

Christian Gross  
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January 27th, 2013

Dear Dr. Rebelo, dear Prof. Branco,

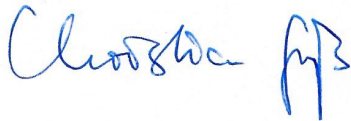
I would like to apply for a postdoc research position at the Centro de Fisica Teorica de Particulas of the Instituto Superior Tecnico Lisbon.

My research interests concern various aspects of Physics beyond the Standard Model, in particular flavor physics (regarding neutrinos, charged leptons as well as quarks), supersymmetry, LHC physics and particle cosmology. I believe that with these research interests I would fit well into the theory group at the IST Lisbon, and I see an interesting overlap with several of the researchers at the CFTP. Currently, I am a postdoc at the University of Basel in the group of Prof. Antusch.

Please find attached my CV, a list of my publications and a brief statement of my research interests. I asked Prof. S. Antusch, Prof. L. Covi and Prof. G. Hiller to send you reference letters.

I would be most happy to join the theory group at the IST Lisbon in the fall of 2013 and I hope to hear from you soon.

With best regards,

A handwritten signature in blue ink, appearing to read 'Christian Gross' followed by a stylized monogram or initials.

# CURRICULUM VITAE

CHRISTIAN GROSS

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**PERSONAL DETAILS**

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Born: December 20th, 1978 in Bremen, Germany

Citizenship: German

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**EDUCATION AND RESEARCH EXPERIENCE**

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- since Oct. '11    **2nd Postdoc** *Universität Basel* (group S. Antusch)
- Nov. '09 - Sep. '11    **1st Postdoc** *Technische Universität Dortmund* (group G. Hiller)
- Aug. '09 - Oct. '09    '0th Postdoc' *Universität Hamburg*
- Nov. '06 - Jul. '09    **Ph.D. in Physics** (grade: "very good") *Universität Hamburg*  
Supervisors: *Laura Covi and Jan Louis*
- Jul. '06    **Physics Diploma** (grade: "1.0 with distinction") *Universität Heidelberg*  
Supervisor for diploma thesis: *Arthur Hebecker*
- Jan. '04 - Jul. '06    **Physics studies** *Universität Heidelberg*
- Mar. '03 - Dec. '03    **Physics studies** *University of Adelaide*  
with scholarship of "Landesprogramm Baden-Württemberg"
- Apr. '00 - Feb. '03    **Physics studies** *Universität Heidelberg*
- Jul. '99 - Mar. '00    Backpacking trip
- Jun. '98 - Jun. '99    Community service (substitute for military service) *Bielefeld*
- Jun. '98    **Abitur** (secondary school graduation) *Helmholtz-Gymnasium Bielefeld*

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**RESEARCH INTERESTS**

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Various aspects of Physics beyond the Standard Model, in particular

- \* Flavor physics (model building and phenomenology)
- \* Supersymmetry
- \* Particle cosmology (inflation and dark matter)

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SEMINAR TALKS AND TALKS GIVEN AT CONFERENCES/WORKSHOPS

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- Sep. '12 *Hamburg, DESY Theory Workshop 2012*  
"Squark Flavor Implications from  $\bar{B} \rightarrow \bar{K}^{(*)} l^+ l^-$ "
- Aug. '12 *Beijing, SUSY 2012 conference*  
"Squark Flavor Implications from  $\bar{B} \rightarrow \bar{K}^{(*)} l^+ l^-$ "
- May '12 *Cambridge, HEP phenomenology joint Cavendish-DAMTP seminar*  
"Squark Flavor Implications from  $\bar{B} \rightarrow \bar{K}^{(*)} l^+ l^-$ "
- Sep. '11 *Fermilab, SUSY 2011 conference*  
"Squark flavor constraints from  $\bar{B} \rightarrow \bar{K}^{(*)} l^+ l^-$ "
- May '11 *DESY Hamburg, LHC-D SUSY/BSM + Neutrinos and LFV Workshop*  
"Flavorful hybrid anomaly-gravity mediation"
- Apr. '11 *Mainz, Theory Seminar*  
"Flavorful hybrid anomaly-gravity mediation"
- Mar. '11 *MPI für Physik, Munich, Astroparticle Seminar*  
"Flavorful hybrid anomaly-gravity mediation"
- Dec. '10 *Rome, Discrete 2010 conference*  
"Hybrid anomaly-gravity mediation"
- May '10 *MPI Munich, Theory Seminar*  
"de Sitter vacua and inflation in no-scale string models"
- Sep. '09 *TU Dortmund, Theory Seminar*  
"de Sitter vacua and inflation in no-scale string models"
- May '09 *Padua, Planck 2009 conference*  
"de Sitter vacua in no-scale string models without uplifting"
- Mar. '09 *Hamburg, SFB 676 meeting*  
"de Sitter vacua and inflation in supergravity and string theory"
- Mar. '08 *Bad Honnef, "Beyond the Standard Model" workshop*  
"de Sitter vacua in no-scale supergravity from string theory"
- May. '06 *Heidelberg, "Beyond the Standard Model" Seminar*  
"Stabilizing supersymmetric orbifold models"

