



Dr. rer. nat. Martin Bies

Curriculum Vitae



 RPTU Kaiserslautern-Landau
Department of Mathematics
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German	Native	●●●●●
English	Full Proficiency	●●●●●
French	Modest (CEFR Level B1)	●●●●●

SUMMARY

I hold a **PhD in Physics** (*Heidelberg Univ.*, 2018), specializing in **string theory** and **mathematics**. My research is inspired by **computational analysis** of **massless spectra in string vacua**, resulting in publications on **toric geometry**, **Freyd categories**, **Brill-Noether theory**, and **root bundles**. Proficient in *julia*, *C++*, and *python*, I excel in **open-source software development** (*git*) to advance **computational research**. My diverse expertise emphasizes my interdisciplinary commitment. With a history of **international collaborations**, full **English proficiency**, and extensive **teaching experience**, I showcase a versatile skill set.

RESEARCH EXPERIENCE

Mathematics Dept., RPTU Kaiserslautern-Landau, GER

Research Associate

I enhance the toric geometry capabilities and develop advanced algebraic geometry tools for string theory geometries within the OSCAR computer algebra system (oscar-system.org). Funded by the *SFB-TRR 195 – Symbolic Tools in Mathematics and their Application*, I added/modified 142,000+ lines of code.

Dept. of Phys. & Astron., University of Pennsylvania, USA

Simons Postdoctoral Fellow

Continuation of *Simons Foundation* project.

Dept. of Mathematics, University of Pennsylvania, USA

Simons Postdoctoral Fellow

Work with M. Cvetič and R. Donagi on root bundles and the F-theory QSMs (funded by the *Simons Foundation*).

Mathematical Institute, University of Oxford, UK

Long Term Visitor

Continuation of *Wiener-Anspach* project initiated at PTM, Brussels.

PTM, Université Libre de Bruxelles, BE

Postdoctoral Researcher

M/F-Theory: Engineering Of Super Conformal Field Theories (funded by the *Foundation Wiener-Anspach*).

02/2018 – 09/2018 (FT)

EDUCATION

- 03/2014 – 02/2018 **PhD in Physics (Grade: Magna Cum Laude)**
ADVISOR: PROF. T. WEIGAND (PHYSICS) & PROF. M. BARAKAT (MATHEMATICS)
Heidelberg University, GER
- 09/2012 – 02/2014 **Master of Physics (Grade: 1.0)**
ADVISOR: PROF. T. WEIGAND
Heidelberg University, GER
- 10/2010 – 06/2011 **ERASMUS exchange student**
Imperial College, London
- 10/2008 – 08/2012 **Bachelor of Physics (Grade: 1.1)**
ADVISOR: PROF. T. WEIGAND
Heidelberg University, GER

SCHOLARSHIPS AND AWARDS

- 04/2024 – CURRENT **TU-Nachwuchsring**
Funding: 3000€.
Status: M. Mikelsons (BSc. Mathematics) hired as research assistant.
Goal: Improve FTheoryTools and exploit this software tool for research paper.
- 01/2010 – 02/2018 **Studienstiftung des deutschen Volkes**
2014: Awarded PhD scholarship.
2010: Awarded Master scholarship.

CURRENT COLLABORATIONS

- FROM 2022 **FTheoryTools in OSCAR**
Initiated with **A. P. Turner** (*University of Pennsylvania, USA*).
Later joined by **M. Zach** (*RPTU KL-LD, GER*), **Prof. Frühbis-Krüger** (*Univ. Oldenburg, GER*).
Goal: In OSCAR, create computer tools for F-theory applications.
Key features: Crepant singularity resolution and database of existing constructions.
Status: First paper expected by mid-2024, paving way for cutting-edge applications.
From 04/2024: Research Assistant M. Mikelisons (funded by *TU-Nachwuchsring*).
- FROM 2021 **Toric Geometry in OSCAR**
Together with **L. Kastner** (*Technische Universität Berlin, GER*) and support by the OSCAR team.
Goal: Solid foundation of toric geometry in OSCAR and integration with Polymake.
Status: **S. Telen**'s (MPI-MiS Leipzig, GER) lecture used OSCAR's toric geometry: [arxiv-2203.01690](#).
An overview over the available functionality has been given in publication #10 (Mar. 2023).
G. Muratore's (Univ. de Lisboa, PRT) article [arxiv-2309.03741](#) is based on our work.
A dedicated OSCAR book chapter will detail further updates, due in 2024.
- FROM 2020 **Applications of Root Bundles to F-theory Standard Models**
Collaboration with **Prof. M. Cvetič** and **Prof. R. Donagi** (*University of Pennsylvania, USA*).
Initially, contributions from **M. Liu** (back then, PhD student at *University of Pennsylvania, USA*).

