Dr. Alexander Shakeel Bates

Neuroscientist & Computational Biologist

I am a neuroscientist and computational biologist specialising in neuroanatomy, neurophysiology and connectomics of the insect brain. My research focuses on understanding how neural circuits wire and fire to generate complex behaviours, including olfactory processing and animal navigation. I develop open-source tools for neuroanatomical analysis and collaborate internationally on connectomics projects. In the wetlab, I use virtual reality and calcium imaging experiments to interrogate neurobiological circuits in living, behaving flies. I am a UK citizen.

Contact: alexander_bates@hms.harvard.edu | ORCID: 0000-0002-1195-0445 | GitHub: alexanderbates

Metrics: 4325 citations | h-index: 21 | i10-index: 24 | 16 peer reviews

Professional Research

Postdoctoral Fellow in Neurobiology • Harvard Medical School • Boston, US • present - 01/10/2020

Investigating navigational circuitry using calcium imaging, neurophysiology and behavioural studies involving virtual reality with *Drosophila melanogaster*, in the laboratory of Prof. Rachel Wilson • Co-leading an international collaboration with Prof. Wei-Chung Allen Lee, flywire and a network of international research groups on the first whole fly central nervous system connectome, open-access

Fellowships & Grants

Harvard Nomination for The Warren Alpert Distinguished Scholar Award • N/A • TBD • Current - 01/10/2022

Decision not yet made

Sir Henry Wellcome Fellowship • Wellcome Trust & University of Oxford • UK • 01/02/2026 - 01/06/2022

300,000 GBP towards my current research • Collaboration between groups of Rachel Wilson, Wei Lee, Scott Waddell and Jan Drugowitsch • Also accepted as Life Science Research Foundation fellow

EMBO fellow • European Molecular Biology Organization • Europe • 01/06/2022 - 01/04/2021

Also accepted as a International Human Frontier Science Program fellow

Herchel Smith PhD Scholarship • Herchel Smith Foundation • Cambridge, UK • 30/09/2019 - 01/08/2015

Boehringer Ingelheim PhD Scholarship • Boehringer Ingelheim Foundation • European • 01/08/2018 - 01/08/2016

Education

Neuroscience PhD • MRC LMB, University of Cambridge • Cambridge, UK • 30/02/2021 - 01/09/2015

PhD student with Dr. Greg Jefferis • **Thesis**: The lateral horn, a brain region in the fly, primes innate olfactory behaviours by combining patterns of second-order olfactory projection neuron activity. In my work, I developed tools and analyses, and reconstructed neural networks from electron microscopy data, in order to better understand this brain region and how memory systems interact with it • Neuroinformatics, data science, R programming • **Awards:** Honorary Vice Chancellor's Award, MRC LMB Max Perutz Prize 2019, Winner of the British Neuroscience Association Postgraduate Prize 2020

Neuroscience BSc • University College London • London, UK • 01/07/2015 - 01/09/2012

1st class degree with honours • Modules taken listed on linkedIn • **Awards:** Burnstock Sessional Prize in Neuroscience BSc (ranked first in year) (2012–2013) (2013-2014) (2014-2015), Dean's list for the Faculty of Life Sciences (2013-2014) (2014-2015), Rob Clarke Award from the Society of Physiology

High School • Woodbridge High School • London, UK • 01/09/2012 - 01/09/2008

6 A*s at A-level, comprising: Physics, Chemistry, Mathematics, English Literature, Philosophy and Russian, and in a history related EPQ (level 3) project • 13 A*s at GCSE: English Literature, English Language, Mathematics, Statistics, Core Science, Additional Science, History, Philosophy, Geography, French, Italian, Russian and Expressive Arts. Jack Petchey Achievement Award

Presentations

Selected Talks: 4th Asia-Pacific Drosophila Neuroscience Conference (APDNC4) (2026) • CSHL Neurobiology of Drosophila (2025) • FlyWire Townhall (2025) • HMS Neurobiology Department Talk (2025) • CRANTb Connectomics Symposium (2025) • CSHL Neuronal Circuits (2024) • ECRO meeting (2019) • Boehringer Ingelheim Meeting (2018) • MPI Connectomics meeting (2017) • ECRO meeting (2017) • Boehringer Ingelheim Meeting (2017) • Brains and Roses (2016)

