Marie Skłodowska-Curie Actions Postdoctoral Fellow

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## Employment\_

### Università degli Studi di Padova

#### **MSCA Postdoctoral Fellow**

Marie Skłodowska-Curie Fellowship (supervisors: Paride Paradisi, Luca Di Luzio), funded by the EU's Horizon programme (GA No. 101065579). Development of software tools to study axion phenomenology.

#### KIT

Postdoctoral researcher

With Felix Kahlhoefer. Phenomenology of axions in cosmology and using SN1987A data.

#### Georg-August-Universität Göttingen

#### Postdoctoral researcher

With David 'Doddy' J. E. Marsh (Sofja Kovalevskaja research group). Phenomenology of axions with Xenon-1T, TOORAD, IAXO; statistical methodology; global fits with GAMBIT.

### **Education**

Imperial College London	London, UK
PhD in Physics	2015–2019
Thesis on "Global Fits of Axions and WIMPs in Astrophysics, Cosmology, and Particle Physics" (supervisors: Pat	t Scott, Roberto Trotta).
Ruprecht-Karls-Universität Heidelberg	Heidelberg, Germany
Master of Science (Physics)	2013–2015
Thesis on "Axion Dark Matter and Two Periods of Inflation" (supervisor: Joerg Jaeckel; overall grade: 1,0).	
Ruprecht-Karls-Universität Heidelberg	Heidelberg, Germany
Bachelor of Science (Physics)	2009–2013
Thesis on "Correlation of Particle and Background Signal in Al2O3:C,Mg Fluorescent Nuclear Track Detectors" (s	supervisors: Oliver
Jäkel, Steffen Greilich; overall grade: 1,2).	
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	A samples.
UCL (University College London)	London, UK
Erasmus Exchange Programme	2011–2012
"Physics Project BSc" dissertation on "Bio-AFM by magnetic resonance-enhancement" (supervisor: Bart Hooge	enboom).

## **Publications**

Up-to-date overview of citations from e.g. the INSPIRE database; current *h*-index  $\approx$  14.

### **Textbook Chapters**

[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].

### Articles

- [2] S. Hoof, J. Jaeckel, and G. Lucente, *HyperLSW: Ultimate light-shining-through-a-wall experiments to establish QCD axions as the dominant form of dark matter, arXiv e-prints* (2024) arXiv:2407.04772, [arXiv:2407.04772]. With **Python**; accepted in PRD.
- S. Hoof, J. Jaeckel, and L. J. Thormaehlen, Axion helioscopes as solar thermometers, JCAP 2023 (2023) 024, [arXiv: 2306.00077]. With C++ & Python.
- [4] S. Hoof and L. Schulz, Updated constraints on axion-like particles from temporal information in supernova SN1987A gamma-ray data, JCAP **2023** (2023) 054, [arXiv:2212.09764]. With C++ & 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++.

### Padua, Italy

1/2023-12/2024

Karlsruhe, Germany

Göttingen, Germany

10/2022-12/2022

9/2019-8/2022

### 1

- [6] S. Hoof, J. Riess, and D. J. E. Marsh, Statistical Uncertainties of the N<sub>DW</sub> = 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].
- 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].

#### Community Papers, Proceedings

- [19] 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].
- [20] C. B. Adams, N. Aggarwal, et. al., Axion Dark Matter, arXiv e-prints (2022) arXiv:2203.14923, [arXiv:2203.14923].

#### Preprints

- [21] L. Di Luzio, S. Hoof, C. Marinissen, and V. Plakkot, *Catalogues of Cosmologically Self-Consistent Hadronic QCD Axion Models, arXiv* e-prints (2024) arXiv:2412.17896, [arXiv:2412.17896]. With **Python**.
- [22] S. Ahyoune, K. Altenmueller, et. al., An accurate solar axions ray-tracing response of BabyIAXO, arXiv e-prints (2024) arXiv:2411.13915, [arXiv:2411.13915].
- [23] S. Hoof, D. J. E. Marsh, J. Sisk-Reynés, J. H. Matthews, and C. Reynolds, *Getting More Out of Black Hole Superradiance: a Statistically Rigorous Approach to Ultralight Boson Constraints, arXiv e-prints* (2024) arXiv:2406.10337, [arXiv:2406.10337]. With **Python**.

