

Dr. Noah Fitch

curriculum vitae

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Education

- 2006–2014 **PhD Physics**, *JILA / University of Colorado Boulder*, Dissertation: Traveling-Wave Stark-Decelerated Molecular Beams for Cold Collision Experiments..
- 2000–2006 **B.S. Physics**, *Humboldt State University*, Arcata, CA, USA.

Research

- 2018–present **Royal Society University Research Fellow**, *Imperial College London*, Searching for new physics using ultracold molecules.
- 2014–2018 **Postdoctoral Research Associate**, *Imperial College London*, Laser cooling of molecules to ultracold temperatures for precision measurements.
- 2011–present **Embedded Systems Design and Development**, *AcroOptics LLC*, Firmware and hardware development of a LED lighting fixture.
- 2007–2014 **Doctoral Research Assistant**, *JILA / CU Boulder*, Stark deceleration of polar molecules for cold collision studies. Advisor: Heather Lewandowski.
- Summer 2005 **NSF Research Experience for Undergraduates (REU)**, *University of Oregon*, Building a magneto-optical trap of Rubidium.
- 2005–2006 **Undergraduate Research Assistant**, *Humboldt State University*, Automating the Cavendish Balance and data acquisition with Mathematica.

Teaching

- 2020 – 2021 **Master’s course instructor**, *Imperial College*.
Atomic physics
- Fall 2018 **Master’s course instructor**, *Imperial College*.
Lectures and worked activities as an introduction to *Mathematica* for controlled quantum dynamics and quantum system engineering masters students for the doctoral training centre.
- 2017–2018 **1st year undergraduate lab demonstrator**, *Imperial College*.
Introductory labs and Python programming, head of the “not-so-simple pendulum” experiment.
- 2016–2017 **2nd year undergraduate lab demonstrator**, *Imperial College*.
Interferometry and Holography.
- 2014–2015 **Microcontroller (year 3 undergraduate) lab demonstrator**, *Imperial College*.
Research project supervision and lab demonstration for Atmel micro-controller course.
- 2006–2007 **Undergraduate teaching assistant**, *University of Colorado*.
Tutorial-based instruction and demonstration for calculus-based electromagnetism.
- 2005–2006 **Supplemental undergraduate course instructor**, *Humboldt State University*.
Supplemental instruction for classical mechanics, thermodynamics, and electromagnetism.

2004–2006 **Grader**, *Humboldt State University*, Arcata, California.
Algebra-based classical mechanics, electromagnetism, and modern physics.

Mentoring and Supervision

- Oct. 2020 – **PhD candidate co-supervisor**, *Imperial College*, Yixin Wang.
present A vibrational lattice clock of CaF molecules
- Oct. 2020 – **PhD candidate co-supervisor**, *Imperial College*, Stefan Poppa.
present YbF molecules in a lattice for precision measurements of the electron’s electric dipole moment
- 2020 **Supervisor for master’s literature review project(s)**, *Imperial College*.
Stark deceleration of molecular beams; laser cooled molecules in optical traps; observing chemical reactions at the single-particle level
- 2020 **Master’s student cohort mentor**, *Imperial College*.
Mentor for 12 students in the Quantum Dynamics MSc (masters) course stream
- Fall 2020 **BSc project mentor**, *Imperial College*.
Magnetic shielding and degaussing for precision measurements
- Oct. 2019 – **PhD candidate supervisor**, *Imperial College*, Freddie Collings.
present A next generation search for the electron’s electric dipole moment using ultracold YbF molecules
- Summer **UROF project mentor**, *Imperial College*.
2019 Building a precision micropower 50 kV floating pico-ammeter for leakage current monitoring. Testing the noise floor of atomic vapour vector magnetometers. Modeling magnetic shields.
- Aug. 2018 – **PhD candidate co-supervisor**, *Imperial College*, Simon Swarbrick.
present Laser cooling of YbF molecules for electron edm searches
- Oct. 2018 – **PhD candidate co-supervisor**, *Imperial College*, Gautam Kambhampati.
present Zeeman-Sisyphus deceleration of a molecular beam of CaF
- Summer **Project mentor**, *Imperial College*, French Engineering Internship.
2018 Next-generation electric field plates for searching for the eEDM.
- Summer **UROF project mentor**, *Imperial College*, Summer research internship.
2017 Construction of a Zeeman-Sisyphus molecular-beam decelerator.
- Summer **Project mentor**, *Imperial College*.
2016 Dynamics of a resonant elastic pendulum. Mechanical analogs, dynamics, and chaos in circuits.
- Summer **Project mentor**, *Imperial College*, French Engineering Internship.
2016 Development of a neon buffer gas beam of YbF.
- Summer **Project mentor**, *Imperial College*, French Engineering Internship.
2015 A YbF buffer-gas beam via laser ablation of compressed ceramic targets.

