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February 13, 2013

Dear Profs. Branco and Rebelo,

I am writing in response to the advertised postdoc position on SPIRES starting in fall 2013. Currently I am a PostDoc in the Particle and Astroparticle Theory Group at the Max-Planck Institut für Kernphysik in Heidelberg, Germany. Right before christmas I have defended my Ph.D. thesis with the title "Towards Testable Theories with Discrete Flavour Symmetries" (under the supervision of Prof. Manfred Lindner).

My research interests are in the field of theoretical particle and astro-particle physics. Recently I have been working on a scenario where a discrete flavour symmetry is broken by flavoured Higgses at the electroweak scale. There, the flavour symmetry also provides a dark matter candidate and the overall scenario is therefore testable both at collider experiments and at experiments looking for lepton flavour violating processes and dark matter, for example. I have furthermore worked on electroweak symmetry breaking and the vacuum alignment problem that arises if one tries to break discrete flavour symmetries spontaneously. Of especial interest to your group might be my recent work on the compatibility of discrete flavour symmetries and CP transformations. You find further details of my past and present work and future interests in my statement of research interests.

Besides my Ph.D. supervisor, my Ph.D. co-supervisor Dr. Werner Rodejohann and Dr. Michael Schmidt, who is a postdoc at the University of Melbourne and a collaborator of mine, will provide additional reference letters. Please let me know, if I can provide additional information in support of my application.

Sincerely yours,

Martin Holthausen

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Martin Holthausen

Personal Details

Born	December 16, 1983 in Stuttgart-Bad Cannstatt, Germany
Nationality	German
Martial Status	Single

Education

01/2013-	**PostDoc**, *Max-Planck-Institute for Nuclear Physics*, Heidelberg. in the group of Prof. Manfred Lindner
05/2009- 12/2012	**Ph. D. student**, *Max-Planck-Institute for Nuclear Physics*, Heidelberg. Supervisor: Prof. Manfred Lindner, overallgrade: magna cum laude (1.25)
11/2007- 01/2009	**Diploma student**, *Max-Planck-Institute for Nuclear Physics*, Heidelberg. Supervisor: of Prof. Manfred Lindner, grade 1.0
10/2005- 01/2009	**Physics studies**, *University of Heidelberg, Germany*, Diploma. overall grade: 1.0 (marks lie between 1.0 (very good) and 6.0 (failed))
10/2003- 10/2005	**Physics studies**, *University of Constance, Germany*, Pre-Diploma. overall grade: 1.0 (marks lie between 1.0 (very good) and 6.0 (failed)), best prediploma of class
1994-2003	**High School** , *Hohenstaufen-Gymnasium* , Bad Wimpfen, Abitur. overall grade: 1.6 (marks lie between 1.0 (very good) and 6.0 (failed)), physics prize
8/2000- 6/2001	**Exchange student** , *Queen Anne's High School* , Centreville, Maryland, Maryland High School Certificate.
1990-1994	**Primary School** , *Bad Wimpfen, Germany*.

Honors and Awards

2009	Otto-Haxel Award for best diploma thesis in theoretical physics of the spring term 2009 in Heidelberg
2008	Participation at the Lindau Nobel Laureate Meeting 2008 (fellow of the Wilhelm and Else Heraeus foundation)
2003	Physics award of the Hohenstaufen-Gymnasium Bad Wimpfen

Theses

2012 **Ph.D. thesis**, *"Towards Testable Theories with Discrete Flavour Symmetries"*, University of Heidelberg.
Supervisor: Manfred Lindner

2009 **Diploma thesis**, *"Conformal Symmetry in the Minimal Left-Right Symmetric Model"*, University of Heidelberg.
Supervisor: Manfred Lindner

Teaching

2011 Informal Supervision Diploma Thesis Kher Sham Lim

2010 Organization Ph.D./Diploma Student Block Seminar on Electroweak Symmetry Breaking and Supersymmetry Breaking, March 29-31, 2010

Spring 2010 Teaching Assistant, Theoretical Physics I(Classical Mechanics), Heidelberg University

Fall 2009 Teaching Assistant, Theoretical Physics IV(Statistical Mechanics), Heidelberg University

Spring 2007 Teaching Assistant, Theoretical Physics II(Electrodynamics), Heidelberg University

Graduate Schools

- Member of Heidelberg Graduate School for Fundamental Physics
- Member of International Max-Planck Reasearch School Precision Tests of Fundamental Symmetries(IMPRS-PTFS)

Seminars

Jun 2012 **TU Munich**, *Theoretical High Energy Physics Seminar*.
Invited Talk: Natural Vacuum Alignment from Group Theory

Conferences and Workshops

Oct 2012 **Japanese-German Symposium on Neutrino, Dark Matter, Higgs and Beyond the Standard Model**, *Kanazawa University*, Kanazawa, Japan.
Talk: "Natural Vacuum Alignment from Group Theory"

Jul 2012 **FLASY12**, *Workshop on Flavor Symmetries and Consequences in Accelerators and Cosmology*, Dortmund, Germany.
Talk: "Natural Vacuum Alignment from Group Theory"