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JOURNAL CLUB TALKS

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- Dec. '09 *Dortmund*  
"Direct dark matter detection with CDMS"
- Dec. '07 *Hamburg*  
"Metastable supersymmetry breaking vacua"
- Jun. '07 *Hamburg*  
"Inflation in string-inspired supergravity"

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RESEARCH VISITS

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- Jul. '11 - Sep. '11 *Boston University, Boston*
- Jun. '10 *CERN, Geneva*
- Dec. '08 *EPFL, Lausanne*

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## ATTENDED SCHOOLS

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- Jan. '12 *Ascona, LHCPHenoNet Winter School 2012*  
topic: LHC phenomenology
- Jul. '08 *Princeton, Prospects in Theoretical Physics*  
topic: "Strings and Phenomenology"
- Aug. '07 *Cargèse Summer School*  
topic: "Cosmology and Particle Physics Beyond the Standard Models"
- Sep. '06 *Wolfersdorf, Saalburg Summer School*  
topic: "Foundations and New Methods in Theoretical Physics"

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## TEACHING

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- fall sem. '12 *Universität Basel*  
Tutorial for lecture *Theoretical Elementary Particle Physics* by S. Antusch
- spring sem. '12 *Universität Basel*  
Tutor for undergraduate seminar *The Early Universe* by S. Antusch
- spring sem. '12 *Universität Basel*  
Tutorial for lecture *Higher Quantum Mechanics* by S. Antusch
- summer sem. '11 *TU Dortmund*  
Tutorial for lecture *Higher Quantum Mechanics* by G. Hiller
- summer sem. '10 *TU Dortmund*  
Tutorial for lecture *Quantum Field Theory* by A. Lenz
- winter sem. '05 *Universität Heidelberg*  
Tutorial for lecture *Quantum Mechanics* by O. Nachtmann
- summer sem. '05 *Universität Heidelberg*  
Tutorial for lecture *Theoretical Mechanics* by A. Hebecker

# LIST OF PUBLICATIONS

CHRISTIAN GROSS

note: my publications are found at <http://inspirehep.net> using the search  
ea gross, christian and not (primarch quant-ph or cond-mat.quant-gas)

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## JOURNAL PUBLICATIONS

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- C. Gross, G. Marques Tavares, M. Schmaltz and C. Spethmann  
**Light axigluon explanation of the Tevatron  $t\bar{t}$  asymmetry and multijet signals at the LHC**  
*Phys. Rev. D* **87** (2013) 014004; [[arXiv:1209.6375 \[hep-ph\]](#)]
- A. Behring, C. Gross, G. Hiller and S. Schacht  
**Squark Flavor Implications from  $\bar{B} \rightarrow \bar{K}^{(*)} l^+ l^-$**   
*JHEP* **1208** (2012) 152; [[arXiv:1205.1500 \[hep-ph\]](#)]
- S. Antusch, C. Gross, V. Maurer and C. Sluka  
 **$\theta_{13}^{\text{PMNS}} = \theta_C / \sqrt{2}$  from GUTs**  
*Nucl. Phys. B* **866**, 255 (2013); [[arXiv:1205.1051 \[hep-ph\]](#)]
- C. Gross and G. Hiller  
**Flavorful hybrid anomaly-gravity mediation**  
*Phys. Rev. D* **83** (2011) 095015; [[arXiv:1101.5352 \[hep-ph\]](#)]
- C. Gross and A. Hebecker  
**A Realistic Unified Gauge Coupling from the Micro-Landscape of Orbifold GUTs**  
*Nucl. Phys. B* **821**, 354 (2009); [[arXiv:0812.4267 \[hep-ph\]](#)]
- L. Covi, M. Gómez-Reino, C. Gross, G. A. Palma and C. A. Scrucca  
**Constructing de Sitter vacua in no-scale string models without uplifting**  
*JHEP* **0903**, 146 (2009); [[arXiv:0812.3864 \[hep-th\]](#)]
- L. Covi, M. Gómez-Reino, C. Gross, J. Louis, G. A. Palma and C. A. Scrucca  
**Constraints on modular inflation in supergravity and string theory**  
*JHEP* **0808**, 055 (2008); [[arXiv:0805.3290 \[hep-th\]](#)]
- L. Covi, M. Gómez-Reino, C. Gross, J. Louis, G. A. Palma and C. A. Scrucca  
**De Sitter vacua in no-scale supergravities and Calabi-Yau string models**  
*JHEP* **0806**, 057 (2008); [[arXiv:0804.1073 \[hep-th\]](#)]