Selected Posters: HHMI Investigators' Meeting (2023) • UK Neural Computation (2019) • Boehringer Ingelheim Fonds communication workshop (2017) • Maggot Meeting (2016) • High-resolution circuit reconstruction meeting (2016) • LMB GSA Symposium (2016)

Leadership Experience

COSYNE 2026 abstract reviewer (2026) • Teaching at the San Juan Winter School for Connectomics (2025) • Attended HFP Leadership and Management Skills Course for Postdocs (2023) • President of BlueSci (01/10/2019 - 01/01/2016) • Officially mentored summer student (2018) • Officially mentored undergraduate student (01/05/2018 - 01/09/2017) • Officially mentored summer student (2017) • LMB graduate symposium lead organiser (2017) • LMB graduate symposium organiser (2016) • President of the UCLU Writer's Society (01/10/2015 - 01/10/2014) • Science Editor, Pi Magazine (01/10/2015 - 01/10/2014) • UCL iGEM 2014 Advisor (2014)

Other Experience

Research Visits: Janelia Research Campus (2019) | Worked in FlyEM, Dr. Gerry Rubin's Group, Worked on the hemibrain connectome • Janelia Research Campus (2016) | Worked with Dr. Albert Cardona's Group, Worked on the L1 larval connectome • University of Queensland Winter Scholarship, University of Queensland (2015) | Worked on tectal activity in zebrafish larvae, light sheet imaging, Dr. Ethan Scott's Group • Amgen Scholarship, Dept. Zoology, University of Cambridge (2014) | Worked on neuronal structural plasticity in *Drosophila melanogaster* larvae, Dr. Landgraf's group

Training: Paris Spring School in Neuroscience Techniques, Paris Descartes University (2018) | A course in Optical Imaging and Electrophysiological Recording in Neuroscience • UCL iGEM 2013 team member, University College London (2013) | Team member, cloning, cell culture, project planning, Gold medallist • Summer student in the biomolecular modelling laboratory, Cancer Research UK, London Research Institute (2013) | Student Placement with Dr. Tammy Cheng, python programming

Technical Skills: R • python • MATLAB • github • git • markdown • Illustrator • InDesign • communication • text editing • journalistic writing • creative writing • open access

Data and Code

Public Datasets:
- BANC Adult Fly Brain Connectome (DOI: 10.7910/DVN/8TFGGB) - Complete synaptic-resolution connectome of an adult female Drosophila melanogaster brain and ventral nerve cord

Open Source Software Contributions:
natverse (20 repositories): nat • nat.nblast • fafbseg • natverse • nat.examples • rcatmaid • mouselightr • elmr • hemibrainr • flycircuit • neuprintr • nat.ggplot • fishatlas • nat.h5reg • neuromorphr • neuronbridger • influencer • drvid • natverse_hugo • insectbrainr
wilson-lab (3 repositories): design-files • nat-tech • panels-matlab
htem (1 repositories): BANC-project
flyconnectome (4 repositories): 2020hemibrain_examples • bancr • hemibrain_olf_data • crantr

Zenodo Datasets:
- Connectome Influence Calculator (DOI: 10.5281/zenodo.17693838) - Downloads: 16
- Supplementary data to accompany Information flow, cell types and stereotypy in a full olfactory connectome (DOI: 10.5281/zenodo.4383228) - Downloads: 551
- Supplemental Files for Eckstein and Bates et al., Cell (2024) (DOI: 10.5281/zenodo.10593546) - Downloads: 954
- BAcTrace a new tool for retrograde tracing of neuronal circuits (DOI: 10.5281/zenodo.3797211) - Downloads: 1,491

Publications

A. S. Bates†‡, J. S. Phelps†‡, M. Kim†, H. H. Yang†, A. Matsliah, Z. Ajabi, E. Perlman, J. Blyth, B. J. Morris, L. J. Sizemore, A. Murray, S. Koskela, Z. Poon, A. Yazdan-Shahmorad, K. Eichler, A. Drubay, J. Brown, G. L. Ferreira, A. Santana-Cruz, R. I. Wilson, W.-C. A. Lee, J. T. Maniates-Selvin, T. Stürner, J. W. Truman, P. Schlegel, FlyWire Consortium, M. Zlatic, G. S. X. E. Jefferis, **Distributed control circuits across a brain-and-cord connectome.** *bioRxiv,* in review at Nature** (2025) [citations: 11]

