

Graeme Wilkin - Curriculum Vitae

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| Position | Lecturer | Citizenship | Australian |
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| | | Website | https://graemewilkin.github.io |
| | | ORCID | https://orcid.org/0000-0002-1504-7720 |
| | | Google | Google Scholar Profile |

Personal Profile

I use a range of techniques from differential geometry, geometric analysis and algebraic geometry to study moduli spaces in gauge theory, with particular emphasis on moduli spaces of Higgs bundles and quiver varieties. I have proved new results in Morse theory with a view to computing topological invariants of these moduli spaces, as well as understanding the algebraic structures that arise on the associated Morse complex. In my work I have shown that these structures have a number of surprising connections with Nakajima's constructions in Geometric Representation Theory.

Employment History

Aug 2019 - present - [University of York](#)
Lecturer

Jul 2011 - Jun 2019 - [National University of Singapore](#)
Assistant Professor

Aug 2009 - Jun 2011 - [University of Colorado](#)
Burnett Meyer Postdoctoral Instructor

Jul 2006 - Jun 2009 - [Johns Hopkins University](#)
J.J. Sylvester Assistant Professor

Education

2001-2006 PhD in Mathematics - [Brown University](#)
Thesis title An analytic stratification of the space of Higgs bundles
Thesis Advisor Georgios Daskalopoulos

1994-1999 B.Sc. (Hons) / B. Eng. (Hons) - [University of Melbourne](#)
First class honours in Mathematics
First class honours in Electrical Engineering

