

John Gargalionis

PHD STUDENT · PARTICLE PHENOMENOLOGY

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Education

University of Melbourne

Melbourne, Australia

DOCTOR OF PHILOSOPHY (THEORETICAL PARTICLE PHYSICS)

2016 — 2019

- *Prospective thesis title:* Studies in particle and collider phenomenology
- *Primary supervisor:* Prof. Raymond VOLKAS
- *Research topics:* Lepton-flavour non-universality, radiative neutrino mass, effective field theories for model building, machine learning and data analysis in high-energy physics
- *Main outcomes:*
 - Developed an algorithm to systematically generate theoretical models that explain how neutrinos gain mass
 - Applied computer-vision and machine-learning techniques to particle identification at the Large Hadron Collider (LHC), our analysis is one of the first to pioneer the use of real LHC data in the theory community
 - Developed models to explain recently measured discrepancies from the LHC, and explored their phenomenological and high-energy implications

MASTER OF SCIENCE (WITH DISTINCTION)

2014 — 2016

- *Thesis title:* Neutrino mass through leptoquarks: a new radiative model and its experimental prospects
- *Supervisors:* Prof. Raymond VOLKAS and Prof. Elisabetta BARBERIO
- *Coursework:* General Relativity, Non-equilibrium Statistical Mechanics, Particle Physics, Quantum Field Theory, Quantum Mechanics, Science Communication, String Theory
- *Research outcomes:*
 - Research project split between experiment and theory
 - Developed a model of neutrino mass involving exotic particles called leptoquarks. Explored its discovery prospects at the second run of the LHC

BACHELOR OF SCIENCE

2010 — 2014

- *Specialisations:* Physics, Neuroscience, Ancient Languages

Publications

Publications

TRAINING ON DATA: QUARK/GLUON DISCRIMINATION WITH THE CMS OPEN DATA (IN PREPARATION)

2019

Matthew J. Dolan & John Gargalionis

Manuscript in preparation

arXiv:2001.xxxxx

- Trained a deep neural network to classify images representing sprays of particles within the LHC
- Unsupervised learning techniques used to train directly on real data provided by the CMS collaboration
- Built a computational framework for processing and analysing the data, one of the first theory groups in the world to do so
- Involved working with large datasets (dozens of TB)

EXPLODING OPERATORS FOR MAJORANA NEUTRINO MASSES (IN PREPARATION)

2019

John Gargalionis & Raymond R. Volkas

Manuscript in preparation

arXiv:2001.xxxxx

- Wrote an algorithm to automate the procedure of generating particle physics models that could explain the origin of neutrino mass
- Wrote smaller modules implementing methods from tensor calculus and group theory in Python
- Technique can be expanded to other similar problems in the field

RADIATIVE NEUTRINO MASS MODEL FROM A MASS DIMENSION 11 $\Delta L = 2$ EFFECTIVE OPERATOR

2019

John Gargalionis, Iulia Popa-Mateiu & Raymond R. Volkas

Manuscript in preparation

arXiv:1912.xxxxx

- Explores the phenomenology of the first model derived from a dimension-11 operator, found using the algorithm and code I wrote for ‘Exploding operators for Majorana neutrino masses’

A NEAR-MINIMAL LEPTOQUARK MODEL FOR RECONCILING FLAVOUR ANOMALIES AND GENERATING RADIATIVE NEUTRINO MASS

2019

Innes Bigaran, John Gargalionis & Raymond R. Volkas

JHEP

arXiv:1906.01870, JHEP 10:106 (2019)

- Addresses the shortcomings of the model developed in our paper arXiv:1704.05849 with a more involved spectrum of new particles

RECONSIDERING THE ONE LEPTOQUARK SOLUTION: FLAVOUR ANOMALIES AND NEUTRINO MASS

2017

Yi Cai, John Gargalionis, Michael A. Schmidt & Raymond R. Volkas

JHEP

arXiv:1704.05849, JHEP 10:047 (2017)