N. Eckstein†, **A. S. Bates**†, A. Champion, M. Du, Y. Yin, P. Schlegel, A. K. Y. Lee, L. J. Pinto-Duartez, B. J. Pedersen, S. Valdes-Aleman, A. Dokaji, G. Sterne, K. Eichler, T. Schlegel, M.-J. Dolan, T. Grynhaus, D. Ramirez, D. C. Turner, A. Li, S. Farias, I. A. Meinertzhagen, S. C. Turaga, R. Dahmen, T. Wolff, K. Kruk, **A. S. Bates**†, G. S. X. E. Jefferis, D. D. Bock, FlyWire Consortium, **Neurotransmitter classification from electron microscopy images at synaptic sites in Drosophila melanogaster.** *Cell* 187 (10), 2574-2594. e23 (2024) [citations: 205]

P. Schlegel†, **A. S. Bates**†, T. Stürner, S. R. Jagannathan, N. Drummond, J. Hsu, L. A. Capogrosso, R. J. V. Roberts, M. Zimmer, I. F. M. Tamimi, S. Takemura, S. Berg, M. Costa, G. S. X. E. Jefferis, **Information flow, cell types and stereotypy in a full olfactory connectome.** *Elife* 10, e66018 (2021) [citations: 158]

A. S. Bates†, P. Schlegel†, R. J. V. Roberts, N. Drummond, I. F. M. Tamimi, R. Turnbull, X. Zhao, E. C. Marin, P. D. Popovici, S. Dhawan, A. Jamasb, A. Javier, F. Li, G. M. Rubin, S. Waddell, D. D. Bock, M. Costa, G. S. X. E. Jefferis, **Complete connectomic reconstruction of olfactory projection neurons in the fly brain.** *Curr. Biology* 30 (16), 3183-3199. e6 (2020) [citations: 207]

A. S. Bates†, J. D. Manton†, S. R. Jagannathan, M. Costa, P. Schlegel, T. Rohlfing, G. S. X. E. Jefferis, **The natverse, a versatile toolbox for combining and analysing neuroanatomical data.** *Elife* 9, e53350 (2020) [citations: 206]

S. Berg, I. R. Beckett, M. Costa, P. Schlegel, M. Januszewski, E. C. Marin, A. Nern, S. Preibisch, W. Qiu, S. Y. Takemura, A. M. C. Fragniere, A. S. Champion, D. Y. Adjavon, M. Cook, M. Gkantia, K. J. Hayworth, G. B. Huang, F. Kampf, W. T. Katz, Z. Lu, C. Ordish, T. Paterson, T. Stuerner, E. T. Trautman, C. R. Whittle, L. E. Burnett, J. Hoeller, F. Li, F. Loesche, B. J. Morris, T. Pietzsch, M. W. Pleijzier, V. Silva, Y. Yin, I. Ali, **A. S. Bates**, R. J. Beresford, J. Bogovic, P. Brooks, S. Cachero, B. S. Canino,

B. Chaisrisawatsuk, J. Clements, A. Crowe, I. de Haan Vicente, G. Dempsey, E. Dona, M. Dos Santos, M. Dreher, C. R. Dunne, K. Eichler, S. Finley-May, M. A. Flynn, I. Hameed, G. P. Hopkins, P. M. Hubbard, L. Kiassat, J. Kovalyak, S. A. Lauchie, M. Leonard, A. Lohff, K. D. Longden, C. A. Maldonado, I. Moitra, S. S. Moon, C. Mooney, E. J. Munnelly, N. Okeoma, D. J. Olbris, A. Pai, B. Patel, E. M. Phillips, S. M. Plaza, A. Richards, J. Rivas Salinas, R. J. V. Roberts, E. M. Rogers, A. L. Scott, L. A. Scuderi, P. Seenivasan, L. Serratosa Capdevila, C. Smith, R. Svirskas, S. Takemura, I. Tastekin, A. Thomson, L. Umayam, J. J. Walsh, H. Whittome, C. S. Xu, E. A. Yakal, T. Yang, A. Zhao, R. George, V. Jain, V. Jayaraman, W. Korff, G. W. Meissner, S. Romani, J. Funke, C. Knecht, S. Saalfeld, L. K. Scheffer, S. Waddell, G. M. Card, C. Ribeiro, M. B. Reiser, H. F. Hess, G. M. Rubin, G. S. X. E. Jefferis, **Sexual dimorphism in the complete connectome of the Drosophila male central nervous system.** *bioRxiv* 2025.10. 09.680999 (2025) [citations: 4]

