Matthew Black

Curriculum Vitae

Kölner Str. 17, 57072 Siegen, Germany
+49 173 9173782, DoB: 26/10/1998
Matthew.Black@uni-siegen.de
https://github.com/mbr-phys

EDUCATION

2016 – 2020 **Master of Physics**
FIRST CLASS HONOURS
Theoretical Physics
University of Durham

2009 – 2016 **Secondary Education**

- Advanced Highers - A in Physics, Maths, Chemistry, and English
- Highers - A in Physics, Chemistry, Biology, Maths, and English

The High School of Glasgow

MASTERS THESIS

"CP Violation In and Beyond The Standard Model: Two Higgs Doublet Model Type II Contributions to Flavour Observables"

The Standard Model of particle physics is one of the great achievements of the 20th century. This describes the fundamental interactions of particles and successfully unifies all observed forces of nature apart from gravity. However, there are still many things that cannot be explained by the Standard Model, such as how the conditions of the early universe after the Big Bang lead to our current universe existing. These questions require adapting and adding to the Standard Model to find answers which are also consistent with the rest of physics. This thesis studies a well-known extension of the Standard Model called the Two Higgs Doublet Model (2HDM), where four new Higgs bosons are introduced in addition to the famous particle found in 2012. This model has the potential to explain several of the problems of the Standard Model in the early universe, but is dependent on the specific values of the parameters of the 2HDM. The 2HDM was used to modify the predictions of many important processes for many different values of two important parameters, and the new predictions were compared to experimental values for each process. Upper and lower bounds on the values of the parameters of the 2HDM were then found, along with the statistical significance of these values. These bounds inform us where we could confirm this model in experiment and still be consistent with other experiments.

We first cover the theory of the Standard Model and then test the 2HDM of Type II as an extension to the Standard Model using indicative flavour observables, such as leptonic and semileptonic decays of B and D mesons, $B\bar{B}$ mixing, and the $b \to s\gamma$ radiative decay. Testing the 2HDM parameter space (m_{H^+}, $\tan\beta$) to find alignment between theoretical calculations and experiment, constraints on the parameters were found for flavour phenomena to work towards a global fit. Strongly dominated by the $b \to s\gamma$ branching ratio, the mass of a charged Higgs particle would be expected to have a minimum value at 95% CL of 490 GeV.The value of $\tan\beta$ is limited by $B_q \to \mu^+\mu^-$ decays, yielding a maximum value at 95% CL of 20.8.

AWARDS

2019 President's Vote of Thanks, and Full Colours
St Mary's College, Durham University

2016 British Red Cross Emergency First Aid and ITC Outdoor First Aid

2015,16 National Finalist and Company President at UK Space Design Competition

2014,15 CREST Bronze & Silver Science Awards

COMPUTER SKILLS

INTERMEDIATE Fortran, Perl, HTML

EXPERT Python, C++, Unix, LaTeX

SKILLS

All the following skills have been crucial throughout my academic career, and have been particularly important in order to complete the rigorous academic study of my Masters thesis and the current progress of developing an academic publication as part of a research team.

Critical Thinking

I am able to conceptualise and analyse complex ideas and concepts. It is an important part of any role, particularly in science, to perceive the merits and flaws of a system and comprehend how to optimise this based on the information provided. One must also know when a system is flawed and must be reviewed.

Goal Oriented and Dedicated

Understanding tasks properly is important to me. Performing these tasks properly is important to the efficient running of a workspace. I use my judgement to act and achieve goals quickly and efficiently. As part of a workplace, I dedicate myself fully to the task at hand. Focusing on what task needs done and putting the full effort needed towards its completion results in a better job being performed.

Passionate

I have been interested in theoretical physics such as quantum mechanics and particle phenomenology from an early age. My education and research have cemented this interest into a passion. I greatly enjoy carrying out fundamental physics research with potential experimental implications.

Communication Skills and Collaborative Working

I have spent a lot of time working in customer service and enjoy interacting with people of all backgrounds. I have learned how to work together with other people to achieve a goal, and adapt to many working environments to best make use of my resources.

WORK EXPERIENCE

MARCH 2021 – PRESENT (FT)

Universität Siegen
PhD Student

I am currently working as a PhD student in the TP1 research group for particle physics at Universität Siegen, focusing on lattice simulations of QCD. This role involves participating in research projects requiring strong dedication and focus. I work with others both within the TP1 group and internationally to complete research, and also as part of the larger RHQ collaboration focused on delivering high precision lattice results. Further research interests include new physics models and quantum computation for high energy physics.

RESEARCH WORKS

See iNSPIRE-HEP/Matthew Black.

➥ O. Atkinson, **M. Black**, A. Lenz, A. Rusov and J. Wynne, *Cornering the Two Higgs Doublet Model Type II*, JHEP **04** (2022) 172, [arXiv:2107.05650 [hep-ph]]

➥ O. Atkinson, **M. Black**, C. Englert, A. Lenz, A. Rusov and J. Wynne, *The Flavourful Present and Future of 2HDMs at the Collider Energy Frontier*, in review at JHEP, [arXiv:2202.08807 [hep-ph]]

➥ O. Atkinson, **M. Black**, C. Englert, A. Lenz and A. Rusov, *MUonE, muon $g-2$ and electroweak precision constraints within 2HDMs*, in review at Phys.Rev.D, [arXiv:2207.02789 [hep-ph]]

ACADEMIC EXPERIENCES

Python Tutoring

As part of my fourth year undergraduate, I volunteered to help tutor in First Year programming workshops, assisting in teaching the new students the fundamentals of Python programming for physics. I put my knowledge of Python to good use by sharing with newer students, and this allowed me to develop a better understanding of the language in teaching it.

Quarkonia Modelling

Throughout my degree course, I have had several courseworks that have required extensive Python programming, thus far leading up to the year-long project in my Third Year, where I modelled the early (n,l) wavefunctions for a Hydrogen atom, and then applied this to Quarkonia phenomena. I was able to calculate good approximations for several lower state masses, with the inclusion of hyperfine splitting. A full repository of this study can be found in my github profile.

SUPERVISORS

Dr. Alexander Lenz

POSITION Chair, Professor
GROUP *Theoretical Particle Physics Group Universität Siegen*

EMAIL Alexander.Lenz@uni-siegen.de
PHONE +49 (0)271/740-3890

Dr. Oliver Witzel

POSITION Akademischer Rat
GROUP *Theoretical Particle Physics Group Universität Siegen*

EMAIL Oliver.Witzel@uni-siegen.de
PHONE +49 (0)271/740-3703