- Explored the extent to which a simple model could explain recent anomalous measurements of B -meson decays and neutrino mass
- Involved resolving discrepancies in the literature and the analysis of large Monte-Carlo datasets
- Results showed varied ability of the model to explain the discrepancies in different regions of its parameter space

EXPLAINING THE 750 GeV DIPHOTON EXCESS WITH A COLOURED SCALAR CHARGED UNDER A NEW CONFINING GAUGE INTERACTION

2016

Robert Foot & John Gargalionis

PRD

arXiv:1604.06180, Phys. Rev. D94:011703 (2016)

- Described a model with an additional class of particle and force whose cleanest experimental signature is the two-photon decay of an otherwise invisible bound state
- Model was motivated by hints of an exotic particle seen to decay to two photons

Other publications

SOLUTIONS TO PROBLEMS AT LES HOUCHES SUMMER SCHOOL ON EFT

2019

Marcel Balsiger, Marios Bounakis, Medhi Drissi, John Gargalionis, Erik Gustafson, Greg Jackson, Matthew Leak, Christopher Lepenik, Scott Melville, Daniel Moreno, Michele Tommaro, Selim Touati & Timothy Trott

Chapter in preparation

arXiv:20xx.xxxxx

- Worked solutions to high-level problem sets given throughout the Les Houches 2017 Summer School on Effective Field Theories, solved and written voluntarily by subset of students
- Will be published as a chapter in the book 'Lecture Notes of the Les Houches School on Effective Field Theories' by the Oxford University Press
- Will be uploaded to the arXiv

General Skills

Programming

Python, Mathematica (Wolfram Language), C/C++, Clojure(Script), Scheme (and Racket), Haskell, Elm

- Familiar with the use of scripting languages like Python and Racket for large-scale (thousands of lines) package development
- Practised in test-driven software development
- Have taught scientific computation in both C/C++ (to undergraduates) and Python (to graduate students)
- Confident in the use of the SciPy suite (SciPy, NumPy, SymPy, Jupyter, etc.) for high-performance and scientific computation
- Experience with common algorithms, data structures and computational methods
- Limited experience in web-application development with ClojureScript and Elm
- Hobbyist interest in functional and logic programming

Data analysis

ROOT, SciPy, Pandas, Dask, h5py, SQLite

- Extensive experience with R-style data-frame objects in Pandas and Mathematica for data analysis and analytics
- ROOT objects and their Pythonic interface through rootpy
- Use of scalable data structures from Dask and h5py
- SQL database management including cross-table references and complex queries

Machine learning

TensorFlow, Keras, (Un)supervised learning, Image classification

- Experience with Keras' functional API for defining complex machine-learning models with TensorFlow backend
- Have used unsupervised and supervised learning techniques in image classification problems
- Understanding of common machine-learning architectures including feed-forward, convolutional and max-out

Communication

Public speaking, scientific writing, science communication

- Confident public speaker (see invited and contributed talks, scientific outreach and teaching)
- Published year-12 study guide for writing English essays 'How to write that A+ English Language essay' (2010)

Visualisation

Matplotlib, Seaborn, pgf-plots, TikZ, gnu-plot, quilt

- Confident with many scientific plotting libraries
- Vector graphics and visual arts in TikZ and quilt

Management

Git, Cluster computing, GNU Make, FTP, Unix command line

- Confident with git for version control
- Proficient in common Unix tools and bash for shell scripting
- Working knowledge of make for writing Makefiles

Markup

T_EX, HTML, Markdown, org

- Typesetting of academic texts with mathematical content in T_EX
- Preparation of high-quality slides with beamer and reveal.js
- Translation between various markup languages with pandoc

Academic Skills

Physics

Effective field theories (EFTs), model building, flavour physics, collider physics

- Constructing and analysing extensions of the Standard Model, experience mostly in models of radiative neutrino mass
- Knowledgeable about new-physics explanations of the B -meson anomalies and their connection to other topics in flavour
- Worked extensively with the Standard Model EFT at mass-dimension 6 and higher
- Well acquainted with concepts in experimental analysis, experience with a range of physics objects and signatures