A. Rayshubskiy, S. L. Holtz, **A. S. Bates**, Q. X. Vanderbeck, L. S. Capdevila, R. I. Wilson, **Neural circuit mechanisms for steering control in walking Drosophila.** *ELife* 13, RP102230 (2025) [citations: 101]

T. Stürner, P. Brooks, L. S. Capdevila, B. J. Morris, A. Javier, S. Namiki, I. Siwanowicz, C. J. Dallmann, FlyWire Consortium, **A. S. Bates**, G. S. X. E. Jefferis, **Comparative connectomics of Drosophila descending and ascending neurons.** *Nature* 1-15 (2025) [citations: 35]

D. Y. Adjavon, N. Eckstein, **A. S. Bates**, G. S. X. E. Jefferis, J. Funke, **Quantitative Attributions with Counterfactuals.** *bioRxiv* 2024.11. 26.625505 (2024)

P. K. Shiu, G. R. Sterne, N. Spiller, R. Franconville, A. Sandoval, J. Zhou, N. Simha, C. H. Kang, S. W. Oh, **A. S. Bates**, S. Dorkenwald, A. Matsliah, A. R. Sterling, S. Yu, C. E. McKellar, M. Costa, K. Eichler, G. S. X. E. Jefferis, G. M. Card, D. Sussillo, FlyWire Consortium, V. Jayaraman, **A Drosophila computational brain model reveals sensorimotor processing.** *Nature* 634 (8032), 210-219 (2024) [citations: 76]

A. Lin, R. Yang, S. Dorkenwald, A. Matsliah, A. R. Sterling, P. Schlegel, S. Yu, C. E. McKellar, K. Eichler, T. Wolff, D. Deutsch, S. Farias, M. Costa, **A. S. Bates**, N. Eckstein, J. Funke, G. S. X. E. Jefferis, FlyWire Consortium, **Network statistics of the whole-brain connectome of Drosophila.** *Nature* 634 (8032), 153-165 (2024) [citations: 111]

P. Schlegel, Y. Yin, **A. S. Bates**, S. Dorkenwald, K. Eichler, P. Brooks, D. S. Han, M. Gkantia, M. dos Santos, E. J. Munnelly, G. Sterne, Z. Wang, N. Doyle, E. Perlman, S. Molina-Obando, FlyWire Consortium, A. Matsliah, S. Yu, C. E. McKellar, A. R. Sterling, M. Costa, N. Eckstein, J. Funke, G. S. X. E. Jefferis, **Whole-brain annotation and multi-connectome cell typing of Drosophila.** *Nature* 634 (8032), 139-152 (2024) [citations: 337]

S. Dorkenwald, A. Matsliah, A. R. Sterling, P. Schlegel, S. Yu, C. E. McKellar, A. Lin, M. Costa, K. Eichler, Y. Yin, W. Silversmith, C. Schneider-Mizell, C. S. Jordan, D. Brittain, A. Halageri, K. Kuehner, O. Ogedengbe, R. Morey, J. Gager, K. Kruk, E. Perlman, R. Yang, D. Deutsch, D. Bland, M. Sorek, R. Lu, T. Macrina, K. Lee, J. A. Bae, S. Mu, B. Nehoran, E. Mitchell, S. Popovych, J. Wu, Z. Jia, J. Phelps, C. Baker, M. Kim, N. Kemnitz, M. Mahalingam, G. Eberle, E. Nobles, V. Jain, M. Januszewski, **A. S. Bates**, N. Eckstein, J. Funke, F. Collman, D. D. Bock, G. S. X. E. Jefferis, H. S. Seung, M. Murthy, FlyWire Consortium, **Neuronal wiring diagram of an adult brain.** *Nature* 634 (8032), 124-138 (2024) [citations: 483]

H. Lee, **A. S. Bates**, S. Callier, M. Chan, N. Chambwe, A. Marshall, M. B. Terry, J. Sauder, W. K. Chung, **Analysis and optimization of equitable US cancer clinical trial center access by travel time.** *JAMA oncology* 10 (5), 652-657 (2024) [citations: 14]