Publications

- ¹J. Greenberg, O. A. Krohn, J. A. Bossert, Y. Shyur, D. Macaluso, N. J. Fitch, and H. J. Lewandowski, “Velocity-tunable beam of continuously decelerated polar molecules for cold ion-molecule reaction studies”, Under review in *Rev. Sci. Instrum.* (2021).
- ²N. J. Fitch and M. R. Tarbutt, “Laser-cooled molecules”, *Adv. at. mol. opt. phys.* Vol. 70 (Elsevier, 2021), pp. 157–262.
- ³X. Alauze, J. Lim, M. A. Trigatzis, S. Swarbrick, N. J. Fitch, B. E. Sauer, and M. R. Tarbutt, “An ultracold molecular beam for testing fundamental physics”, *Quantum Sci. Technol.* **6**, 044005 (2021).

- ⁴N. J. Fitch and M. R. Tarbutt, “From hot beams to trapped ultracold molecules: motivations, methods and future directions”, *Molecular beams in physics and chemistry – from Otto Stern’s pioneering exploits to present-day feats*, edited by B. Friedrich and G. Schmidt-Böcking (Springer, 2021), pp. 491–516.
- ⁵S. Jurgilas, A. Chakraborty, C. J. H. Rich, H. J. Williams, N. J. Fitch, B. E. Sauer, M. D. Frye, J. M. Hutson, and M. R. Tarbutt, “Collisions between ultracold molecules and atoms in a magnetic trap”, *Phys. Rev. Lett.* **126**, 153401 (2021), Editors’ suggestion, featured in *APS Physics*.
- ⁶N. J. Fitch, J. Lim, E. A. Hinds, B. E. Sauer, and M. R. Tarbutt, “Methods for measuring the electron’s electric dipole moment using ultracold YbF molecules”, *Quantum Sci. Technol.* **6**, 014006 (2020).
- ⁷C. J. Ho, J. A. Devlin, I. M. Rabey, P. Yzombard, J. Lim, S. C. Wright, N. J. Fitch, E. A. Hinds, M. R. Tarbutt, and B. E. Sauer, “New techniques for a measurement of the electron’s electric dipole moment”, *New J. Phys.* **22**, 053031 (2020).
- ⁸N. J. Fitch, L. P. Parazzoli, and H. J. Lewandowski, “Collisions between ultracold atoms and cold molecules in a dual electrostatic-magnetic trap”, *Phys. Rev. A* **101**, 032703 (2020).
- ⁹L. Caldwell, H. J. Williams, N. J. Fitch, J. Aldegunde, J. M. Hutson, B. E. Sauer, and M. R. Tarbutt, “Long rotational coherence times of molecules in a magnetic trap”, *Phys. Rev. Lett.* **124**, 063001 (2020).
- ¹⁰L. Caldwell, J. A. Devlin, H. J. Williams, N. J. Fitch, E. A. Hinds, B. E. Sauer, and M. R. Tarbutt, “Deep laser cooling and efficient magnetic compression of molecules”, *Phys. Rev. Lett.* **123**, 033202 (2019).
- ¹¹Y. Shyur, N. J. Fitch, J. A. Bossert, T. Brown, and H. J. Lewandowski, “A high-voltage amplifier for traveling-wave Stark deceleration”, *Rev. Sci. Instr.* **89**, 084705 (2018), Editors’ featured article and focus of an *API Scilight*.
- ¹²H. J. Williams, L. Caldwell, N. J. Fitch, S. Truppe, J. Rodewald, E. A. Hinds, B. E. Sauer, and M. R. Tarbutt, “Magnetic trapping and coherent control of laser-cooled molecules”, *Phys. Rev. Lett.* **120**, 163201 (2018).
