

# Eshwen Bhal

PHD STUDENT

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## Profile

I am a final year PhD student in particle physics, searching for dark matter using big data from the Large Hadron Collider (LHC) as part of the CMS experiment at CERN. This involves statistical analysis of large datasets with expertise in Python, and solving wide ranging problems from physics standpoints to programming challenges. Additional responsibilities have included providing detector-related expertise and software, teaching undergraduates and doing public outreach. Aside from work, I partake in many activities such as taekwondo, weight lifting, hiking and skiing.

## Education

### University of Bristol

Bristol, United Kingdom

DOCTOR OF PHILOSOPHY IN PHYSICS

Sep. 2016 – Present

- Thesis title: **Hadronic Dark Matter Searches at CMS at 13 TeV** — Under supervision of H. Flücher. Expected submission in June 2020
  - Performing searches for dark matter arising from various physics models by analysing data from LHC's CMS experiment.
  - Simulated data for signal and background processes compared to LHC data in a statistical analysis framework to prove or disprove a model.
  - Code to simulate data and perform each step of analysis predominantly written in Python, leveraging modern data science tools and distributed computing where possible to process multiple terabytes of data.
- **Postgraduate student representative** for the particle physics group, 2019–20 — Role in the Student-Staff Liaison Committee for the School of Physics
- **CERN** (European Organisation for Nuclear Research), Geneva, Switzerland — Long term attachment, Oct. 2017 – Mar. 2019
- **Calorimeter Layer-2 on call expert** and **Level-1 Trigger shifter**, Geneva, Switzerland — Additional responsibilities at CERN
  - Trained to carry out tasks to assist CMS experiment so operations continue smoothly.
  - Helped develop and implement software for subsystem of Level-1 Trigger to apply corrections and calibrations to data.

### University of Exeter

Exeter, United Kingdom

MASTER OF PHYSICS WITH HONOURS IN PHYSICS WITH ASTROPHYSICS. AWARD: FIRST CLASS (77 %)

Sep. 2012 – Jul. 2016

- Dissertation title: **Simulations of Exoplanet Light Curves** — Under supervision of T. Harries
  - Developed software in C to simulate how photons interact in simple planetary atmospheres, producing light curves akin to data from telescopes. Maps of density and composition were also created for model planets.
  - More complex atmospheres can also be modelled and compared to real exoplanets to infer their composition.
  - Utilised Monte Carlo random sampling for scattering of photons, and parallelisation to efficiently run the code over millions of photons.

### Monmouth Comprehensive School

Monmouth, United Kingdom

SECONDARY SCHOOL QUALIFICATIONS

Sep. 2005 – Aug. 2012

- **A Level**, 2010–12 — Biology (A\*), Mathematics (A\*), Physics (B), Chemistry (AS Level) (B)
- **Open University**, 2011–12 — Introducing Astronomy (10 credit course)
- **GCSE**, 2008–10 — 10 including English Language and Mathematics at grades A\* (4) to A (6)

## Experience

### University of Bristol

Bristol, United Kingdom

COMPUTING DEMONSTRATOR

Nov. 2019 – Present

- Teaching third year undergraduate students Python and its applications for numerically solving physics problems. Also involves formal marking of assignments and providing feedback.

### University of Bristol

Bristol, United Kingdom

MATHEMATICS TUTOR

Jan. 2017 – May 2017

- Taught mathematics for physicists to first year undergraduate students. Also involved formal marking of problem sheets, discussions with the students, and teaching concepts for subsequent assignments.

## Skills

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### Data analysis

- The primary focus of my PhD concerns statistical analysis of large (multi-terabyte) datasets collected by the CMS experiment from the Large Hadron Collider.
- Developed analysis software for dark matter searches and detector-effect calibrations in Python and C++, using modern data science tools and distributed computing.
- Visualisation with ROOT and matplotlib. Formal presentations of results with LaTeX and Microsoft PowerPoint.

### Collaboration

- Belonging to, and working alongside several groups of around a dozen people as well as a global research collaboration of over 4,000 people.

### Problem solving

- Principal component of any physics degree. As an undergraduate, conducted more traditional pen-and-paper problem solving in many topics. As a PhD student, wrote code to solve physics problems numerically and perform data analysis for high energy particle physics.

### Multitasking

- Often working on multiple projects at once with different working groups during PhD. These have included data analysis, software-implemented calibrations to data from detector effects, and expertise and shift work for subsystems of the detector.

### Communication

- Presented formally in my PhD at all levels: regular working group updates, research group and collaboration-wide talks, and several conference posters and talks.
- Participated in outreach to the public at the CERN Open Days 2019 and at @Bristol.

## Awards

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2016	<b>Dean's Commendation</b> , in recognition of outstanding achievement at the fourth stage of my degree	<a href="#">University of Exeter</a>
2015	<b>Physics Award</b> , for being one of the three students with the highest marks at the third stage of my degree	<a href="#">University of Exeter</a>
2014	<b>Dean's Commendation</b> , in recognition of outstanding achievement at the second stage of my degree	<a href="#">University of Exeter</a>
2013	<b>Physics Award</b> , for being one of the three students with the highest marks at the first stage of my degree	<a href="#">University of Exeter</a>
2013	<b>Dean's Commendation</b> , in recognition of outstanding achievement at the first stage of my degree	<a href="#">University of Exeter</a>

## Publications

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2020	Searches for semi-visible jets in proton-proton collisions at $\sqrt{s} = 13$ TeV in hadronic final states	<a href="#">In preparation</a>
2020	Search for an invisibly decaying Higgs boson in proton-proton collisions at $\sqrt{s} = 13$ TeV in final states with jets and missing transverse momentum	<a href="#">In preparation</a>
2018	Search for natural and split supersymmetry in proton-proton collisions at $\sqrt{s} = 13$ TeV in final states with jets and missing transverse momentum	<a href="#">JHEP</a>

## Conference talks & posters

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2019	<b>CMS UK Conference</b> , Searches for semi-visible jets in hadronic final states	<a href="#">Oxfordshire, UK</a>
2019	<b>University of Bristol PGR Conference</b> , Search for dark matter via an invisibly decaying Higgs boson at CMS	<a href="#">Bristol, UK</a>
2019	<b>Institute of Physics HEPP and APP Conference</b> , Combined search for an invisibly decaying Higgs boson in hadronic channels at 13 TeV with CMS	<a href="#">London, UK</a>
2018	<b>LHCP Conference</b> , The CMS Level-1 jet and energy sum triggers in the LHC Run-II	<a href="#">Bologna, Italy</a>
2017	<b>University of Bristol PGR Conference</b> , Dark matter searches at CMS at 13 TeV	<a href="#">Bristol, UK</a>

## References

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Available on request.