Jun 2012 **Planck 2012**, *'From the Planck Scale to the ElectroWeak Scale'*, Warsaw, Poland.
Talk: "Natural Vacuum Alignment from Group Theory"

Mar 2012 **DPG 2012**, *Spring Meeting of the German Physical Society*, Goettingen, Germany.
Talk: "Natural Vacuum Alignment from Group Theory"

Feb 2012 **497. Wilhelm and Else Heraeus Seminar**, *"Strong Interactions beyond the Standard Model"*, Bad Honnef, Germany.
Talk: "Natural Vacuum Alignment from Group Theory"

Sep 2011 **2. Workshop on single top quark production and fourth generations**, *DESY*, Hamburg, Germany.
Invited Talk: "Conformal Symmetry in the Minimal Left-Right Symmetric Model"

Jun 2011 **Planck 2011**, *'From the Planck Scale to the ElectroWeak Scale'*, Lisbon, Portugal.
Talk: "Conformal Symmetry in the Minimal Left-Right Symmetric Model"

Jan 2011 **WIN 2011**, *23rd Workshop on 'Weak Interactions and Neutrinos'*, Cape Town, South Africa.
Invited Talk: "Conformal Symmetry in the Minimal Left-Right Symmetric Model"

Mar 2010 **Planck 2010**, *'From the Planck Scale to the ElectroWeak Scale'*, CERN, Geneva.

Mar 2010 **DPG 2010**, *Spring Meeting of the German Physical Society*, Bonn, Germany.
Talk: "Conformal Symmetry in the Minimal Left-Right Symmetric Model"

Publications

Journal Papers

[1] M. Holthausen, M. Lindner, and M. A. Schmidt, "Lepton Flavour at the Electroweak Scale: A Complete A4 Model," *to appear in PRD* , 1211.5143.

[2] M. Holthausen, M. Lindner, and M. A. Schmidt, "CP and Discrete Flavour Symmetries," *submitted to JHEP* , 1211.6953.

[3] M. Holthausen, K. S. Lim, and M. Lindner, "Lepton Mixing Patterns from a Scan of Finite Discrete Groups," *to appear in PLB* , 1212.2411.

[4] M. Holthausen, K. S. Lim, and M. Lindner, "Planck scale Boundary Conditions and the Higgs Mass," *JHEP* **1202** (2012) 037, 1112.2415 [hep-ph].

[5] M. Holthausen and M. A. Schmidt, "Natural Vacuum Alignment from Group Theory: The Minimal Case," *JHEP* **1201** (2012) 126, 1111.1730 [hep-ph].

[6] M. Holthausen and R. Takahashi, "GIMPs from Extra Dimensions," *Phys.Lett.* **B691** (2010) 56–59, 0912.2262 [hep-ph].

[7] M. Holthausen, M. Lindner, and M. A. Schmidt, "Radiative Symmetry Breaking of the Minimal Left-Right Symmetric Model," *Phys.Rev.* **D82** (2010) 055002, 0911.0710 [hep-ph].

Proceedings

[8] M. Holthausen, "Vacuum Alignment from Group Theory." in Proceedings of FLASY12, Second Workshop on Flavor Symmetries and Consequences in Accelerators and Cosmology, 30 June 2012 – 4 July 2012. Dortmund, Germany.

[9] M. Holthausen, "Radiative Symmetry Breaking in the Minimal Left-Right Symmetric Model." to appear in Proceedings of 23rd International Workshop on Weak Interactions and Neutrinos (WIN'11), 31 Jan - 5 Feb 2011. Cape Town, South Africa.

List of Publications on SPIRES: FIND A HOLTHAUSEN.

RESEARCH STATEMENT

My primary research interest is in beyond the SM physics. In particular I am interested in TeV scale model building, flavour symmetries and electroweak symmetry breaking.