- ¹³J. Lim, J. R. Almond, M. A. Trigatzis, J. A. Devlin, N. J. Fitch, B. E. Sauer, M. R. Tarbutt, and E. A. Hinds, “Laser cooled YbF molecules for measuring the electron’s electric dipole moment”, *Phys. Rev. Lett.* **120**, 123201 (2018).
- ¹⁴H. J. Williams, S. Truppe, M. Hambach, L. Caldwell, N. J. Fitch, E. A. Hinds, B. E. Sauer, and M. R. Tarbutt, “Characteristics of a magneto-optical trap of molecules”, *New J. Phys.* **19**, 113035 (2017).
- ¹⁵S. Truppe, H. J. Williams, M. Hambach, L. Caldwell, N. J. Fitch, E. A. Hinds, B. E. Sauer, and M. R. Tarbutt, “Molecules cooled below the Doppler limit”, *Nat. Phys.* **13**, 1173–1176 (2017), Featured in (1), (2), (3), (4), and (5).
- ¹⁶N. J. Fitch, “What goes up must come down: Viewpoint on the first demonstration of a molecular fountain by H. L. Bethlem et al.”, *Physics* **9**, 56 (2017).
- ¹⁷S. Truppe, H. J. Williams, N. J. Fitch, M. Hambach, T. E. Wall, E. A. Hinds, B. E. Sauer, and M. R. Tarbutt, “An intense, cold, velocity-controlled molecular beam by frequency-chirped laser slowing”, *New J. Phys.* **19**, 022001 (2017), Featured in an *NJP perspective*.
- ¹⁸N. J. Fitch and M. R. Tarbutt, “Principles and design of a Zeeman-Sisyphus decelerator for molecular beams”, *Chem. Phys. Chem.* **17**, 3579 (2016).
- ¹⁹N. J. Fitch, “Traveling-Wave Stark-Decelerated Molecular Beams for Cold Collision Experiments”, PhD thesis (University of Colorado, Boulder, 2013).

- ²⁰M. I. Fabrikant, T. Li, N. J. Fitch, N. Farrow, J. D. Weinstein, and H. J. Lewandowski, “Method for traveling-wave deceleration of buffer-gas beams of CH”, *Phys. Rev. A* **90**, 033418 (2014).
- ²¹N. J. Fitch, D. A. Esteves, M. I. Fabrikant, T. C. Briles, Y. Shyur, L. P. Parazzoli, and H. J. Lewandowski, “State purity of decelerated beams”, *J. Mol. Spec.* **278**, 1–6 (2012).
- ²²L. P. Parazzoli, N. J. Fitch, P. S. Zuchowski, J. M. Hutson, and H. J. Lewandowski, “Large effects of electric fields on atom-molecule collisions at millikelvin temperatures”, *Phys. Rev. Lett.* **106**, 193201 (2011).
- ²³N. J. Fitch, C. A. Weidner, L. P. Parazzoli, H. Dullin, and H. J. Lewandowski, “Experimental demonstration of classical Hamiltonian monodromy in the 1:1:2 resonant elastic pendulum”, *Phys. Rev. Lett.* **103**, 034301 (2009), Editors’ suggestion, featured in *APS Physics*.
- ²⁴L. P. Parazzoli, N. J. Fitch, D. Lobser, and H. J. Lewandowski, “High-energy-resolution molecular beams for cold collision studies”, *New J. Phys.* **11**, 055031 (2009).
- ²⁵N. J. Fitch, W. Bliven, and T. Mitchell, “Automating data acquisition for the Cavendish balance to improve the measurement of G”, *Am. J. Phys.* **75**, 4 (2007).

