Sebastian Hoof

Marie Skłodowska-Curie Actions Postdoctoral Fellow

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Employment

Università degli Studi di Padova *Padua, Italy*

MSCA Postdoctoral Fellow *Since 2023*

MSCA PF for my project "AxiTools" with Luca Di Luzio, funded by the EU's Horizon programme (grant agreement No 101065579).

KIT *Karlsruhe, Germany*

Postdoctoral researcher *2022*

Three-month stay in Felix Kahlhoefer's group. Work on axions and axion-like particles in cosmology and using SN1987A data.

Georg-August-Universität Göttingen *Göttingen, Germany*

Postdoctoral researcher *2019–2022*

Postdoc position funded by David 'Doddy' J. E. Marsh's Sofja Kovalevskaja grant. Research on the phenomenology of QCD axions and axion-like particles, incl. experimental searches (Xenon-1T, TOORAD, IAXO), statistical methodology and global fits with GAMBIT.

Education

Imperial College London *London, UK*

PhD in Physics *2015–2019*

PhD thesis on *"Global Fits of Axions and WIMPs in Astrophysics, Cosmology, and Particle Physics"* supervised by Pat Scott and Roberto Trotta. Global statistical analyses combining the available experimental data and theoretical constraints for axions and WIMPs. I used Bayesian and frequentist techniques in C++ and Python, and contributed to the GAMBIT global fitting software.

Ruprecht-Karls-Universität Heidelberg *Heidelberg, Germany*

Master of Science (Physics) *2013–2015*

Overall grade: 1,0. Master's thesis on *"Axion Dark Matter and Two Periods of Inflation"* (supervised by Joerg Jaeckel).

Ruprecht-Karls-Universität Heidelberg *Heidelberg, Germany*

Bachelor of Science (Physics) *2009–2013*

Overall grade: 1,2. Bachelor's thesis in medical physics on the "Correlation of Particle and Background Signal in Al_2O_3:C,Mg Fluorescent Nuclear Track Detectors" (supervised by Oliver Jäkel and Steffen Greilich).

LCN (London Centre for Nanotechnology) *London, UK*

Summer student at the Hoogenboom lab *06/2012–08/2012*

I improved and characterised the design of my magnetically actuated cantilever setup and used it to image DNA samples [18].

UCL (University College London) *London, UK*

Erasmus Exchange Programme *2011–2012*

"Physics Project BSc" dissertation on "Bio-AFM by magnetic resonance-enhancement" (supervised by Bart Hoogenboom).

Publications

Up-to-date overview of citations from e.g. the INSPIRE database; current h-index ≈ 11.

Textbooks

[1] D. J. E. Marsh and S. Hoof, *Astrophysical Searches and Constraints*, in *The Search for Ultralight Bosonic Dark Matter* (D. F. J. Kimball and K. van Bibber, eds.), pp. 73–122. 2023. [arXiv:2106.08797].

Proceedings & White Papers

[2] J. Jaeckel, G. Rybka, and L. Winslow, *Axion Dark Matter*, *arXiv e-prints* (2022) arXiv:2203.14923, [arXiv:2203.14923].

[3] GAMBIT: S. Hoof, *A Preview of Global Fits of Axion Models in GAMBIT*, in *Proceedings, 13th Patras Workshop on Axions, WIMPs and WISPs, (PATRAS 2017): Thessaloniki, Greece, 15 May 2017 - 19, 2017* (2018) 32–38, [arXiv:1710.11138].

Articles

[4] S. Hoof and L. Schulz, *Updated constraints on axion-like particles from temporal information in supernova SN1987A gamma-ray data*, *arXiv e-prints* (2022) arXiv:2212.09764, [arXiv:2212.09764]. Accepted in JCAP, with **Python**.

[5] C. Balázs, S. Bloor, *et. al.*, *Cosmological constraints on decaying axion-like particles: a global analysis*, *JCAP* **2022** (2022) 027, [arXiv:2205.13549]. With **C++**.

[6] S. Hoof, J. Riess, and D. J. E. Marsh, *Statistical Uncertainties of the $N_{DW} = 1$ QCD Axion Mass Window from Topological Defects*, *The Open Journal of Astrophysics* **5** (2022) 5, [arXiv:2108.09563]. With **Python**.

