris
[Code, v1.1], [DOI:10.5281/zenodo.2846401], [ascl:1803.001]
- (1) [DaMaSCUS](#) (2017) – Dark Matter Simulation Code for Underground Scatterings
Timon Emken, Chris Kouvaris
[Code, v1.1], [DOI:10.5281/zenodo.3726878], [ascl:1706.003]

CONFERENCE & SEMINAR TALKS [[Link to website](#)]

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| 2022-07-05 | Direct detection of sub-GeV dark matter with graphene | Internal meeting | Nordita, Stockholm (remote) |
| 2022-06-15 | Status of the Light Dark Matter KAW project | Fysikdagarna 2022 | Lund, Sweden |
| 2022-05-30 | Direct searches for sub-GeV dark matter with electrons and stars | BSM Seminar | Stockholm University |
| 2021-10-29 | Solar reflection of light dark matter | SOTU Seminar (Invited talk) | TIFR, Mumbai (remote) |
| 2021-09-02 | Solar reflection of sub-GeV dark matter | TAUP 2021 | IFIC (remote) |
| 2021-04-21 | Diurnal modulations in DM-electron scattering experiments | SENSEI collaboration meeting (Invited talk) | (remote) |
| 2021-04-20 | The particle accelerator in the Sky – Solar reflection of sub-GeV dark matter | Science seminar (Invited talk) | Lund University (remote) |
| 2020-11-23 | How atoms respond to general dark matter-electron interactions | Partikeldagarna 2020 | (remote) |
| 2020-01-15 | Direct Detection of sub-GeV Dark Matter with General Electron Interactions | Theory Seminar, Chalmers | Göteborg, Sweden |
| 2019-12-03 | How atoms respond to general Dark Matter-electron interactions | QM4DM Workshop | Nordita, Stockholm, Sweden |
| 2019-10-31 | Detecting low-mass Dark Matter after Scatterings in the Earth and Sun | LNGS Seminar (Invited talk) | INFN-LNGS L'Aquila, Italy |
| 2019-10-30 | How sensitive are direct detection experiments to strongly interacting light Dark Matter? | CRESST meeting (Invited talk) | Santo Stefano di Sessanio, Italy |
| 2019-10-09 | Direct Detection and Solar Reflection of sub-GeV Dark Matter | Theory Seminar (Invited talk) | University of Oslo, Norway |
| 2019-10-02 | Direct Detection of sub-GeV Dark Matter with strong Matter Interactions | Partikeldagarna 2019 | Linköping, Sweden |
| 2019-09-26 | Direct Detection of sub-GeV Dark Matter with strong Matter Interactions | Seminar for Frank Wilczek's visit | Göteborg, Sweden |

REFERENCES

1. Prof. Jan Conrad


 Stockholm University

 +46 8553 787 69

 conrad@fysik.su.se

2. Prof. Rouven Essig


 Stony Brook University

 +1 631 632 7990

 rouven.essig@stonybrook.edu

3. Prof. Nicola A. Spaldin

 ETH Zürich

 +41 44 633 37 55

 nicola.spaldin@mat.ethz.ch

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| 2019-09-18 | How Scatterings affect the Dark Matter Velocity Distribution in the Laboratory | Autumn Institute 2019 (Invited talk) | INFN-LNF, Frascati, Italy |
| 2019-08-12 | Direct detection of sub-GeV dark matter with strong interactions through a light mediator | Light Dark World 2019 (Invited talk) | ESI, Vienna, Austria |
| 2019-04-16 | Detecting dark matter after scatterings inside the Earth or Sun | TSP seminar | Göteborg, Sweden |
| 2019-02-28 | Simulating Dark Matter in the Earth and the Sun | PhD defence | Odense, Denmark |
| 2018-06-01 | How sensitive are direct detection experiments to strongly interacting dark matter? | MASS2018 | Odense, Denmark |
| 2018-04-24 | The Impact of Earth Scatterings on Light Dark Matter Detection | Theory Seminar | C.N. YITP, Stony Brook, USA |
| 2017-08-29 | Terrestrial Effects on Light Dark Matter Detection | DarkCo 2017 | Odense, Denmark |
| 2016-07-14 | Simulating Dark Matter Trajectories for Direct Detection Experiments | DTP 2016 | ECT*, Trento, Italy |
| 2013-11-28 | Supergravity & Supernovae | GRK1147 seminar | Würzburg, Germany |
| 2013-11-06 | Gravitino Phenomenology with Supernovae | Cosmology seminar | Göttingen, Germany |
| 2013-09-17 | Gravitino Phenomenology with Supernovae | Theory Seminar | Würzburg, Germany |
| 2013-07-08 | Gravitino Phenomenology in Astrophysics | IMPRS Workshop | MPI, München, Germany |

SCIENTIFIC WORKSHOPS

| | | | |
|------|----------------------|-------------------------------------------------|-------------------------------------------|
| 2019 | Workshop | STRONG-DM | ESI, Vienna, Austria |
| 2017 | Workshop | Code Refinery | NelC, Aarhus, Denmark |
| 2017 | Winter school | 9th Odense Winter School on Theoretical Physics | CP ³ -Origins, Odense, Denmark |
| 2016 | Summer school | Doctoral Training Program | ECT*, Trento, Italy |
| 2014 | Workshop | DESY Theory Workshop | DESY, Hamburg, Germany |
| 2014 | Workshop | Terascale C++ school | DESY, Hamburg, Germany |
| 2013 | Summer school | Summer school on particle physics | ICTP, Trieste, Italy |
| 2013 | Workshop | Computer Algebra in Particle Physics, | DESY, Zeuthen, Germany |