Collider

CMSSW, MadGraph, Pythia, Fastjet, Delphes

- Confident in the generation of Monte-Carlo data starting from a Lagrangian
- Experience with the CMS analysis framework through the use of their publicly available data

Calculation

Package-X, FeynRules, FeynArts, FormCalc, LoopTools

- Calculating loop-level amplitudes with Mathematica packages

Invited Seminars

Oct 2018	Belle II Theory Interface Platform , Leptoquarks and flavour	KEK, Japan
May 2018	Monash University , Radiative neutrino mass and the flavour anomalies: a circumstantial case	Melbourne, Australia
May 2017	Instant workshop on B-meson anomalies , Reconsidering the ‘one leptoquark’ solution: flavour anomalies and neutrino mass, https://cds.cern.ch/record/2265323	CERN, Switzerland

Contributed Seminars

Sep 2017	Geoff Opat Seminar Series , Radiative neutrino mass and the flavour anomalies: a circumstantial case	Melbourne, Australia
Aug 2017	Technische Universität Dortmund , Radiative neutrino mass and the flavour anomalies: a circumstantial case	Dortmund, Germany
Aug 2017	Technische Universität München , Radiative neutrino mass and the flavour anomalies: a circumstantial case	Garching, Germany
Dec 2016	APPC-AIP Congress , Reconsidering the ‘one leptoquark’ solution: flavour anomalies and neutrino mass	Brisbane, Australia
Jun 2016	University of Melbourne , Light leptoquarks at the LHC: neutrino mass and flavour physics	Melbourne, Australia
Nov 2015	MSc completion seminar , Radiative neutrino mass through leptoquarks	Melbourne, Australia

Training

Summer schools

Aug 2017	Joint Challenges for Cosmology and Colliders , MITP	Mainz, Germany
Jul 2017	EFT in Particle Physics and Cosmology , Ecole de Physique des Houches	Les Houches, France
Jul 2016	Pre-SUSY School , University of Melbourne	Melbourne, Australia

Summer research projects

Dark matter and heavy-flavoured quarks

Melbourne, Australia

ATLAS EXOTICS GROUP

Jan 2016

- *Supervisor:* Dr. Francesca UNGARO
- *Main outcomes:*
 - Suggested a more stringent criterion for the identification of b -quark jets in the analysis
 - Explored the potential of various kinematic variables to improve the reach of the search

Honours & Awards

2018	Science Abroad Travel Scholarship , University of Melbourne	Melbourne, Australia
2017	Research poster award , CoEPP	Adelaide, Australia
2016 – 2019	Australian Postgraduate Award (APA) , Australian Research Council	Melbourne, Australia
2015	Prof. Kernot Research Scholarship in Physics , University of Melbourne	Melbourne, Australia
2014	N. D. Goldsworthy Scholarship , University of Melbourne	Melbourne, Australia

Teaching

2018	Tutor , 1st year Physics	University of Melbourne
2018, 2019	Tutor , 3rd year Quantum Mechanics	University of Melbourne
2018	Tutor , Advanced Scientific Programming in Python (Asia-Pacific)	Melbourne Bioinformatics
2016, 2018	Teaching assistant and course content creator , 3rd year Subatomic Physics	University of Melbourne
2014 – 2016	Curriculum designer and language teacher , Modern and Ancient Greek	Centre for Adult Education
2014 – 2018	Laboratory demonstrator , 1st year Physics Lab, 3rd year Particle Lab, 2nd year Computational Physics	University of Melbourne
2010 – 2019	Private Tutor , Physics, Mathematics, Greek	

Scientific Outreach

2018, 2019	CoEPP Work Experience Program , Introductory talk: The Standard Model	University of Melbourne
2017	Physics Workshops , Project coordinator	Hume Central Secondary
2016	Undergraduate Seminar Series , Research talk targeted at undergraduate physics students	University of Melbourne
2015, 2016	International Masterclass in Particle Physics	South Oakleigh Grammar
2015	CoEPP Work Experience Program , Organising committee	University of Melbourne
2015	International Masterclass in Particle Physics	University of Melbourne

Other

Citizenship	Australian
Birth year	1991
Languages	English (native), Greek (fluent)