Continued work with **M. Ong** (PhD student at *University of Pennsylvania, USA*).
Goal: Explore creating a single Higgs field in F-theory standard models using root bundles.
Status: Resulted in 4 peer-reviewed papers (#1, 2, 3, 4) and preprint #9 from Jul. 2023.

SERVICES

- 07/2024 Organizing session at conference *ICMS 2024* (together with M. Zach & L. Kastner).
- 02/2024 Studienstiftung des deutschen Volkes: Member of the admission board – virtual event via *zoom*.
- FALL 2023 Expert at European Commission: Accessment of research proposals in Mathematics and Physics.
- SINCE 2021 10+ letters of recommendation.
- 06/2018 Studienstiftung des deutschen Volkes: Member of the admission board *Heidelberg*.
- 12/2017 Studienstiftung des deutschen Volkes: Member of the admission board *Ellwangen III*.
- 05/2017 Studienstiftung des deutschen Volkes: Training for admission board members – successfully completed.
- 11/2016 Studienstiftung des deutschen Volkes: Member of the admission board *Heidelberg*.

OTHER TRAININGS

- 03/2024 Moderation of meetings and project discussions (Kaiserslautern, GER).
Offered by: *TU Nachwuchsring*
- 05/2018 Kontaktseminar – Schwerpunkt Banken und Beratung (Bonn, GER)
Offered by: *Studienstiftung des deutschen Volkes*
- 05/2018 Physiker im Beruf (Bad Honnef, GER)
Offered by: *Deutsche Physikalische Gesellschaft (DPG)*

PUBLICATIONS

ORCID	0000-0002-9609-1693
SCOPUS	57197835420
H-INDEX	5 (Based on peer-reviewed works, only.)
TOTAL PUBLICATIONS	16
PEER REVIEWED/ACCEPTED	8
UNDER REVIEW	1
OUTREACH	3
UNPUBLISHED	1
THESIS	3
JOURNALS	Journal of High Energy Physics (5) Journal of Algebra and Its Applications (1) Physical Review D (1) Proceedings of Symposia in Pure Mathematics (AMS) (1)

Peer Reviewed Publications

- 1 **M. Bies**, *Root bundles: Applications to F-theory Standard Models*, in *String-Math 2022*, R. Donagi, A. Langer, P. Sułkowski, and K. Wendland, eds., Proceedings of Symposia in Pure Mathematics, vol. 107, American Mathematical Society, 2024, pp. 17–43. ISBN: 978-1-4704-7240-5. DOI: [10.1090/pspum/107](https://doi.org/10.1090/pspum/107). (A preprint is available at [arXiv:2303.08144](https://arxiv.org/abs/2303.08144).)
- 2 **M. Bies**, M. Cvetič, R. Donagi, M. Ong, *Brill-Noether-general Limit Root Bundles: Absence of vector-like Exotics in F-theory Standard Models*, *Journal of High Energy Physics*, Nov. 2022, DOI: [10.1007/JHEP11\(2022\)004](https://doi.org/10.1007/JHEP11(2022)004).
- 3 **M. Bies**, M. Cvetič, M. Liu, *Statistics of Root Bundles Relevant for Exact Matter Spectra of F-theory MSSMs*, *Physical Review D*, Sept. 2021, DOI: [10.1103/PhysRevD.104.L061903](https://doi.org/10.1103/PhysRevD.104.L061903).
- 4 **M. Bies**, M. Cvetič, R. Donagi, M. Liu, M. Ong, *Root Bundles and Towards Exact Matter Spectra of F-theory MSSMs*, *Journal of High Energy Physics*, Sept. 2021, DOI: [10.1007/JHEP09\(2021\)076](https://doi.org/10.1007/JHEP09(2021)076).
- 5 **M. Bies**, S. Posur, *Tensor Products of Finitely Presented Functors*, *Journal of Algebra and Its Applications*, July. 2021, DOI: [10.1142/S0219498822501869](https://doi.org/10.1142/S0219498822501869).
- 6 **M. Bies**, M. Cvetič, R. Donagi, L. Ling, M. Liu, F. Ruehle, *Machine Learning and Algebraic Approaches towards Complete Matter Spectra in 4d F-theory*, *Journal of High Energy Physics*, Jan. 2021, DOI: [10.1007/JHEP01\(2021\)196](https://doi.org/10.1007/JHEP01(2021)196).
- 7 **M. Bies**, C. Mayrhofer, T. Weigand, *Algebraic Cycles and Local Anomalies in F-theory*, *Journal of High Energy Physics*, Nov. 2017, DOI: [10.1007/jhep11\(2017\)100](https://doi.org/10.1007/jhep11(2017)100).
- 8 **M. Bies**, C. Mayrhofer, T. Weigand, *Gauge Backgrounds and Zero-Mode Counting in F-theory*, *Journal of High Energy Physics*, Nov. 2017, DOI: [10.1007/jhep11\(2017\)081](https://doi.org/10.1007/jhep11(2017)081).