Awards, Honors, and Funding

- Mar. 2021 – **CaF BEC: cooling molecules to quantum degeneracy**, *Researcher co-investigator*, EPSRC EP/V011499/1, £1,912,724.
- Mar. 2021 – **Quantum sensors for fundamental physics: QSNET – A network of clocks for measuring the stability of fundamental constants**, *Researcher co-investigator*, STFC ST/T006234/1, £959,536.
- Jan. 2020 – **Joint lattice EDM grant**, *Researcher co-investigator*, Sloan (G-2019-12505) and Dec. 2022 Moore (8864) foundations, \$ 1,555,042.
- Oct. 2018 – **Joint ultracold beam EDM grant**, *Researcher co-investigator*, STFC Jun. 2021 (ST/S000011/1) and Templeton (61104), £1,725,622.
- Oct. 2018 – **Royal Society Research Fellows Enhancement Award**, *Principal investigator*, Mar. 2021 RGF\EA\181031, £200,000.
- Oct. 2018 – **Royal Society University Research Fellowship**, *Principal investigator*, Sep. 2023 URF\R1\180578, £526,800.
- Feb. 2018 **STFC Ernest Rutherford Fellowship finalist**.
- May 2006 **Magna Cum Laude graduation honors**, *Humboldt State University*.
- 2000–2002 **Humboldt Area Foundation Science Scholarship**.

Patents, Inventions, and Copyrights

- Nov. 2013 **Provisional Patent Application**, *Analog high voltage amplifiers*, Invention disclosure number: CU3476B-PPA1, Provisional application number: 61/904,382.

Presentations (talks and posters)

Invited

- Mar. 2021 **Exploring the frontiers of physics using ultracold molecules**, *Physics seminar*, Van Swinderen Institute, University of Groningen.
- Dec. 2018 **Ultracold YbF molecules for measuring the electric dipole moment of the electron**, *Searching for new physics with cold and controlled molecules workshop*, Mainz Institute for Theoretical Physics.

- Nov. 2017 **Smaller, weaker, slower. How the ultracold molecule is taking over the world**, *Physics and Astronomy Colloquium*, Humboldt State University.
- June 2016 **Deceleration techniques for loading molecular MOTs**, *Joint Quantum Institute (JQI) Special Seminar*, University of Maryland.
- Feb. 2010 **Hamiltonian monodromy in the 1:1:2 resonant elastic pendulum**, *Dynamics Seminar Series*, Applied Math Department, UC Boulder.

Contributed

- July 2019 **Long rotational coherence times with magnetically-trapped molecules**, *QSUM meeting*, Durham University.
- July 2018 **Zeeman Sisyphus Deceleration**, *QSUM meeting*, Durham University.
- Mar. 2018 **A DC MOT of CaF Molecules**, *CCMI*, Athens, Georgia.
- Sep. 2017 **Making and controlling ultracold CaF**, *QSUM meeting*, Durham University.
- May 2016 **CaF MOT loading via Zeeman-Sisyphus deceleration**, *MMQA meeting*, Imperial College London.
- May 2016 **Zeeman-Sisyphus deceleration of molecular beams**, *DAMOP*, Providence, RI.
- June 2015 **A YbF Fountain for Next-Generation Searches for the Electron Electric Dipole Moment**, *ICOLS*, Singapore.
- Mar. 2015 **A Zeeman-Sisyphus Decelerator for CaF**, *MMQA meeting*, Durham University.
- Mar. 2015 **Progress Towards a YbF Fountain**, *MMQA meeting*, Durham University.
- Sep. 2014 **A YbF fountain for measurement of the electron EDM**, *CCMI*, Monte Verita, Switzerland.
- Nov. 2013 **Traveling-wave Stark-decelerated molecular beams for cold collision experiments**, *Thesis defense*, JILA, UC Boulder.
- June 2013 **Method for deceleration of a cryogenic beam of CH molecules using a traveling-wave Stark decelerator**, *ICOLS*, UC Berkeley.
- Nov. 2012 **A traveling-wave Stark decelerator**, *ESF Cold and Ultracold Molecules*, Obergurgl, Austria.
- June 2011 **Continuous-wave Stark deceleration of supersonic molecular beams**, *Gordon conference*, Mount Snow Resort, Vermont.
- May 2010 **Cold collisions of co-trapped ND_3 molecules and Rb atoms**, *DAMOP*, Houston, Texas.
- July 2009 **Monodromy in the resonant elastic pendulum**, *Conference on cold molecules*, JILA, UC Boulder.
- May 2009 **Cold collisions of Stark decelerated ND_3 molecules and magnetically trapped Rb atoms**, *DAMOP*, Charlottesville, Virginia.
- May 2008 **State sensitive detection of decelerated polar molecules**, *DAMOP*, College Park, Pennsylvania.