### Data & Software

- [24] S. Hoof, BHSR. Black hole superradiance exclusions of ultralight bosons, 2024. [Python Github repo].
- [25] 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].
- [26] V. Plakkot and S. Hoof, Model catalogues and histograms of KSVZ axion models with multiple heavy quarks, 2021. [Zenodo record].
- [27] A. Fowlie, S. Hoof, and W. Handley, Code and data for 'Nested sampling for frequentist computation', 2021. [Python Github repo].
- [28] 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].
- [29] The GAMBIT Cosmology Workgroup, Supplementary Data: CosmoBit: A GAMBIT module for computing cosmological observables and likelihoods (arXiv:2009.03286), 2020. [Zenodo record].
- [30] 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].
- [31] GAMBIT Collaboration, Supplementary Data: Axion global fits with Peccei-Quinn symmetry breaking before inflation using GAMBIT, 2018. [Zenodo record].

### Supervision.

2023/24	<b>M.Sc. student</b> , Ruben Zatini, on ALP signals from magnetic white dwarf stars (lead supervisor: Luca Di Luzio)	U Padua
2022/23	<b>B.Sc. student</b> , Santiago Rosellón Inclán, on freeze-in production of axion-like particles (lead supervisor: Felix Kahlhöfer).	KIT
2020/21	<b>B.Sc. student</b> , Lena Schulz, on the statistical analysis of ALP decays into photons from SN1987A (co-supervisor: Jens Niemeyer).	U Göttingen
2021	Internship student (postgrad), Jamal El Kuweiss, on solving the Saha equation in multi-ion plasmas (lead supervisor: Jens Niemeyer).	U Göttingen
2020/21	<b>M.Sc. student</b> , Vaisakh Plakkot, on the landscape of KSVZ axion models (co-supervisor: Laura Covi).	U Göttingen
2020	<b>Internship student (postgrad)</b> , Jana Riess, on statistical uncertainties of the QCD axion relic density, including realignment, axion strings and domain walls (lead supervisor: David J. E. Marsh).	U Göttingen
2019	<b>Summer student (postgrad)</b> , Marie Lecroq (ENS Paris-Saclay), on ALP decays from Supernova 1987A (lead supervisor: Csaba Balzacs, Monash U).	remotely
Teachir	1g	
Certificate	S	
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.	U Heidelberg
Graduate <sup>-</sup>	Teaching	
2017 2014/15	Teaching assistant (tutorials), Advanced Quantum Field Theory Teaching assistant (tutorials), Quantum Field Theory	King's College London U Heidelberg
Undergrad	luate 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)	U Heidelberg
2013/14	Teaching assistant (tutorials), Theoretische Physik I (Classical Mechanics)	U Heidelberg
2013	Teaching assistant (tutorials), Theoretische Physik IV (Quantum Mechanics)	U Heidelberg

2012/13 **Teaching assistant** (tutorials), in *Theoretische Physik III* (Electrodynamics)

2011, '13, '14 Teaching assistant (tutorials), Physik für Mediziner (physics for medical students)

# Awards & Funding\_\_\_\_\_

2023	ISCRA Class C Project, 100,000 CPUh on GALILEO100	Italy
2023	ISCRA Class C Project, 50,000 CPUh on GALILEO100	Italy
2023	Marie Skłodowska-Curie Actions Postdoctoral Fellowship, ca. €173 000	Padua, Italy
2022	Paris Region Fellowship (MSCA COFUND), research fellowship (ca. €147 000) - declined	Paris, France
2022	MSCA Seal of Excellence@UNIPD 2022 Call, research fellowship (€100 000) — declined	Padua, Italy
2022	Marie Skłodowska-Curie Actions Seal 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, UK
	London (ca. €112 000)	
2012	Vacation bursary, awarded by the EPSRC (British Engineering and Physical Sciences Research	London, UK
	Council) to conduct a summer research project in the group of Bart Hoogenboom at the London	
	Centre for Nanotechnology	
2011/12	Erasmus stipend, for a one-year exchange programme at UCL (total value ca. €6 900)	London, UK

## Service\_

U Heidelberg

U Heidelberg

Refereeing	Physical Review Letters (5 papers reviewed), Astronomy & Astrophysics (1), JCAP (1) Scientific Reports (Nature Research journal; 1)	), NIMA (1), Physical Review D (3),
GAMBIT XVI	@ LNF	Frascati, Italy
Conference orga	iniser	16–20 Sept 2024
The official GAN	MBIT collaboration meeting at the National Labs of Frascati. Website available at this li	ink
Particle Phe	nomenology Journal Club	Padua, Italy
Co-organiser		01/2023–12/2023
Chairing the jou	urnal club short presentations and encouraging discussions of the papers, administration	ive tasks
CAT Semina	r 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 jou	urnal club short presentations and encouraging discussions of the papers, administration	ive tasks
Fuzzy Dark	Matter Workshop 2020	online
Conference co-o	organiser	20–22 July 2020
Online conferer	Inline conference with mostly pre-recorded talks, live discussion sessions and talks, as well as virtual interactions mediated through	
an avatar-based	d online platform. Website available at this link	
Spokesperso	on	London, UK
PhD student rep	resentative	10/2017–10/2018
Representing th	ne interests of the Astrophysics PhD students in staff and faculty-level meetings at Imp	perial College, organising social
events within th	ne group and other research groups, moderating conflicts between students	