Preprints currently under Review

- 9 **M. Bies**, M. Cvetič, R. Donagi, M. Ong, *Improved Statistics for F-theory Standard Models*, Preprint: <https://arxiv.org/abs/2307.02535>, Jul. 2023, under review at *Communications in Mathematical Physics*.

Outreach

- 10 **M. Bies**, A. P. Turner, *F-Theory Applications*, in *The Computer Algebra System OSCAR: Algorithms and Examples*, W. Decker, C. Eder, C. Fieker, M. Horn, and M. Joswig, eds., Algorithms and Computation in Mathematics, vol. 32, Springer, 1st ed., August 2024, pp. 453–475. **ISSN: 1431-1550**.
- 11 **M. Bies**, L. Kastner, *Toric Geometry*, in *The Computer Algebra System OSCAR: Algorithms and Examples*, W. Decker, C. Eder, C. Fieker, M. Horn, and M. Joswig, eds., Algorithms and Computation in Mathematics, vol. 32, Springer, 1st ed., August 2024, pp. 193–213. **ISSN: 1431-1550**.
- 12 **M. Bies**, L. Kastner, *Toric Geometry in OSCAR*, *ComputerAlgebraRundbrief* 72 (03/2023), 20-25, Mar. 2023, Preprint: <https://arxiv.org/abs/2303.08110>.

Unpublished Works

- 13 **M. Bies**, C. Mayrhofer, C. Pehle, T. Weigand, *Chow Groups, Deligne Cohomology and Massless Matter in F-theory*, Feb. 2014, <https://arxiv.org/abs/1402.5144>.

Thesis

- 14 **M. Bies**, *Cohomologies of Coherent Sheaves and Massless Spectra in F-theory*, PhD thesis, Heidelberg university, Feb. 2018, [Heidelberg University Library](#), available at DOI: [10.11588/HEIDOK.00024045](https://nbn-resolving.org/urn:nbn:de:heider:00024045).
- 15 **M. Bies**, *Cohomologies of holomorphic line bundles in smooth and compact normal toric varieties*, MSc. thesis, Heidelberg university, February 2014, [available on author's academic homepage](#).
- 16 **M. Bies**, *Intersecting D6-brane models on $T^2 \times T^2 \times T^2 / (\sigma \times \Omega)$ and $T^2 \times T^2 \times T^2 / (\mathbb{Z}_2 \times \mathbb{Z}_2 \times \sigma \times \Omega)$ orientifolds*, BSc. thesis, Heidelberg university, August 2012, [available on author's academic homepage](#).

TALKS, POSTERS, CONFERENCES

Invited Talks (8)

- 07/2023 *Third Annual Meeting 2023 of SFB-TRR 195* (Saarbruecken, GER)
Title: *F-Theory: Exemplifying OSCAR's Pursuit for Multidisciplinary Excellence*
- 05/2023 *Oberseminar algebraische Geometrie* (Saarbruecken, GER)
Title: *F-Theory and Singular Elliptic Fibrations*
- 10/2020 Philadelphia, USA
Title: *Machine Learning and Algebraic Approaches towards Complete Matter Spectra in 4d F-theory*
- 06/2020 *Summer Series on String Phenomenology (Virtual)*
Title: *On Stratification Diagrams, Algorithmic Spectrum Estimates and Vector-Like Pairs in F-theory*
- 12/2019 Philadelphia, USA
Title: *From F-theory Standard Models to Freyd Categories and back*
- 10/2018 Brussels, BE
Title: *Counting Massless Matter in F-theory with CAP*
- 08/2018 *CAP_days 2018* (Siegen, GER)
Title: *CAP, Machine Learning and String Theory*
- 07/2014 Aachen, GER
Title: *The Standard Model from String Theory*

Other Talks at Conferences, Workshops etc. (14)

- 07/2023 *StringMath 2023* (Melbourne, AU)
Title: *Root bundles: Applications to F-theory Standard Models*
- 07/2023 *StringPheno 2023* (Daejeon, KR)
Title: *Root bundles: Applications to F-theory Standard Models*
- 05/2023 *Computeralgebra Tagung 2023* (Hannover, GER)
Title: *F-Theory Tools: String theory Applications of OCSAR*
- 07/2022 *String Math 2022* (Warsaw, PL)
Title: *Towards F-theory MSSMs*
- 07/2022 *String Pheno 2022* (Liverpool, UK)
Title: *Towards F-theory MSSMs*
- 09/2021 *Summer Series on String Phenomenology (virtual meeting)*
Title: *Root Bundles and Towards Exact Matter Spectra of F-theory MSSMs*
- 12/2020 *String Data 2020* (virtual conference)
Title: *Vector-like spectra in F-theory* (joined with M. Liu)
- 08/2019 *Gap Singular Meeting and School* (Lambrecht, GER)
Title: *Monoidal Structures in Freyd Categories*
- 05/2018 *Seminar on Holography and Large-N duality* (Heidelberg, GER)
Title: *Conformal Invariants; Fefferman–Graham Expansion; Graham–Lee Theorem* (with M. Zikidis)
- 07/2017 *String Pheno 2017* (Virginia, USA)
Title: *Zero Mode Counting in F-Theory via CAP*
- 08/2014 *GAP Days* (Aachen, GER)
Title: *String Theory, Sheaf Cohomology and the homalg Package*

