

# CURRICULUM VITAE

## DR. RER. NAT. MARTIN BIES

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### PERSONAL DETAILS

Address: Department of Physics and Astronomy  
David Rittenhouse Laboratory  
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Email: mbies@sas.upenn.edu

Nationality: German

Date of birth: 15/12/1987



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### SUMMARY

Education	<b>PhD in Physics</b> (Heidelberg university – defended on 01/02/2018)
Past research	<b>Physics:</b> <ul style="list-style-type: none"><li>• Phenomenological aspects of standard models in <b>string theory</b>.</li><li>• In particular <b>computation of massless spectra of string vacua</b>.</li></ul> <b>Mathematics:</b> <ul style="list-style-type: none"><li>• Algorithms for cohomologies of <b>coherent sheaves</b>.</li><li>• Constructive approaches to <b>Freyd categories</b>.</li><li>• <b>Brill-Noether theory</b> and <b>root bundles</b>.</li></ul> <b>Software development</b> via <b>github</b> since December 2015: <ul style="list-style-type: none"><li>• Github-metric:<ul style="list-style-type: none"><li>– More than <b>2500 contributions</b>.</li><li>– More than <b>500.000 lines of code added</b>.</li><li>– More than <b>480.000 lines of code modified/deleted</b>.</li></ul></li><li>• Contributions to <b>homalg_project</b>, <b>CAP_project</b>, each consisting of more than 200.000 lines of code.</li><li>• Other contributions include <b>ToricVarieties_project</b>, <b>oscar-system</b>.</li><li>• Experience in <b>gap</b>, <b>python</b>, <b>julia</b>, <b>C++</b>, <b>git</b>.</li></ul>
Teaching experience	<b>Instructor</b> (2021): <i>Computational Linear Algebra</i> , University of Pennsylvania Senior Tutor in 2016 and 2018 (Heidelberg University) Tutor for 8 lecture courses (Oct. 2012 – Oct. 2018, Heidelberg University)
Language skills	German – mother tongue <b>English – fluent</b> ( <b>Imperial College International Diploma</b> ) French – (CEFR level B1)
Scholarships	<b>Simons Postdoctoral Fellow</b> (since Sept. 2020) <b>FWA – Foundation Wiener-Anspach</b> (Oct. 2018 – Sept. 2020) <b>Studienstiftung des deutschen Volkes</b> (Jan. 2010 – Feb. 2018)

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## PROFESSIONAL EXPERIENCE

Since Sept. 2021	Simons Postdoctoral Fellow Department of Physics and Astronomy, University of Pennsylvania
Sept. 2020 - Aug. 2021	Simons Postdoctoral Fellow Department of Mathematics, University of Pennsylvania
Oct. 2019 – Sept. 2020	Long term visitor Mathematical institute, University of Oxford
Oct. 2018 – Sept. 2019	Postdoctoral Researcher Physique Théorique et Mathématique, Université Libre de Bruxelles
Feb. 2018 – Sept. 2018	Postdoctoral Researcher Institut für theoretische Physik, Ruprecht-Karls-Universität Heidelberg

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## EDUCATION

Mar. 2014 – Feb. 2018	PhD studies in physics (Heidelberg university) on the subject <i>Cohomologies of coherent sheaves and massless spectra in F-theory</i> Supervisor physics: Prof. Dr. Timo Weigand (Uni. Heidelberg) Supervisor mathematics: Prof. Dr. Mohamed Barakat (Uni. Siegen) Result: Magna cum laude (very good)
Sept. 2012 – Feb. 2014	Master studies in physics (Heidelberg university) on the subject <i>Cohomologies of holomorphic line bundles in smooth and compact normal toric varieties</i> Supervisor: Prof. Dr. Timo Weigand Result: 1.0
Oct. 2008 – Aug. 2012	Bachelor studies in physics (Heidelberg university) on the subject <i>Intersecting D6-brane models on <math>T^2 \times T^2 \times T^2/(\sigma \times \Omega)</math> and <math>T^2 \times T^2 \times T^2/(\mathbb{Z}_2 \times \mathbb{Z}_2 \times \sigma \times \Omega)</math> orientifolds</i> Supervisor: Prof. Dr. Timo Weigand Result: 1.1
Oct. 2010 – June 2011	Studies abroad at Imperial College (London, United Kingdom)