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## CONFERENCE PROCEEDINGS

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- C. Gross  
**Hybrid anomaly-gravity mediation with flavor**  
*J. Phys. Conf. Ser.* **335** (2011) 012026; [[arXiv:1102.2875 \[hep-ph\]](#)]

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## THESES

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- C. Gross  
**De Sitter vacua and inflation in no-scale string models**  
*PhD thesis, 2009; DESY-THESIS-2009-029*  
<http://www-library.desy.de/preparch/desy/thesis/desy-thesis-09-029.pdf>
- C. Gross  
**Radius stabilization for supersymmetric gauge theories on 5d orbifolds**  
*Diploma thesis, 2006*  
<http://katalog.ub.uni-heidelberg.de/titel/66185540>

# RESEARCH STATEMENT

CHRISTIAN GROSS

My research interests concern various aspects of Physics beyond the Standard Model (BSM). During my PhD I worked on how to realize realistic vacua and inflation in extra-dimensional supersymmetric (SUSY) models. I decided to shift the focus of my research after my PhD and since then have worked on different issues of flavor physics in the context of SUSY models (regarding both model building and phenomenology) and also on a non-supersymmetric BSM model which can explain the Tevatron  $t\bar{t}$  asymmetry. I will describe this in a bit more detail in the following and outline ideas for future research.

The central question for my PhD thesis was the issue how the scalar fields which govern the size and shape of string compactifications can be made sufficiently massive to yield realistic de Sitter vacua and a phase of inflation. I analyzed – in collaboration with L. Covi, M. Gómez-Reino, J. Louis, G. Palma and C. Scrucca – a condition on the Kähler potential of N=1 supergravity models which turns out to be necessary for this end. We applied this to so-called ‘no-scale’ Kähler potentials, which frequently arise from string compactifications. Since the specific form of the Kähler potential depends on the compactification, we obtained criteria which the compactified space must satisfy for de Sitter vacua [1] and inflation [2] to be possible. As a next step, we developed a procedure to find appropriate superpotentials [3] which lead to scalar potentials with a realistic vacuum.

This problem of ‘stabilizing’ the extra dimensions applies of course also to supersymmetric orbifold GUT models. The latter are interesting for instance because they can lead to a solution of the doublet-triplet splitting problem of 4d GUTs. In collaboration with A. Hebecker, I studied how the radion field, which governs the distance of the branes in 5d orbifold models, can be stabilized by Casimir energy and how a realistic de Sitter minimum can be obtained [4].

After my PhD I started working (in collaboration with G. Hiller) on a model with a specific type of SUSY breaking where anomaly- and gravity mediation give comparable contributions to the soft terms [5]. The main idea here is that the (non-flavor-blind) gravity mediated soft terms cure the tachyonic slepton problem of pure anomaly mediation, while the gravitino remains as heavy as in anomaly mediation so that the cosmological gravitino problem of gravity mediation is avoided.