## Skills & Experience\_

 Programming
 C++, Python, Git, LaTeX, Mathematica

 HPC
 Work on 3 tier-0, 2 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

2023/24	Volunteering, Member of the Scientific Commission for the 9th edition of the "Asimov	Padua, Italy
	prize" for popular science books (in Italian)	
10 July 2016	Outreach, Public engagement for the "What happened at the Big Bang?" exhibit at the	London, UK
	Summer Science Exhibition of the Royal Society	
5–6 July 2016	Outreach, Joint presentation and supervision for bubble chamber lab experiments for	London, UK
	students from junior high schools in outer London at the NEUTRINO 2016 conference	
10–22 Sept.	Volunteering, Public engagement activities at the European Union's pavilion at EXPO	Milan, Italy
2015	2015	

## Presentations\_

In total **14** invited talks, **16** regular talks, **1** poster.

		Invited talks
Sendai, Japan	"Axion Models and Phenomenology in Astrophysics and Cosmology", GPPU Lecture,	Nov. 2024
	Tohoku University	
remotely	"HyperLSW Experimental Setups for Determining the Amount of Axion Dark Matter	Aug. 2024
	After a Discovery", ALPS Group Meeting, DESY	
Frascati, Italy	"Helioscope Searches for Axion Phenomenology", Seminar, LNF	April 2024
Amsterdam, Netherlands	"Tools for axion model predictions and prospects for their detection in astrophysics",	Jan. 2024
	Seminar, Nikhef (U Amsterdam)	
Naples, Italy	"Searching for axions using data from astrophysics, cosmology, and the lab", Seminar,	Nov. 2023
	INFN Sezione di Napoli	
remotely	"Axion Helioscopes as Solar Thermometers", IAXO Collaboration Meeting, CEFCA	Sept. 2023
	Teruel	
Avignon, France	"Selected aspects of the particle vs wave nature of dark matter" (slides), PONT 2023	May 2023
New York City, USA	"Nested sampling for Bayesian evidence calculation and beyond". CCM Colloquium.	June 2022
	Flatiron Institute	

Nov. 2021	"Definition and Probes of the Axion Model Landscape", Seminar, TTK Theory Group	Aachen, Germany
Mar. 2019	"Global Fits of Axion Models with PQ Symmetry Breaking Before Inflation", IAXO	Paris, France
Mar. 2019 Dec. 2018	"Global Fits of Axion Models with PQ Symmetry Breaking Before Inflation",	Heidelberg, Germany London, UK
Oct. 2018 Sept. 2018	Stockholm-London-Amsterdam-Paris Workshop (SLAP), King's College London (KCL) "Global Fits of Axion Models" ( <b>slides</b> ), DESY Theory Workshop 2018 "Axion Global Fits with Peccei-Quinn Symmetry Breaking Before Inflation using GAMBIT", CAST Collaboration Meeting, CERN	Hamburg, Germany remotely
Regular talks	S	
Oct. 2024	"Axion Models Their Role in Cosmology and as Potential Astrophysical Probes", Seminar, Kanazawa University	Kanazawa, Japan
Oct. 2024	"Axion Models Their Role in Cosmology and as Potential Astrophysical Probes", Seminar, Tokyo Metropolitan University	Tokyo, Japan
July 2024	"HyperLSW Experimental Setups for Determining the Amount of Axion Dark Matter After a Discovery" (slides) IDM 2024	L'Aquila, Italy
April 2024	"Finding Axions in a Universe of Data and Envisioning Their Use as Multi-Messenger Probes" Seminar L PTHE (Sorbonne LI)	Paris, France
Oct. 2023	"Visions of Axion Multi-Messenger Physics with Helioscopes", Seminar & COST Action "Cosmic WISPers" Colleguium, Osservatorio Astronomico d'Abruzzo	Teramo (hybrid), Italy
Sept. 2023	"Axion Helioscopes as Solar Thermometers" (slides), Axions++, I APTh	Annecy, France
June 2023	"Axions as Solar Thermometers", GGI Conference "Axions across boundaries", Galileo Galilei Institute	Florence, Italy
Feb. 2023	"Updated constraints on axion-like particles from supernova SN1987A gamma-ray data". COST Action "Cosmic 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), IDM 2022	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", BISE-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	Padua, Italy