PAST RESEARCH I: Flavour Symmetries

Models with flavour symmetries attempt to explain patterns observed in experimentally observed fermion masses and mixings. In the lepton sector, discrete flavour symmetries broken to non-commuting subgroups in the charged lepton and neutrino sectors may be a way to explain the large mixing angles. The recent discovery of a non-vanishing value for θ_{13} in reactor experiments has ruled out the tri-bi-maximal mixing hypotheses that can be explained in models based on small groups such as A_4 or S_4. In the paper "Lepton mixing patterns from a scan of finite discrete groups"[3] (with K.S. Lim and M. Lindner) we have presented a general scan of all finite discrete groups up to order 1536 and have identified interesting candidate groups that can explain the present best fit values. In particular we have found that the resulting mixing matrix for all of the groups is given by the TBM matrix multiplied from the right-hand side by a discrete 1-3 rotation and in this setup can thus be falsified by a precision measurement of the atmospheric mixing angle. In concrete models based on this idea, the discrete flavour group is broken to different subgroups by two different scalar fields (flavons), that to leading order only couple to charged leptons or neutrinos, respectively. The required vacuum expectation values (in the $(1,0,0)-$ and $(1,1,1)-$ directions) cannot be obtained from a straightforward minimization of the most general scalar potential but rather require an additional dynamical input. The previous solutions in the literature either require continuous R-symmetries in supersymmetry or extra dimensions and therefore do not admit the possibility of breaking flavour symmetries at scales accessible at colliders. In the paper "Natural Vacuum Alignment from Group Theory: The Minimal Case"[5] (with M.A. Schmidt) we have presented a solution to this problem that does not require high scale physics but rather solves the problem by extending the flavour group in a non-trivial way such that there emerges an accidental symmetry of the scalar potential at tree-level. We performed a scan over all possible discrete groups of size smaller than 1000 and identified suitable symmetry groups. In particular we build a model based on the smallest such extension of A_4, the group $Q_8 \rtimes A_4$, and we have shown that in this model required vacuum configuration can be obtained without additional dynamical input. Since this symmetry group allows the flavour symmetry breaking scale to be low, we have in the subsequent publication "Lepton Flavour at the Electroweak Scale: A Complete A_4 Model"[1](with M. Lindner and M.A. Schmidt) built a model that realizes flavour symmetry breaking at the electroweak scale taking care of the vacuum alignment problem. In the model, the flavour symmetry not only provides a rationale for the leptonic mixing structure but also provides a dark matter candidate and explains the smallness of neutrino masses via a suppressed one-loop diagram. We have studied the phenomenology of the model focussing on lepton flavour violating decays, dark matter and implications for collider physics. In this model the Higgs is part of a flavour triplet and there are many additional flavoured doublets that couple to the Higgs we have studied the modification of the Higgs to gamma gamma rate.
Another interesting avenue for model building after the discovery of a non-vanishing value for θ_{13} is to try and predict the last remaining parameter that can be measured in oscillation experiments, namely the CP phase δ. To be able to do this a consistent definition of CP in the context of discrete flavour symmetries is needed. For example in the group T‘ there are necessarily complex Clebsch-Gordon coefficients, which have been advocated as the source of CP violation. In the paper "CP and Discrete Flavour Symmetries"[2] (with M. Lindner and M.A. Schmidt) we have given a

consistent definition of CP in the context of discrete groups and discuss explicit examples. This allows to clear up the confusion surrounding T‘ models and to find a new interpretation of the 'geometric phases' in models based on $\Delta(27)$.

PAST RESEARCH II: Electroweak Symmetry Breaking

So far the results of the LHC are consistent with the minimal Standard Model surviving up to a very high energy scale. In "Planck Scale Boundary Conditions and the Higgs Mass"[4] (with K.S. Lim and M. Lindner) we have discussed (before the Higgs seminar in Dec. 2011) possible boundary conditions on SM parameters that are able to predict the Higgs mass. After the discovery of a 126 GeV Higgs boson a lot of attention has been given to the fact that this mass value corresponds to a vanishing value for the Higgs self-coupling at the Planck scale (within theoretical errors and accounting for unknown Planck scale threshold effects). This paper has collected a number of citations.
A direct embedding of the SM into quantum gravity at the Planck scale might be beneficial from the standpoint of the naturalness problem of the SM: it is unclear if such an embedding acts as a hard-cutoff and really produces a hierarchy problem. This line of thought has been entertained in the publication "Radiative Symmetry Breaking in the Minimal Left-Right Symmetric Model" [7](w. M. Lindner and M.A. Schmidt), where following Nicolai and Meissner classical conformal invariance of the particle physics action was taken to be a consequence of the Plack scale embedding. While Coleman-Weinberg breaking is not possible in the SM, in a left-right(LR) symmetric extension the additional bosonic degrees of freedom stabilize the potential. We have studied the symmetry breaking in this model, focussing in particular on generating a large hierarchy between the LR and Planck scales through the logarithmic running of the scalar couplings. This way of symmetry breaking leads to a unique prediction connecting Higgs decay modes and the ratio of right- over left-handed gauge boson masses.
In collaboration with Ryo Takahashi we have also built an extra-dimensional model [6] that provides a dark matter candidate that interacts only gravitationally with the SM and discussed production and stability of such a particle.

FUTURE RESEARCH

I am interested to work in the field of particle physics theory and phenomenology. In particular I am interested in learning what experiment is able to teach us about nature. Especially the results from the LHC should be taken as an opportunity for a more data-driven theoretical approach. While there has been no unambiguous sign of new physics from the LHC so far, it is at least within the realm of possibilities that precision studies of Higgs decay modes etc. reveal new phenomena that one could use to build models. Apart from the LHC there are also many other experiments such as MEG, FERMI, Planck and XENON 100/1T among many others that may give important input. My main focus so far has been to try and build models that have experimentally testable consequences at accessible energy scales as opposed to models that cannot be directly tested. As an example let me mention that at the moment I am working with Pavel Perez on spontaneous R-parity breaking in low-energy supersymmetry. This is data-driven in the sense that spontaneous R-symmetry breaking alleviates bounds from missing energy searches for supersymmetry at the LHC and such scenarios might therefore be interesting in light of the increasingly stringent bounds. Interesting questions are the origin of dark matter and neutrino masses in such a scenario.
In conclusion, I see the role of my research as trying to come up with new ideas that describe nature at short distance scales whereby keeping in mind the relevant collider and non-collider experiments.

Names and Contact Details of Referees

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