Other

- Dec. 2020 **Using Mathematica on Imperial's high-performance computing clusters**, *Centre for Cold Matter T-day series*, Imperial College London.
- Dec. 2019 **Cold molecules and new physics**, *Imperial Lates event*, Imperial College London.
- Nov. 2019 **Let's talk about *git* baby**, *Centre for Cold Matter T-day series*, Imperial College London.

- July 2019 **Advice for fellowship interviews**, QSUM collaboration talk, Durham University.
- June 2019 **Successful fellowship applications**, Physics Department, University College London.
- Oct. 2016 **Structures of Classical Mechanics and Hamiltonian Mondodromy**, Centre for Cold Matter T-day series, Imperial College London.
- June 2016 **Zeeman-Sisyphus deceleration of molecular beams**, Centre for Cold Matter T-day series, Imperial College London.

— Languages and Programs

Labview	<i>Graphical experimental control and data acquisition</i>
Mathematica	<i>Scientific computational software and programming</i>
Comsol Multiphysics	<i>Multiphysics finite-element analysis</i>
C / C++ / C# / Python	<i>General purpose programming</i>
PicBasic / PIC and Atmel Assembly / Arduino-C++	<i>Microcontroller programming</i>
Autodesk Eagle / PADS	<i>Electronic design and layout</i>
Origin	<i>Scientific plotting and data analysis</i>
Solidworks / Autodesk Inventor	<i>3D CAD design</i>
Microsoft Office	<i>Generic word processing and presentation</i>
LaTeX	<i>Scientific typesetting</i>
Bash	<i>Unix/Linux shell scripting/operation</i>
Git	<i>Distributed version control</i>

— Service and Refereeing

- 2019– **Research computing representative for quantum optics and laser science (QOLS) section.**
- 2019– **Reviewer for New Journal of Physics.**
- 2019– **Reviewer for Communications Physics.**
- 2019– **Grant reviewer for National Science Foundation (NSF).**
- 2018– **Grant reviewer for UK space agency (UKSA).**
- 2017– **Reviewer for APS Physical Review Journals.**
- 2016– **Reviewer for Chem. Phys. Chem..**
- 2015– **Reviewer for Journal of Physics B.**

— Media and Outreach

- Dec. 2019 **Public talk and booths at Imperial Lates “Winter Wonderlab” event.**
- Oct. 2018 **Interviewed by Chemistry World about the nobel prize for optical tweezers.**
- Sep. 2018 **Interviewed for article in Chemistry World about ultracold chemistry.**
- Feb. 2015 **Forces Teaching Day, Our Friend’s House School, Kingston Upon Thames, UK.**
- Dec. 2012 **Science fair judge, Boulder Country Day School, Boulder, Colorado.**
- July 2010 **Aerodynamics and pressure, Wild Bear Outdoor Education, Nederland, Colorado.**
- May 2009 **Temperature and phases of matter, Friend’s School, Boulder, CO.**