Besides analyzing specific SUSY breaking models, I also worked on improving the model-independent constraints on the mass insertion (MI) parameters of the MSSM. Especially the wealth of recent results from the LHCb experiment has a significant power in constraining BSM flavor effects. I exploited, with my collaborators A. Behring, G. Hiller and S. Schacht, the recently improved bounds from  $\bar{B} \rightarrow \bar{K}^{(*)} l^+ l^-$  data on the Wilson coefficients of the relevant four-fermion operators [6]. This led to new constraints on the chirality-flipping 2-3 mixing MI parameter in the up-sector. We also worked out phenomenological implications for other processes such as flavor-changing top decays and  $\bar{B}_s \rightarrow \mu^+ \mu^-$ .

Regarding neutrino flavor physics, I proposed, together with S. Antusch, V. Maurer and C. Sluka, how – in the context of SUSY GUTs – the recently measured value of the reactor angle  $\theta_{13}^{\text{PMNS}} \sim 9^\circ$  could result from charged lepton corrections to a vanishing 1-3 mixing in the neutrino sector. Since in GUTs the charged lepton and down quark

Yukawa matrices are related, one can under certain conditions which we specify in the paper [7] obtain the approximate relation  $\theta_{13}^{\text{PMNS}} \simeq \theta_C/\sqrt{2}$  which numerically agrees well with the measured value. We are presently working on constructing an explicit model with a non-Abelian discrete family symmetry that realizes the scenario described above. In view of the increasing precision of the data, it is important here to make predictions beyond order one approximations and to take into account also effects such as SUSY threshold corrections and RG running.

I will continue working on exploring New Physics (NP) using present and future flavor data, both in the quark, charged lepton and neutrino sectors.

My interest in BSM physics is driven not only by the theoretical motivations but also by the observed anomalies. One of these is the Tevatron  $t\bar{t}$  asymmetry. While most NP models aiming to explain it are in trouble e.g. due to the fact that the invariant mass spectrum of the  $t\bar{t}$  cross section as well as the ‘charge asymmetry’ measured at the LHC agree with the SM prediction, BSM models with a light axigluon are able to explain the asymmetry while being consistent with all data. The axigluons must not decay to dijets however, or else they would have been seen already, so that they should instead be detectable in multijet signals. In the paper [8] with G. Marques Tavares, M. Schmaltz and C. Spethmann we explore the prospects of observing such multijet signals at the LHC.

Another aspect of BSM physics I plan to work on in the future are the constraints imposed on SUSY models by the Higgs data. While it would of course be most exciting if more accurate measurements of Higgs branching fractions revealed a clear tendency for a non-SM behavior, there are also constraints from demanding that SUSY models give rise to the observed mass  $\sim 125$  GeV in a ‘natural’ way. The most popular class of models here is the NMSSM, but e.g. also models with non-universal gaugino masses can serve this purpose. There are various interesting questions – which have if at all previously been studied only in by now disfavored constrained SUSY models – which could be analyzed in the framework of these more natural SUSY versions. One concrete example would, for instance, be the prospects of observing lepton flavor violation in seesaw extensions of the above SUSY scenarios, ideally also taking into account constraints from allowing for successful leptogenesis.

Another topic which I am eager to work on is Dark matter (DM). Possibly the best hint for the presence of a new particle beyond the SM at present comes from the  $\sim 130$  GeV gamma-ray line signal in the Fermi-LAT data. The DM annihilation cross section to photons required to fit the signal is however much larger than one expects in ‘generic’ WIMP models which give rise to the correct relic density and are consistent with constraints from the data on continuum  $\gamma$ -radiation. I plan to work on building models which can surmount this difficulty, and on exploring their phenomenological properties.

## References:

- [1] *L. Covi et al.*; JHEP **0806**, 057 (2008)
- [2] *L. Covi et al.*; JHEP **0808**, 055 (2008)
- [3] *L. Covi et al.*; JHEP **0903**, 146 (2009)
- [4] *C. Gross, A. Hebecker*; Nucl. Phys. B **821**, 354 (2009)
- [5] *C. Gross, G. Hiller*; Phys. Rev. D **83** (2011) 095015
- [6] *A. Behring, C. Gross, G. Hiller, S. Schacht*; JHEP **1208** (2012) 152
- [7] *S. Antusch, C. Gross, V. Maurer, C. Sluka*; Nucl. Phys. B **866**, 255 (2013)
- [8] *C. Gross, G. Marques Tavares, M. Schmaltz, C. Spethmann*; Phys. Rev. D **87** (2013) 014004