[7] V. Plakkot and S. Hoof, *Anomaly ratio distributions of hadronic axion models with multiple heavy quarks*, *Phys. Rev. D* **104** (2021) 075017, [arXiv:2107.12378]. With **Python**.

[8] A. Fowlie, S. Hoof, and W. Handley, *Nested Sampling for Frequentist Computation: Fast Estimation of Small p-Values*, *Phys. Rev. Lett.* **128** (2022) 021801, [arXiv:2105.13923]. With **Python**.

[9] J. Schütte-Engel, D. J. E. Marsh, *et. al.*, *Axion quasiparticles for axion dark matter detection*, *JCAP* **2021** (2021) 066, [arXiv:2102.05366].

[10] S. Hoof, J. Jaeckel, and L. J. Thormaehlen, *Quantifying uncertainties in the solar axion flux and their impact on determining axion model parameters*, *JCAP* **2021** (2021) 006, [arXiv:2101.08789]. With **C++** & **Python**.

[11] S. S. AbdusSalam, F. J. Agocs, *et. al.*, *Simple and statistically sound recommendations for analysing physical theories*, *Reports on Progress in Physics* **85** (2022) 052201, [arXiv:2012.09874].

[12] J. J. Renk, P. Stöcker, *et. al.*, *CosmoBit: a GAMBIT module for computing cosmological observables and likelihoods*, *JCAP* **2021** (2021) 022, [arXiv:2009.03286]. With **C++**.

[13] P. Athron, C. Balázs, *et. al.*, *Global fits of axion-like particles to XENON1T and astrophysical data*, *Journal of High Energy Physics* **2021** (2021) 159, [arXiv:2007.05517]. With **C++**.

[14] S. Ando, A. Geringer-Sameth, *et. al.*, *Structure formation models weaken limits on WIMP dark matter from dwarf spheroidal galaxies*, *Phys. Rev. D* **102** (2020) 061302, [arXiv:2002.11956]. With **C++** & **Python**.

[15] S. Hoof, A. Geringer-Sameth, and R. Trotta, *A global analysis of dark matter signals from 27 dwarf spheroidal galaxies using 11 years of Fermi-LAT observations*, *JCAP* **2020** (2020) 012, [arXiv:1812.06986]. With **C++** & **Python**.

[16] S. Hoof, F. Kahlhoefer, P. Scott, C. Weniger, and M. White, *Axion global fits with Peccei-Quinn symmetry breaking before inflation using GAMBIT*, *Journal of High Energy Physics* **2019** (2019) 191, [arXiv:1810.07192]. With **C++**.

[17] S. Hoof and J. Jaeckel, *QCD axions and axionlike particles in a two-inflation scenario*, *Phys. Rev. D* **96** (2017) 115016, [arXiv:1709.01090]. With **Mathematica**.

[18] S. Hoof, N. Nand Gosvami, and B. W. Hoogenboom, *Enhanced quality factors and force sensitivity by attaching magnetic beads to cantilevers for atomic force microscopy in liquid*, *J. Appl. Phys.* **112** (2012) 114324, [arXiv:1211.1881].

Data & Software

[19] S. Hoof, C. Balázs, M. Lecroq, and L. Schulz, *Snax. Computational routines for axion and axion-like particle signatures from supernovae*, 2022. [**C++** & **Python** Github repo].

[20] V. Plakkot and S. Hoof, *Model catalogues and histograms of KSVZ axion models with multiple heavy quarks*, 2021. [Zenodo record].

[21] A. Fowlie, S. Hoof, and W. Handley, *Code and data for 'Nested sampling for frequentist computation'*, 2021. [**Python** Github repo].

[22] S. Hoof and L. Thormaehlen, *Solar Axion Flux. A C++ library to calculate the expected flux from axion-photon and axion-electron interactions inside the Sun*, 2021. [**C++** & **Python** Github repo].

[23] The GAMBIT Cosmology Workgroup, *Supplementary Data: CosmoBit: A GAMBIT module for computing cosmological observables and likelihoods (arXiv:2009.03286)*, 2020. [Zenodo record].

[24] S. Hoof, A. Geringer-Sameth, and R. Trotta, *Supplementary Material for A Global Analysis of Dark Matter Signals from 27 Dwarf Spheroidal Galaxies using 11 Years of Fermi-LAT Observations*, 2019. [Zenodo record].