Publications

1. G. Wilkin, *Morse theory for the space of Higgs bundles*, **Communications in Analysis and Geometry**, Vol. 16, No. 2 (2008), pp283-332.
DOI: [dx.doi.org/10.4310/CAG.2008.v16.n2.a2](https://doi.org/10.4310/CAG.2008.v16.n2.a2), Arxiv: [0611113](https://arxiv.org/abs/0611113)
2. G. Wilkin, *Homotopy groups of moduli spaces of stable quiver representations*, **International Journal of Mathematics**, Vol. 21, No. 9 (2010), pp1219-1238.
DOI: doi.org/10.1142/S0129167X1000646X, Arxiv: [0901.4156](https://arxiv.org/abs/0901.4156)
3. G. Daskalopoulos, R. Wentworth, G. Wilkin, *Cohomology of $SL(2, \mathbb{C})$ character varieties and the action of the Torelli group*, **Asian Journal of Mathematics**, Vol. 14, No. 3 (2010), pp359-384.
DOI: [dx.doi.org/10.4310/AJM.2010.v14.n3.a5](https://doi.org/10.4310/AJM.2010.v14.n3.a5), Arxiv: [0808.0131](https://arxiv.org/abs/0808.0131)
4. I. Biswas, G. Wilkin, *Morse theory for the space of Higgs G -bundles*, **Geometriae Dedicata**, Vol. 149, No. 1 (2010), pp189-203.
DOI: doi.org/10.1007/s10711-010-9476-9, Arxiv: [1002.1108](https://arxiv.org/abs/1002.1108)
5. G. Daskalopoulos, J. Weitsman, R. Wentworth, G. Wilkin, *Morse theory and hyperkähler Kirwan surjectivity for Higgs bundles*, **Journal of Differential Geometry**, Vol. 87, No. 1 (2011), pp81-116.
DOI: doi.org/10.4310/jdg/1303219773, Arxiv: [0701560](https://arxiv.org/abs/0701560)
6. M. Harada, G. Wilkin, *Morse theory of the moment map for representations of quivers*, **Geometriae Dedicata**, Vol. 150, No. 1 (2011), pp307-353.
DOI: doi.org/10.1007/s10711-010-9508-5, Arxiv: [0807.4734](https://arxiv.org/abs/0807.4734)
7. R. Wentworth, G. Wilkin, *Morse theory and stable pairs*, **Variational Problems in Differential Geometry**, pp142-181, London Math. Soc. Lecture Note Ser., 394, Cambridge Univ. Press, Cambridge, 2012.
DOI: doi.org/10.1017/CBO9780511863219.009, Arxiv: [1002.3124](https://arxiv.org/abs/1002.3124)
8. S. Bradlow, G. Wilkin, *Morse theory, Higgs fields and Yang-Mills-Higgs functionals*, **Journal of Fixed Point Theory and Applications**, Vol. 11, No. 1 (2012), pp1-41.
DOI: doi.org/10.1007/s11784-012-0073-4, Arxiv: [1308.1460](https://arxiv.org/abs/1308.1460)
9. R. Wentworth, G. Wilkin, *Cohomology of $U(2,1)$ representation varieties of surface groups*, **Proceedings of the London Mathematical Society**, Vol. 106, No. 2 (2013), pp445-476.
DOI: doi.org/10.1112/plms/pds048, Arxiv: [1109.0197](https://arxiv.org/abs/1109.0197)
10. I. Biswas, G. Wilkin, *Anti-holomorphic isometries of hyperkähler manifolds and branes*, **Journal of Geometry and Physics**, Vol. 88 (2015), pp52-55.
DOI: doi.org/10.1016/j.geomphys.2014.11.001, Arxiv: [1410.6616](https://arxiv.org/abs/1410.6616)
11. G. Wilkin, *Moment map flows and the Hecke correspondence for quivers*, **Advances in Mathematics**, Vol. 320 (2017), pp730-794.
DOI: doi.org/10.1016/j.aim.2017.09.011, Arxiv: [1307.3728](https://arxiv.org/abs/1307.3728)
12. G. Daskalopoulos, C. Mese, G. Wilkin, *Higgs bundles over cell complexes and representations of finitely presented groups*, **Pacific Journal of Mathematics**, Vol. 296-1 (2018), pp31-55.
DOI: doi.org/10.2140/pjm.2018.296.31, Arxiv: [1605.04625](https://arxiv.org/abs/1605.04625)
13. S. Kim, G. Wilkin, *Analytic convergence of harmonic metrics for parabolic Higgs bundles*, **Journal of Geometry and Physics**, Vol. 127 (2018), pp55-67.
DOI: doi.org/10.1016/j.geomphys.2018.01.023, Arxiv: [1705.08065](https://arxiv.org/abs/1705.08065)
14. N. Ho, G. Wilkin, S. Wu, *Higgs bundles on a nonorientable manifold*, **Communications in Analysis and Geometry**, Vol. 26, No. 4 (2018), pp857-886.
DOI: doi.org/10.4310/CAG.2018.v26.n4.a6, Arxiv: [1211.0746](https://arxiv.org/abs/1211.0746)

15. G. Wilkin, *Equivariant Morse theory for the norm-square of a moment map on a variety*, **International Mathematics Research Notices**, Vol. 2019, No. 15, pp4730-4763.
DOI: doi.org/10.1093/imrn/rnx286, Arxiv: [1702.05223](https://arxiv.org/abs/1702.05223)
16. N. Ho, G. Wilkin, S. Wu, *Conditions of smoothness of moduli spaces of flat connections and of representation varieties*, **Mathematische Zeitschrift**, Vol. 293, No. 1-2 (2019), pp1-12.
DOI: doi.org/10.1007/s00209-018-2158-2, Arxiv: [1610.09987](https://arxiv.org/abs/1610.09987)
17. M. Pflaum, G. Wilkin, *Equivariant control data and neighbourhood deformation retractions*, **Methods and Applications of Analysis (special issue in memory of John Mather)**, Vol. 26, No. 1 (2019), pp13-36.
DOI: dx.doi.org/10.4310/MAA.2019.v26.n1.a2, Arxiv: [1706.09539](https://arxiv.org/abs/1706.09539)
18. V. Mathai, G. Wilkin, *Fractional quantum numbers via complex orbifolds*, **Letters in Mathematical Physics**, Vol. 109, No. 11 (2019), pp2473-2484.
DOI: doi.org/10.1007/s11005-019-01190-y, Arxiv: [1811.11748](https://arxiv.org/abs/1811.11748)
19. G. Wilkin, *The reverse Yang-Mills-Higgs flow in a neighbourhood of a critical point*, **Journal of Differential Geometry**, Vol. 115, No. 1 (2020), pp111-174.
DOI: doi.org/10.4310/jdg/1586224842, Arxiv: [1605.05970](https://arxiv.org/abs/1605.05970)
20. O. Garcia-Prada, G. Wilkin, *Action of the mapping class group on character varieties and Higgs bundles*, **Documenta Mathematica**, Vol. 25 (2020), pp841-868.
DOI: doi.org/10.25537/dm.2020v25.841-868, Arxiv: [1612.02508](https://arxiv.org/abs/1612.02508)
21. V. Mathai, G. Wilkin, *Fractional Quantum Numbers, Complex Orbifolds and Noncommutative Geometry*, **Journal of Physics A: Mathematical and Theoretical**, Vol. 54 (2021), No. 31.
DOI: doi.org/10.1088/1751-8121/ac0b8c, Arxiv: [2004.06666](https://arxiv.org/abs/2004.06666)

