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

CURRENT, FROM 10/2022 (FT)

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.

09/2021 – 08/2022 (FT)

Dept. of Phys. & Astron., University of Pennsylvania, USA
Simons Postdoctoral Fellow

Continuation of *Simons Foundation* project.

09/2020 – 08/2021 (FT)

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*).

10/2019 – 09/2020 (FT)

Mathematical Institute, University of Oxford, UK
Long Term Visitor

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

10/2018 – 09/2019 (FT)

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)

ITP, Heidelberg University, GER
Research Associate

AI-tools meet jumps in vector-like spectra (preparation of *Cluster of Excellence EXC 2181 STRUCTURES*).

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 Universitaet 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	13
PEER REVIEWED/ACCEPTED	8
OUTREACH	3
UNDER REVIEW	1
UNPUBLISHED	1
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. Preprint: arXiv:2303.08144 [hep-th].

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.

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.

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

5 **M. Bies**, S. Posur, *Tensor Products of Finitely Presented Functors*, Journal of Algebra and Its Applications, July. 2021, DOI: 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.

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.

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.

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**, L. Kastner, *Toric Geometry in* `OSCAR`, ComputerAlgebraRundbrief 72 (03/2023), 20-25, Mar. 2023, Preprint: https://arxiv.org/abs/2303.08110.

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**, 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.

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

- **M. Bies**, *Cohomologies of Coherent Sheaves and Massless Spectra in F-theory*, PhD thesis, Feb. 2018, Heidelberg University Library, DOI: 10.11588/HEIDOK.00024045.
- **M. Bies**, *Cohomologies of holomorphic line bundles in smooth and compact normal toric varieties*, Master thesis, February 2014, Link to thesis on author's academic homepage.
- **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*, Bachelor thesis, August 2012, Link to thesis 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	*Introduction to Topology*	*RPTU KL-LD, GER*	–	1×1.5 hours	–
01/2022 – 05/2022	*Computational Linear Algebra*	*University Of Pennsylvania, USA*	29	2×1.5 hours	2.12
01/2021 – 05/2021	*Computational Linear Algebra*	*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	*Algebraic Geometry*	*RPTU KL-LD, GER*	6	1×1.5 hours
04/2018 – 10/2018	*Methods of Math. Phys.*	*Heidelberg University, GER*	51	1×1.5 hours
04/2016 – 09/2016	*General Relativity*	*Heidelberg University, GER*	132	1×1.5 hours

Teaching Assistant

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

REFERENCES

Prof. Dr. Mirjam Cvetič
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University of Pennsylvania, USA
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