P. Singh, S. Goyal, S. Gupta, S. Garg, A. Tiwari, V. Rajput, **A. S. Bates**, C. J. Potter, N. Gupta, **Combinatorial encoding of odors in the mosquito antennal lobe.** *Nature Comm.* 14 (1), 3539 (2023) [citations: 17]

N. Eckstein, H. Bukhari, **A. S. Bates**, G. S. X. E. Jefferis, J. Funke, **Discriminative attribution from paired images.** *Euro. Conf. on Computer Vision* 406-422 (2022) [citations: 8]

F. Li, J. W. Lindsey, E. C. Marin, N. Otto, M. Dreher, G. Dempsey, I. Stark, **A. S. Bates**, M. Pleijzier, P. Schlegel, A. Nern, S. Takemura, N. Eckstein, T. Wolff, R. J. V. Roberts, G. M. Rubin, S. Berg, D. D. Bock, A. Litwin-Kumar, M. Murthy, G. S. X. E. Jefferis, **The connectome of the adult Drosophila mushroom body provides insights into function.** *Elife* 9, e62576 (2020) [citations: 381]

S. Cachero, M. Gkantia, **A. S. Bates**, S. Frechter, L. Blackie, A. McCarthy, P. Sten-Domrose, G. S. X. E. Jefferis, **BAcTrace, a tool for retrograde tracing of neuronal circuits in Drosophila.** *Nature methods* 17 (12), 1254-1261 (2020) [citations: 45]

L. K. Scheffer, C. S. Xu, M. Januszewski, Z. Lu, S. Takemura, K. J. Hayworth, G. B. Huang, K. Shinomiya, J. Maitlin-Shepard, S. Berg, J. Clements, P. M. Hubbard, W. T. Katz, L. Umayam, T. Zhao, D. Ackerman, T. Blakely, J. Bogovic, T. Dolafi, D. Kainmueller, T. Kawase, K. A. Khairy, L. Leavitt, P. H. Li, L. Lindsey, N. Neubarth, D. J. Olbris, H. Otsuna, E. T. Trautman, M. Ito, **A. S. Bates**, J. Goldammer, T. Wolff, R. Svirskas, P. Schlegel, E. Neace, C. J. Knecht, C. X. Alvarado, D. A. Bailey, S. Ballinger, J. A. Borycz, B. S. Canino, N. Cheatham, M. Cook, M. Dreher, O. Duclos, B. Eubanks, K. Fairbanks, S. Finley, N. Forknall, A. Francis, G. P. Hopkins, E. M. Joyce, S. Kim, N. A. Kirk, J. Kovalyak, S. A. Lauchie, A. Lohff, C. Maldonado, E. A. Manley, S. McLin, C. Mooney, M. Ndama, O. Ogundeyi, N. Okeoma, C. Ordish, N. Padilla, C. M. Patrick, T. Paterson, E. E. Phillips, E. M. Phillips, N. Rampally, C. Ribeiro, M. K. Robertson, J. T. Rymer, S. M. Ryan, M. Sammons, A. K. Scott, A. L. Scott, A. Shinomiya, C. Smith, K. Smith, N. L. Smith, M. A. Sobeski, A. Suleiman, J. Swift, S. Takemura, I. Talebi, D. Tarnogorska, E. Tenshaw, T. Tokhi, J. J. Walsh, T. Yang, J. A. Horne, F. Li, R. Parekh, P. K. Rivlin, V. Jayaraman, M. Costa, G. S. X. E. Jefferis, K. Ito, S. Saalfeld, R. George, I. Meinertzhagen, G. M. Rubin, H. F. Hess, V. Jain, S. M. Plaza, **A connectome and analysis of the adult Drosophila central brain.** *eLife* 9, e57443 (2020) [citations: 1114]

E. C. Marin, L. Büld, M. Theiss, T. Sarkissian, R. J. V. Roberts, R. Turnbull, I. F. M. Tamimi, M. W. Pleijzier, W. J. Laursen, N. Drummond, P. Schlegel, **A. S. Bates**, F. Li, M. Landgraf, M. Costa, D. D. Bock, P. A. Garrity, G. S. X. E. Jefferis, **Connectomics analysis reveals first-, second-, and third-order thermosensory and hygrosensory neurons in the adult Drosophila brain.** *Curr. Biology* 30 (16), 3167-3182. e4 (2020) [citations: 106]