Preprints

22. G. Wilkin, *Local behaviour of an analytic function near the unstable set of a critical point*, submitted.
Arxiv: [1904.08045](https://arxiv.org/abs/1904.08045)
23. G. Wilkin, *Convolution for quiver varieties via cup product on a Morse complex*, submitted.
Arxiv: [2305.05545](https://arxiv.org/abs/2305.05545)

Edited volumes

1. R. Wentworth, G. Wilkin (editors), [The Geometry, Topology and Physics of Moduli Spaces of Higgs Bundles](#), Lecture Notes Series Volume 36, Institute for Mathematical Sciences, National University of Singapore.
DOI: doi.org/10.1142/10683

Invited Talks

Lecture series

- July 2018** *An introduction to Morse theory* (6 hour lecture series)
Institute for Geometry and its Applications, University of Adelaide

May 2016 *Algebraic classification of Yang-Mills-Higgs flow lines* (3 hour lecture series)
KIAS workshop on Higgs bundles and related topics

July 2015 *Lectures on the moduli space of Higgs bundles* (8 hour lecture series)
University of Science and Technology China

Conference/Seminar talks

Dec 7, 2022 *Hitchin systems from curves in an ALE space*
University of Aberdeen Topology Seminar

Sep 17, 2022 *The Morse complex on singular spaces*
A celebration of Karen Uhlenbeck's 80th birthday
IAS, Princeton

May 18, 2022 *Partial compactifications of ALE hyperkähler four manifolds of type A*
UCL Geometry Seminar

Mar 18, 2022 *The Morse complex on the space of representations of a quiver with relations*
SIAM conference on Analysis of PDEs
Berlin, Germany

Jun 23, 2021 *Algebraic and geometric classification of Yang-Mills-Higgs flow lines*
Conference "8th European Congress of Mathematics"
Portorož, Slovenia

Nov 24, 2020 *Equivariant Morse theory on singular spaces*
Rutgers University Geometric Analysis Seminar

May 13, 2020 *The topology and geometry of spaces of Yang-Mills-Higgs flow lines*
Conference "Yorkshire-Durham Geometry Day"
University of Leeds

Feb 11, 2020 *Morse theory on singular spaces*
University of Oxford Geometry and Analysis Seminar

Jan 13, 2020 *Morse theory on singular spaces*
University of Edinburgh Geometry Seminar (EDGE)

Jul 26, 2019 *Representations of the Heisenberg algebra on a singular Morse complex*
University of Adelaide Differential Geometry Seminar

Dec 20, 2018 *Representations of the Heisenberg algebra on a singular Morse complex*
Conference "Character Varieties and Topological Quantum Field Theory"
University of Auckland

Oct 25, 2018 *Representations of the Heisenberg algebra on a singular Morse complex*
Conference "Recent Developments in Higgs Theory"
Laboratory of Mirror Symmetry, Higher School of Economics, Moscow