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## SCIENTIFIC PUBLICATIONS

- *Brill-Noether-general Limit Root Bundles:  
Absence of vector-like Exotics in F-theory Standard Models*  
Journal: Preprint  
Link: <https://arxiv.org/abs/2205.00008>  
Collaborators: Mirjam Cvetič, Ron Donagi, Marielle Ong
- *Statistics of Root Bundles Relevant for Exact Matter Spectra of F-theory MSSMs*  
Journal: *Physical Review D*  
DOI: 10.1103/PhysRevD.104.L061903  
Collaborators: M. Cvetič, M. Liu
- *Root Bundles and Towards Exact Matter Spectra of F-theory MSSMs*  
Journal: *Journal of High Energy Physics*  
DOI: 10.1007/JHEP09(2021)076  
Collaborators: M. Cvetič, R. Donagi, M. Liu, M. Ong
- *Tensor products of finitely presented functors*  
Journal: *Journal of Algebra and Its Applications*  
DOI: 10.1142/s0219498822501869  
Collaborator: Sebastian Posur
- *Machine Learning and Algebraic Approaches towards Complete Matter Spectra in 4d F-theory*  
Journal: *Journal of High Energy Physics*  
DOI: 10.1007/JHEP01(2021)196  
Collaborators: M. Cvetič, R. Donagi, L. Ling, M. Liu, F. Ruehle
- *Cohomologies of coherent sheaves and massless spectra in F-theory*  
Journal: Heidelberg University Library  
DOI: 10.11588/HEIDOK.00024045
- *Algebraic Cycles and Local Anomalies in F-theory*  
Journal: *Journal of High Energy Physics*  
DOI: 10.1007/jhep11(2017)100  
Collaborators: Christoph Mayrhofer and Timo Weigand
- *Gauge Backgrounds and Zero-Mode Counting in F-theory*  
Journal: *Journal of High Energy Physics*  
DOI: 10.1007/jhep11(2017)081  
Collaborators: Christoph Mayrhofer and Timo Weigand
- *Chow groups, Deligne cohomology and massless matter in F-theory*  
Preprint: <https://arxiv.org/abs/1402.5144>  
Collaborators: Christoph Mayrhofer, Christian Pehle and Timo Weigand

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## SOFTWARE DEVELOPMENT

I develop open-source software on **github**. My interest rests on tools which help to investigate geometries relevant to string theory. This includes *toric geometry*, for which I have written a collection of packages [https://github.com/homalg-project/ToricVarieties\\_project](https://github.com/homalg-project/ToricVarieties_project). This includes the *gap-4* package *QSMExplorer*, which is currently under heavy development to reflect and extend recent insights into a class of string theory solutions known as the **Quadrillion Standard Models**. I have also contributed to [https://github.com/homalg-project/CAP\\_project](https://github.com/homalg-project/CAP_project) and <https://github.com/oscar-system/Oscar.jl>. My programming experience includes the languages **gap**, **python**, **julia**, **C++**. For more details please visit my **GitHub-profile** <https://github.com/HereAround> or my **website** <https://martinbies.github.io/>.