N. Otto, M. W. Pleijzier, I. C. Morgan, A. J. Edmondson-Stait, K. J. Heinz, I. Stark, G. Dempsey, M. Ito, I. Kapoor, J. Hsu, P. M. Schlegel, **A. S. Bates**, L. Feng, M. Costa, K. Ito, D. D. Bock, G. M. Rubin, A. Litwin-Kumar, S. Waddell, **Input connectivity reveals additional heterogeneity of dopaminergic reinforcement in Drosophila.** *Curr. Biology* 30 (16), 3200-3211. e8 (2020) [citations: 80]

S. Frechter, **A. S. Bates**, S. Tootoonian, M.-J. Dolan, J. Manton, A. R. Jamasb, J. Kohl, D. D. Bock, G. S. X. E. Jefferis, **Functional and anatomical specificity in a higher olfactory centre.** *eLife* 8, e44590 (2019) [citations: 115]

M.-J. Dolan, S. Frechter, **A. S. Bates**, C. Dan, P. Huoviala, R. J. Roberts, P. Schlegel, S. Dhawan, R. Tabano, H. Dionne, C. Christoforou, K. Close, B. Sutcliffe, B. Giuliani, F. Li, M. Costa, G. Ihrke, G. W. Meissner, D. D. Bock, Y. Aso, G. M. Rubin, G. S. Jefferis, **Neurogenetic dissection of the Drosophila lateral horn reveals major outputs, diverse behavioural functions, and interactions with the mushroom body.** *Elife* 8, e43079 (2019) [citations: 167]

P. H. Li, L. F. Lindsey, M. Januszewski, Z. Zheng, **A. S. Bates**, I. Taisz, M. Tyka, M. Nichols, F. Li, E. Perlman, J. Ros, C. Bosch, M. Fetter, D. D. Bock, D. D. Bock, G. S. X. E. Jefferis, V. Jain, **Automated reconstruction of a serial-section EM Drosophila brain with flood-filling networks and local realignment.** *bioRxiv* 605634 (2019) [citations: 105]

M.-J. Dolan, G. Belliart-Guérin, **A. S. Bates**, S. Frechter, A. Lampin-Saint-Amaux, Y. Aso, R. J. Roberts, P. Schlegel, A. Wong, A. Hammad, D. D. Bock, G. M. Rubin, T. Preat, P.-Y. Plaçais, G. S. X. E. Jefferis, **Communication from learned to innate olfactory processing centers is required for memory retrieval in Drosophila.** *Neuron* 100 (3), 651-668. e8 (2018) [citations: 117]

P. Huoviala, M.-J. Dolan, F. M. Love, P. Myers, S. Frechter, S. Namiki, **A. S. Bates**, R. J. Roberts, E. H. Crosetti, P. Schlegel, F. Li, G. M. Rubin, D. D. Bock, H. Tanimoto, G. S. X. E. Jefferis, **Neural circuit basis of aversive odour processing in Drosophila from sensory input to descending output.** *bioRxiv* 394403 (2018) [citations: 49]

† denotes first author
‡ denotes corresponding author

Review Articles

A. S. Bates, G. S. X. E. Jefferis, **Systems neuroscience: Auditory processing at synaptic resolution.** *Curr. Biology* 32 (15), R830-R833 (2022) [citations: 1]
A. S. Bates, J. Janssens, G. S. X. E. Jefferis, S. Aerts, **Neuronal cell types in the fly: single-cell anatomy meets single-cell genomics.** *Curr. opinion in neurobiology* 56, 125-134 (2019) [citations: 72]

Referees

Postdoc Supervisor: Prof. Rachel Wilson, Harvard Medical School, Rachel_Wilson@hms.harvard.edu **PhD Supervisor:** Dr. Gregory Jefferis, MRC Laboratory of Molecular Biology, Cambridge, jefferis@mrc-lmb.cam.ac.uk **Key Collaborator:** Prof. Wei-Chung Allen Lee, Harvard Medical School, Wei-Chung_Lee@hms.harvard.edu **BSc Tutor:** Dr. Marco Beato, UCL Neuroscience, m.beato@ucl.ac.uk **Supervisee:** Serene Dhawan, Princeton PhD student, serenedhawan@gmail.com

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