- Aug 3, 2018** *The topology and geometry of spaces of Yang-Mills-Higgs flow lines*
University of Melbourne Pure Mathematics Seminar
- Jul 31, 2018** *The topology and geometry of spaces of Yang-Mills-Higgs flow lines*
University of Queensland Pure Mathematics Seminar
- Jul 27, 2018** *The topology and geometry of spaces of Yang-Mills-Higgs flow lines*
University of Adelaide Differential Geometry Seminar
- Sep 27, 2017** *Equivariant Morse theory on singular spaces*
Stanford University Geometry Seminar
- May 15, 2017** *Equivariant Morse theory on singular spaces*
University of Maryland Geometry Seminar
- May 9, 2017** *Equivariant Morse theory on singular spaces*
Brown University Geometry Seminar
- May 6, 2017** *The reverse Yang-Mills-Higgs flow in a neighbourhood of a critical point*
Conference "Geometry and Physics of Augmented Bundles"
University of Illinois, Urbana-Champaign
- Feb 21, 2017** *The reverse Yang-Mills-Higgs flow in a neighbourhood of a critical point*
University of Colorado Geometry Seminar
- Jun 16, 2016** *The reverse Yang-Mills-Higgs flow in a neighbourhood of a critical point*
Conference "New perspectives on Higgs bundles, branes and quantisation"
Simons Centre for Geometry and Physics
- Jan 11, 2016** *An algebraic description of Yang-Mills-Higgs flow lines*
Conference "Vector Bundles on Algebraic Curves"
Centre Interfacultaire Bernoulli, Ecole polytechnique federale de Lausanne
- Oct 9, 2015** *Classification of Yang-Mills flow lines*
Conference "50 years of the Narasimhan-Seshadri theorem"
Chennai Mathematical Institute
- Aug 5, 2015** *Morse theory on singular spaces*
ISAAC 2015 Conference, Special Session on Complex Geometry
University of Macau
- Jun 12, 2015** *Morse theory for Higgs bundles*
2015 joint meeting of the AMS and EMS
Special Session on Higgs Bundles and Character Varieties
University of Porto
- Sep 25, 2014** *Topology of moduli spaces of Higgs bundles*
University of Science and Technology China Geometry Seminar

- Jun 17, 2014** *Moment map flows and the Hecke correspondence for quivers*
Workshop on the Geometry and Physics of Moduli Spaces
ICMAT Madrid
- Nov 4, 2013** *Moment map flows and the Hecke correspondence for quivers*
Workshop on Geometry and Representation Theory
University of Hong Kong
- Sep 2, 2013** *Moment map flows and the Hecke correspondence for quivers*
University of Maryland, Geometry and Topology Seminar
- Jul 2, 2013** *Moment map flows and the Hecke correspondence for quivers*
Asian Mathematical Conference
Busan, South Korea
- Mar 1, 2013** *Moment map flows and the Hecke correspondence for quivers*
Conference on Differential and Algebraic Geometry related to bundles
Tata Institute for Fundamental Research
- Sep 26, 2012** *Moment map flows and the Hecke correspondence for quivers*
National Tsinghua University Geometry and Topology Seminar
- Feb 21, 2012** *Morse theory and Nakajima quiver varieties*
University of Colorado Geometry Seminar
- Feb 20, 2012** *Some applications of Morse theory*
University of Colorado Colloquium
- Feb 7, 2012** *Topology of moduli spaces of $U(2, 1)$ Higgs bundles*
Workshop on moduli spaces of representations
Institut Henri Poincare
- Sep 19, 2011** *Cohomology of Higgs bundle moduli spaces*
National Tsinghua University Geometry and Topology Seminar
- Apr 15, 2011** *Moment map flows and the Hecke correspondence for quivers*
University of Wisconsin Geometry and Topology Seminar
- Mar 7, 2011** *Moment map flows and the Hecke correspondence for quivers*
National University of Singapore
- Feb 10, 2011** *Moment map flows and the Hecke correspondence for quivers*
University of Sydney
- Jan 31, 2011** *Moment map flows and the Hecke correspondence for quivers*
University of Missouri
- Dec 1, 2010** *Moment map flows and the Hecke correspondence for quivers*
Brown University Geometry and Topology Seminar
- Jun 17, 2010** *Morse theory and stable pairs*
Conference "Vector Bundles on Algebraic Curves"
Instituto Superior Tecnico, Universidade de Lisboa
- May 13, 2010** *Morse theory and stable pairs*
Workshop on Bundles on Projective Varieties
Tata Institute for Fundamental Research
- Mar 23, 2010** *Morse theory and stable pairs*
Duke University Geometry and Topology Seminar

