

Dr. Nathan Woollett

CONTACT INFORMATION

Postdoctoral Researcher
Physical and Life Sciences Directorate
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RESEARCH INTERESTS

Advanced detector research and development for national security and fundamental physics applications: microwave cavity searches for axion dark matter, superconducting quantum sensor development, cyclotron radiation emission spectroscopy for precision x-ray and electron energy measurements, and time-projection chambers for nuclear cross section measurements.

EDUCATION

Lancaster University, Lancaster, UK

Ph.D., Physics, January 2016

- Thesis: *Shining light through walls: a search for dark photons*
- Thesis Advisers: Dr Ian Bailey and
- Area of Study: Experimental Particle Physics

M.Phys., Physics, June 2011

- Dissertation: *Binary Star Observations Within the Cassiopeia Constellation*
- Adviser: Dr Ian Bradley

RESEARCH EXPERIENCE

Postdoctoral Researcher

July 2016 to present

Nuclear and Analytical Chemistry (NACS) Division, Physical and Life Sciences Directorate, Lawrence Livermore National Laboratory

- Primary Investigator: Ultra-High-Resolution X-ray Spectroscopy Using Cyclotron Radiation Emission
 - Leading the design and fabrication of microwave, DC, magnet and cryogenic systems.
 - Leading the data acquisition system development.
- [Axion Dark Matter Experiment](#)
 - Project Lead on ADMX: Sidecar RD Platform.
 - Conducting thermal modelling and budgeting for the main cavity insert.
 - Lead quantum amplification testing and operations at LLNL and consulting for University of Washington and Washington University at St Louis groups.
- Superconducting Quantum Sensing
 - Investigating superconducting quantum amplifiers for axion dark matter searches and national security applications.
 - Investigating increasing the rate of generation of entangled photons for sensing applications.
- Fission Time Projection Chamber (NIFTE) Experiment
 - Developing custom simulation software to interface with GEANT 4 for full signal modeling.
- DOE Technology Commercialization Fund, Cold Spray Technology with TTEC
 - Multi-physics simulation of spray technology and material deposition.
 - Modeling of functional devices produced using TTEC technology.

Graduate Assistant

September 2011 to July 2016

Lancaster University Physics Department

- Thesis topic: Designed and operated the CASCADE dark photon search using microwave resonators.
- Designed and characterised microwave resonators using CST Microwave Studio to optimize the expected signal from additional energy leakage via the dark photon field.
- Simulated the use of photonic crystals for high frequency dark photon searches using MIT MEEP.
- Characterized cryogenic amplifiers and receiver chain, quantifying noise performance.
- Performed data taking operations and analysis.

Undergraduate Researcher

September 2007 to May 2011

Lancaster University Physics Department

- Dissertation Project: Worked in team with 3 other students to measure binary star luminosity curves. Project involved identifying suitable eclipsing binary star systems with a period which is measurable within the project length, setting up the telescope and recording images, extracting and interpreting resulting luminosity curves. Lead the groups use of the PHOEBE software package for analysis.

REFEREED JOURNAL PUBLICATIONS

- [1] Boutan, C. et al. "Piezoelectrically Tuned Multimode Cavity Search for Axion Dark Matter", *Phys. Rev. Lett.*, vol. 121, 261302, December 28, 2018.
doi:<https://doi.org/10.1103/PhysRevLett.121.261302>
- [2] Du, N. et al. "Search for Invisible Axion Dark Matter with the Axion Dark Matter Experiment", *Phys. Rev. Lett.*, vol. 120, 151301, April 9, 2018.
doi:<https://doi.org/10.1103/PhysRevLett.120.151301>
- [3] Holland, E. et al. "High-kinetic inductance additive manufactured superconducting microwave cavity", *Appl. Phys. Lett.*, vol. 111, 202602, 2017.
doi:<https://doi.org/10.1063/1.5000241>
- [4] Seviour, R. et al. "Hidden-sector photon and axion searches using photonic band gap structures" *J. Phys. G: Nucl. Part. Phys.*, vol. 41, 035005, 2014.
doi:<https://doi.org/10.1088/0954-3899/41/3/035005>