- 05/2014 Seminar Series *What is?* (Heidelberg, GER)
Title: *What is a Fermion/Boson (in Quantum Mechanics)?*
- 02/2014 Heidelberg, GER
Title: *Cohomology of Holomorphic Pullback Line Bundles on Smooth, Compact Normal Toric Varieties*
- 05/2012 Heidelberg, GER
Title: *Intersecting D6-Brane Models*

Posters at Conferences, Workshops etc. (2)

- 07/2023 *StringMath 2023* (Melbourne, AU)
Title: *FTheoryTools – A Computer Tool for Singular Elliptic Fibrations*
- 09/2019 *Strings and Geometry* (Oxford, UK)
Title: *Tensor Products of Finitely Presented Functors*

Conferences attended without Talk or Poster Contribution (17)

- 07/2022 *Strings 2022* (Vienna, AT)
- 06/2022 Simons Collab.: *Geometry, Topology and Singular Special Holonomy Spaces* (Freiburg, GER)
- 11/2021 Simons Collab. (Homological Mirror Symmetry) *Annual Meeting* (New York, USA)
- 09/2021 Simons Collab.: *Progress and Open Problems* (Stony Brook, USA)
- 09/2021 Simons Collab. (Special Holonomy in Geometry, Analysis, Phys.) *Annual Meeting* (New York, USA)
- 07/2021 *String Pheno 2021* (virtual conference)
- 06/2021 *Strings 2021* (virtual conference)
- 06/2021 *String Math 2021* (virtual conference)
- 06/2020 *String Pheno 2020* (virtual conference)
- 07/2019 *Strings 2019* (Brussels, BE)
- 03/2018 *String Data 2018* (Munich, GER)
- 12/2015 *String Math 2015* (Sanya, CN)
- 09/2015 *Third GAP Days* (Trondheim, NO)
- 03/2015 *Second GAP Days* (Aachen, GER)
- 02/2015 *Physics and Geometry of F-Theory* (Munich, GER)
- 12/2014 *Homological Perturbation Theory* (Galway, IE)
- 02/2014 *Geometry and Physics of String Compactifications* (Heidelberg, GER)

TEACHING RECORD

Autonomous Instruction of Lecture Courses

Period	Title	University	Students	Weekly Teaching	Evaluation
04/2024 – 07/2024	<i>Introduction to Topology</i>	RPTU KL-LD, GER	–	1 × 1.5 hours	–
01/2022 – 05/2022	<i>Computational Linear Algebra</i>	University Of Pennsylvania, USA	29	2 × 1.5 hours	2.12
01/2021 – 05/2021	<i>Computational Linear Algebra</i>	University Of Pennsylvania, USA	57	2 × 1.5 hours	2.04

Scale: Poor (0), Fair (1), Good (2), Very good (3), Excellent (4).

Senior Teaching Assistant

Period	Title	University	Students	Weekly Teaching
10/2023 – current	<i>Algebraic Geometry</i>	RPTU KL-LD, GER	6	1 × 1.5 hours
04/2018 – 10/2018	<i>Methods of Math. Phys.</i>	Heidelberg University, GER	51	1 × 1.5 hours
04/2016 – 09/2016	<i>General Relativity</i>	Heidelberg University, GER	132	1 × 1.5 hours

Teaching Assistant

Period	Title	University	Weekly Teaching
10/2016 – 03/2017	<i>Theoretical Physics I</i>	Heidelberg University, GER	1 × 1.5 hours
04/2015 – 09/2015	<i>Theoretical Physics IV</i>	Heidelberg University, GER	1 × 1.5 hours
10/2014 – 03/2015	<i>Quantum Field Theory</i>	Heidelberg University, GER	1 × 1.5 hours
10/2013 – 03/2014	<i>Theoretical Physics III</i>	Heidelberg University, GER	1 × 1.5 hours
04/2013 – 09/2013	<i>Theoretical Physics II</i>	Heidelberg University, GER	1 × 1.5 hours
10/2012 – 03/2013	<i>Theoretical Physics I</i>	Heidelberg University, GER	1 × 1.5 hours

REFERENCES

Prof. Dr. Mirjam Cvetič

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