[25] GAMBIT Collaboration, *Supplementary Data: Axion global fits with Peccei-Quinn symmetry breaking before inflation using GAMBIT*, 2018. [Zenodo record].

Supervision

As main supervisior

2020/21	**B.Sc. student**, Lena Schulz, on the statistical analysis of ALP decays into photons from SN1987A (co-supervisor: Jens Niemeyer)	*Göttingen U*
2020/21	**M.Sc. student**, Vaisakh Plakkot, on the landscape of KSVZ axion models; parts of the results published in [7] (co-supervisor: Laura Covi)	*Göttingen U*

As co-supervisior

2021	**Internship student (postgrad),** Jamal El Kuweiss, on solving the Saha equation in multi-ion plasmas. Primary supervisor: Jens Niemeyer.	*Göttingen U*
2020	**Internship student (postgrad),** Jana Riess, on statistical uncertainties of the QCD axion relic density, including realignment, axion strings and domain walls; parts of the results published in [6]. Primary supervisor: David J. E. Marsh.	*Göttingen U*
2019	**Summer student (postgrad),** Marie Lecroq (ENS Paris-Saclay), on ALP decays from Supernova 1987A. Primary supervisor: Csaba Balzacs (Monash U)	*remotely*

Teaching

Certificates

2014	**Heidelberg Didactics Teaching Certificate,** comprised of several training workshops in didactics and communicational skills, a peer-reviewed tutorial session, and a reflective report at the end of the term.	*Heidelberg U*

Graduate Teaching

2017	**Teaching assistant** (tutorials), Advanced Quantum Field Theory	*King's College London*
2014/15	**Teaching assistant** (tutorials), Quantum Field Theory	*Heidelberg U*

Undergraduate Teaching

2016/17	**Teaching assistant** (tutorials), Electrodynamics	*King's College London*
2016	**Teaching assistant/supervisor** (short project), First Year Laboratory Projects	*Imperial College*
2015/16	**Teaching assistant** (lab course), Second Year laboratory course "Charges and Fields"	*Imperial College*
2014	**Teaching assistant** (tutorials), *Theoretische Physik II* (Analytical Mechanics)	*Heidelberg U*
2013/14	**Teaching assistant** (tutorials), *Theoretische Physik I* (Classical Mechanics)	*Heidelberg U*
2013	**Teaching assistant** (tutorials), *Theoretische Physik IV* (Quantum Mechanics)	*Heidelberg U*
2012/13	**Teaching assistant** (tutorials), in *Theoretische Physik III* (Electrodynamics)	*Heidelberg U*
2011, '13, '14	**Teaching assistant** (tutorials), *Physik für Mediziner* (physics for medical students)	*Heidelberg U*

Awards & Funding

2023	**Marie Skłodowska-Curie Actions Postdoctoral Fellowship,** total ca. €173 000	*Padua, Italy*
2022	**Paris Region Fellowship (MSCA COFUND),** research fellowship (total ca. €147 000) — *declined*	*Paris, France*
2022	**MSCA Seal of Excellence@UNIPD 2022 Call,** research fellowship (total €100 000) — *declined*	*Padua, Italy*
2022	**Marie Skłodowska-Curie Actions Certificate of Excellence,** awarded by the European Union for MSCA applications with a score above 85% (score: 90.6%).	
2015	**The Imperial College President's Scholarship,** to undertake PhD studies at Imperial College London (total value ca. €112 000)	*London, UK*
2012	**Vacation bursary,** awarded by the EPSRC (British Engineering and Physical Sciences Research Council) to conduct a summer research project in the group of Bart Hoogenboom at the *London Centre for Nanotechnology*	*London, UK*
2011/12	**Erasmus stipend,** for a one-year exchange programme at UCL (total value: ca. €6 900)	*London, UK*

Service

Refereeing Physical Review Letters (3 papers reviewed), Astronomy & Astrophysics (1), JCAP (1), Physical Review D (3), Scientific Reports (Nature Research journal; 1)

CAT Seminar Series *Göttingen & online*

Co-organiser (with Viraf M. Mehta) *10/2021–06/2022*

Organising the "CAT Seminar Series" at the interface of cosmology, astroparticle physics, and theory (11 talks in total)