BOOKS AND REPORTS

- [5] Woollett, N. et al. "Photonic Band Gap Cavities for a Future ADMX" *Springer*, page. 61-65, 2018.
- [6] Woollett, N. et al. "Preliminary Results of the CASCADE Hidden Sector Photon Search" *arXiv preprint* 2015. doi:<https://arxiv.org/abs/1509.07693>

PUBLISHED CONFERENCE PROCEEDINGS

- [7] Kalliokoski, M. et al. "CASCADE: a cavity based dark matter experiment" 16th International Conference on RF Superconductivity, 2014
- [8] Kalliokoski, M. et al. "Status of the CASCADE microwave cavity experiment, Verlag Deutsches Elektronen-Synchrotron, 2013

POSTDOC AND STUDENT ADVISING	<p>Thomas Braine July 2018 - Present Mentoring U. of Washington Physics Graduate Student Researcher on ADMX experiment with focus on superconducting cavity designs for future axion searches.</p> <p>Parashar Mohapatra Summer 2019 Mentoring U. of Washington Physics Undergraduate Student Researcher on ADMX experiment with focus on multi-cavity designs for future ADMX RD platforms.</p>
TEACHING EXPERIENCE	<p>Lancaster University, Lancaster, UK</p> <p><i>Teaching Assistant</i> 2011-2016</p> <ul style="list-style-type: none"> Graded and held workshops for Maths for Physics I, Cosmology, Electromagnetism, Introduction to Java, Advanced Java. for students.
PROFESSIONAL MEMBERSHIPS	<ul style="list-style-type: none"> Member of Institute of Physics 2012 - Present Member of American Physical Society 2016 - Present
SOFTWARE SKILLS	<ul style="list-style-type: none"> Programming Languages: C++, Python, Java, Matlab Others: Latex, COMSOL Multiphysics, CST Microwave Studio, Ansys HFSS, Autodesk Inventor.
CITIZENSHIP	United Kingdom
REFERENCES AVAILABLE TO CONTACT	<p>Dr. Adam Bernstein</p> <ul style="list-style-type: none"> Group Leader and Staff Scientist, Physics Division, Rare Event Detection Group, Lawrence Livermore National Laboratory ◇ e-mail: bernstein3@llnl.gov; phone: +1-925-422-5918 ◇ L-211, 7000 East Ave, Livermore, CA, 94550 ★ <i>Dr. Bernstein is my current group leader.</i> <p>Dr. Gianpaolo Carosi</p> <ul style="list-style-type: none"> Staff Scientist, Physics Division, Rare Event Detection Group, Lawrence Livermore National Laboratory ◇ e-mail: carosi2@llnl.gov; phone: +1-925-423-5527 ◇ L-211, 7000 East Ave, Livermore, CA, 94550 ★ <i>Dr. Carosi is my current supervisor.</i> <p>Dr. Leslie J Rosenberg</p> <ul style="list-style-type: none"> Professor, Physics, The University of Washington ◇ e-mail: ljrosenberg@phys.washington.edu; phone: +1-206-221-5856 ◇ Dept. of Physics, Box 351560, Seattle WA 98195-1560 <p>Dr. Ian Bailey</p> <ul style="list-style-type: none"> Lecturer, Physics Department, Lancaster University ◇ e-mail: i.bailey@lancaster.ac.uk; phone: +44-1524-593742 ◇ Physics Department, Lancaster University, Lancaster, United Kingdom, LA1 4YB, United Kingdom <p>Dr. Peter Williams</p> <ul style="list-style-type: none"> Staff Scientist, Accelerator Science and Technology Centre, Daresbury Laboratory ◇ e-mail: peter.williams@stfc.ac.uk; phone: +44-1925-603994 ◇ Accelerator Science and Technology Centre, Daresbury Laboratory, Sci-Tech Daresbury, Keckwick Lane, Daresbury, WA4 4AD, United Kingdom