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## CONFERENCES AND TALKS

July 2022	Strings 2022 (Vienna, Austria)
July 2022	<b>Talk</b> at String Math 2022 (Warsaw, Poland) Title: <i>Towards F-theory MSSMs</i>
July 2022	<b>Talk</b> at String Pheno 2022 (Liverpool, England) Title: <i>Towards F-theory MSSMs</i>
June 2022	Simons Collaboration on Homological Mirror Symmetry Geometry, Topology and Singular Special Holonomy Spaces (Freiburg, Germany)
Nov. 2021	Simons Collaboration on Homological Mirror Symmetry Annual Meeting (New York, United States)
Sept 2021	<b>Talk</b> at Summer series on string phenomenology Title: <i>Root Bundles and Towards Exact Matter Spectra of F-theory MSSMs</i>
Sept 2021	Simons Collaboration on Special Holonomy in Geometry, Analysis, and Physics Progress and Open Problems (Stony Brook, United States)
Sept 2021	Simons Collaboration on Special Holonomy in Geometry, Analysis and Physics Annual Meeting (New York, United States)
July 2021	String Pheno 2021 (virtual conference)
June 2021	Strings 2021 (virtual conference)
June 2021	String Math 2021 (virtual conference)
Dec. 2020	<b>Talk</b> at String Data 2020 (virtual conference) Title: <i>Vector-like spectra in F-theory</i> (joined with M. Liu)
Oct. 2020	<b>Talk</b> (Philadelphia, United States) Title: <i>Machine Learning and Algebraic Approaches towards Complete Matter Spectra in 4d F-theory</i>
June 2020	<b>Talk</b> at Summer series on string phenomenology Title: <i>On stratification diagrams, algorithmic spectrum estimates and vector-like pairs in F-theory</i>
June 2020	String Pheno 2020 (virtual conference)
Dec. 2019	<b>Talk</b> (Philadelphia, United States) Title: <i>From F-theory Standard Models to Freyd Categories and back</i>
Sept. 2019	Poster at Strings and Geometry (Oxford, United Kingdom) Title: <i>Tensor products of finitely presented functors</i>
Aug. 2019	<b>Talk</b> at gap singular meeting and school (Lambrecht, Germany) Title: <i>Monoidal structures in Freyd categories</i>
July 2019	Strings (Brussels, Belgium)
Oct. 2018	<b>Talk</b> (Brussels, Belgium) Title: <i>Counting massless matter in F-theory with CAP</i>
Aug. 2018	<b>Talk</b> at CAP_days 2018 (Siegen, Germany) Title: <i>CAP, machine learning and string theory</i>
May 2018	<b>Talk</b> in seminar on <i>Holography and Large-N duality</i> (Heidelberg, Germany) Title: <i>Conformal invariants; Fefferman–Graham expansion; Graham–Lee theorem</i> (joined with Menelaos Zikidis)
Mar. 2018	String Data 2018 (Munich, Germany)
Jul. 2017	<b>Talk</b> at String Pheno 2017 (Virginia, USA) Title: <i>Zero Mode Counting in F-Theory via CAP</i>
Dec. 2015	String Math (Sanya, China)
Sept. 2015	Third GAP Days (Trondheim, Norway)
Mar. 2015	Second GAP Days (Aachen, Germany)
Feb. 2015	Physics and Geometry of F-theory (Munich, Germany)

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## CONFERENCES AND TALKS (CONTINUATION)

Dec. 2014	Homological Perturbation Theory (Galway, Ireland)
Aug. 2014	<b>Talk</b> at GAP Days (Aachen, Germany) Title: <i>String theory, sheaf cohomology and the homalg package</i>
July 2014	<b>Talk</b> (Aachen, Germany) Title: <i>The Standard Model From String Theory</i>
May 2014	<b>Talk</b> at seminar series <i>What is?</i> (Heidelberg, Germany) Title: <i>What is a fermion/boson (in quantum mechanics)?</i>
Feb. 2014	Geometry and Physics of String Compactifications (Heidelberg, Germany)
Feb. 2014	<b>Talk</b> (Heidelberg, Germany) Title: <i>Cohomology Of Holomorphic Pullback Line Bundles On Smooth And Compact Normal Toric Varieties</i>
May 2012	<b>Talk</b> (Heidelberg, Germany) Title: <i>Intersecting D6-Brane Models</i>

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## TEACHING EXPERIENCE

Jan. 2021 – May. 2021	Instructor	Computational linear algebra
Apr. 2018 – Oct. 2018	Senior tutor	Methods of mathematical physics 1
Oct. 2016 – Mar. 2017	Tutor	Theoretical physics I
Apr. 2016 – Sept. 2016	Senior tutor	General relativity
Apr. 2015 – Sept. 2015	Tutor	Theoretical physics IV
Oct. 2014 – Mar. 2015	Tutor	Quantum field theory
Oct. 2013 – Mar. 2014	Tutor	Theoretical physics III
Apr. 2013 – Sept. 2013	Tutor	Theoretical physics II
Oct. 2012 – Mar. 2013	Tutor	Theoretical physics I

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## ENGAGEMENT AT *Studienstiftung des deutschen Volkes*

June 2018	Member of the admission board <i>Heidelberg</i>
Dec. 2017	Member of the admission board <i>Ellwangen III</i>
May 2017	Training for admission board members – successfully completed
Nov. 2016	Member of the admission board <i>Heidelberg</i>

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## OTHER SEMINARS/CONFERENCES

May 2018	Kontaktseminar – Schwerpunkt Banken und Beratung (Bonn, Germany)
May 2018	Physiker im Beruf (Bad Honnef, Germany)