Grants

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| Aug 2018 - Jun 2019 | Geometry and topology of singular spaces NUS Academic Research Fund Tier 1 Grant |
| Sep 2014 - Jan 2018 | Morse-Kirwan theory on singular spaces NUS Academic Research Fund Tier 1 Grant |
| Aug 2011 - Dec 2014 | Geometry and Topology of moduli spaces of Higgs bundles and quiver varieties NUS Startup Grant |

Conference Organisation

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| Aug 1-19, 2016 | Geometry, Topology and Dynamics of Moduli Spaces Institute for Mathematical Sciences, Singapore A three week program consisting of two conferences and a week for collaborative work. 96 participants, including 17 graduate students. |
| Jul 7-Aug 29, 2014 | The Geometry, Topology and Physics of Moduli Spaces of Higgs Bundles Institute for Mathematical Sciences, Singapore An eight week program consisting of a summer school, two conferences and time for collaborative work. 136 participants, including 29 graduate students. |
| Apr 14-Jul 11, 2014 | Research Term on the Geometry and Physics of Moduli Spaces ICMAT, Madrid Three month program including a summer school and two workshops. |
| Aug 19-26, 2006 | The topology of hyperkähler quotients Banff International Research Station Research in Teams Workshop |

Student Supervision

Supervision of graduate students

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| Samuel Engleman | University of York August 2022-present |
| Teo Yi Han | National University of Singapore Graduated June 2020 Supported by a National University of Singapore Research Scholarship Thesis title: <i>Branes in the moduli space of Higgs bundles</i> Currently employed as an Instructor at the National University of Singapore |
| Semin Kim | Brown University (co-supervisor) Graduated May 2017 Thesis title: <i>Harmonic Maps and the Moduli of Higgs Bundles</i> Currently employed as a software engineer at Bloomberg, New York |

Supervision of final year project students at the National University of Singapore

These students spent one year working on an undergraduate thesis under my supervision

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| 2017-2018 | Chu Khoon Hwa Toh Teck Wei Doron Loh | <i>Constructing the Central Fibre of the Hitchin Fibration</i> <i>Poincare's Last Gift in Symplectic Geometry</i> <i>Exactly Solved Models in Statistical Mechanics</i> |
| 2016-2017 | Nicholas Chin Cheng Hoong | <i>Morse Theory on Hilbert Manifolds</i> |
| 2015-2016 | Goh Jin Wen Ho Ren An | <i>Fractals and Geometric Measure Theory</i> <i>The Mountain Pass Theorem and its Applications</i> |
| 2014-2015 | Tam Keng Seng | <i>Tropical Geometry and Auction Prices</i> |

Refereeing

I have refereed for a number of journals, including

- *Journal of the American Mathematical Society*
- *Duke Mathematical Journal*
- *Advances in Mathematics*
- *Memoirs of the American Mathematical Society*
- *International Mathematics Research Notices*
- *Selecta Mathematica*
- *Communications in Analysis and Geometry*
- *Asian Journal of Mathematics*
- *Advances in Calculus of Variations*
- *Quarterly Journal of Mathematics*
- *Journal of Geometry and Physics*
- *Pure and Applied Mathematics Quarterly*
- *Geometricae Dedicata*
- *International Journal of Mathematics*
- *Journal of the Australian Mathematical Society*, and
- *Bulletin of the Australian Mathematical Society*.