Cosmology Journal Club *Göttingen & online*

Organiser *10/2020–12/2021*

Chairing the journal club short presentations and encouraging discussions of the papers, administrative tasks

Fuzzy Dark Matter Workshop 2020 *online*

Conference co-organiser *20–22 July 2020*

Online conference with mostly pre-recorded talks, live discussion sessions and talks, as well as virtual interactions mediated through an avatar-based online platform. Website available at this link

Spokesperson *London, UK*

PhD student representative *10/2017–10/2018*

- Representing the interests of the Astrophysics PhD students in staff and faculty-level meetings at Imperial College
- Organising social events within the group but also with the other fundamental physics groups
- Moderating conflicts between PhD students

Skills & Experience

Programming	C++, Python, Git, LaTeX, Mathematica, R
HPC	Work on 3 tier-0, 1 tier-1, 3 tier-2, and 2 tier-3 clusters as defined by PRACE
Languages	German (native speaker), English (professional fluency), Italian (conversational fluency), French (basics)

Outreach & Volunteering

10 July 2016	**Outreach,** Public engagement for the "What happened at the Big Bang?" exhibit at the Summer Science Exhibition of the Royal Society	*London, UK*
5–6 July 2016	**Outreach,** Joint presentation and supervision for bubble chamber lab experiments for students from junior high schools in outer London at the NEUTRINO 2016 conference	*London, UK*
10–22 Sept. 2015	**Volunteering,** Public engagement activites for the pavilion of the European Union at EXPO Milano 2015	*Milan, Italy*

Presentations

In total **7** invited talks, **9** regular talks, **1** poster.

Invited talks

June 2022	"Nested sampling for Bayesian evidence calculation and beyond", CCM Colloquium, Flatiron Institute	New York City (USA)
Nov. 2021	"Definition and Probes of the Axion Model Landscape", TTK Theory Seminar, RWTH Aachen	Aachen (Germany)
Mar. 2019	"Global Fits for BSM Physics", Oberseminar Particle Phenomenology, Institut für theoretische Physik (Heidelberg U)	Heidelberg (Germany)
Mar. 2019	"Global Fits of Axion Models with PQ Symmetry Breaking Before Inflation", IAXO Collaboration Meeting, Sorbonne Université	Paris (France)
Dec. 2018	"Global Fits of Axion Models with PQ Symmetry Breaking Before Inflation", Stockholm-London-Amsterdam-Paris Workshop (SLAP), King's College London (KCL)	London (UK)
Oct. 2018	"Global Fits of Axion Models" (slides), DESY Theory Workshop 2018	Hamburg (Germany)
Sept. 2018	"Axion Global Fits with Peccei-Quinn Symmetry Breaking Before Inflation using GAMBIT", CAST Collaboration Meeting, CERN	remotely

Regular talks

Feb. 2023	"Updated constraints on axion-like particles from supernova SN1987A gamma-ray data", WISPers Journal Club	online
Nov. 2022	"Cosmological constraints on decaying axion-like particles" (slides), DISCRETE 2022	Baden-Baden (Germany)
Aug. 2022	"Cosmological constraints on decaying axion-like particles: a global analysis" (slides), 17th Patras Workshop	Mainz (Germany)
July 2022	"Cosmological constraints on decaying axion-like particles: a global analysis" (slides), 14th Conference on the Identification of Dark Matter	Vienna (Austria)
Sept. 2021	"Uncertainties of the Solar Axion Flux and the KSVZ Axion Model Landscape" (slides), DESY Theory Workshop 2021	Hamburg (Germany)
June 2021	"Uncertainties of the Solar Axion Flux Computation" (slides), 16th Patras Workshop	online
Mar. 2021	"Quantifying uncertainties in the solar axion flux and their impact on determining axion model parameters" (video), Seminar, Virtual Axion Institute	online
June 2017	"Axion dark matter and Bayesian searches for dark matter in dwarf galaxies", RISE-ASTROSTAT Collaboration Meeting	Crete (Greece)
May 2017	"Axion Global Fits in GAMBIT" (slides), 13th Patras Workshop	Thessaloniki (Greece)

Posters

Sept. 2016	"Axions in GAMBIT", Invisibles 16	Padova (Italy)