

Graeme Wilkin - Curriculum Vitae

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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 - [University of York](#)
present *Lecturer*

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

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

Jul 2006 - [Johns Hopkins University](#)
Jun 2009 *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*, to appear in **International Mathematics Research Notices** (accepted 1 November, 2017).
DOI: doi.org/10.1093/imrn/rnx286, Arxiv: [1702.05223](https://arxiv.org/abs/1702.05223)
16. G.Wilkin, *The reverse Yang-Mills-Higgs flow in a neighbourhood of a critical point*, to appear in **Journal of Differential Geometry** (accepted 23 March, 2018).
Arxiv: [1605.05970](https://arxiv.org/abs/1605.05970)
17. N.Ho, G.Wilkin, S.Wu, *Conditions of smoothness of moduli spaces of flat connections and of representation varieties*, to appear in **Mathematische Zeitschrift** (accepted 10 September, 2018).
DOI: doi.org/10.1007/s00209-018-2158-2, Arxiv: [1610.09987](https://arxiv.org/abs/1610.09987)
18. M. Pflaum, G. Wilkin, *Equivariant control data and neighbourhood deformation retractions*, to appear in **Methods and Applications of Analysis (special issue in memory of John Mather)** (accepted 29 January, 2019).
Arxiv: [1706.09539](https://arxiv.org/abs/1706.09539)
19. V. Mathai, G. Wilkin, *Fractional quantum numbers via complex orbifolds*, to appear in **Letters in Mathematical Physics** (accepted 24 June, 2019).
DOI: doi.org/10.1007/s11005-019-01190-y, Arxiv: [1811.11748](https://arxiv.org/abs/1811.11748)

Preprints

20. O.Garcia-Prada, G.Wilkin, *Action of the mapping class group on character varieties and Higgs bundles*, submitted.
Arxiv: [1612.02508](https://arxiv.org/abs/1612.02508)
21. 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)

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 | <i>An introduction to Morse theory</i> (6 hour lecture series)
Insitute for Geometry and its Applications, University of Adelaide |
| May 2016 | <i>Algebraic classification of Yang-Mills-Higgs flow lines</i> (3 hour lecture series)
KIAS workshop on Higgs bundles and related topics |
| July 2015 | <i>Lectures on the moduli space of Higgs bundles</i> (8 hour lecture series)
University of Science and Technology China |

Conference talks

- 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

- 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
- Aug 1-19, 2016** **Geometry, Topology and Dynamics of Moduli Spaces**
SGD120K grant to co-organise this program at the [Institute of Mathematical Sciences](#)
Additional USD48K funding from the NSF to support US participants
- Jul 7 - Aug 29, 2014** **The Geometry, Topology and Physics of Moduli Spaces of Higgs Bundles**
SGD200K grant to organise this program at the [Institute of Mathematical Sciences](#)
Additional USD54K funding from the NSF to support US participants

Conference Organisation

- 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

Semin Kim Brown University (co-supervisor)
Graduated May 2017
Thesis title: *Harmonic Maps and the Moduli of Higgs Bundles*
Currently employed as a software engineer at Bloomberg, New York

Teo Yi Han National University of Singapore
Expected to graduate in June 2020
Supported by a [National University of Singapore Research Scholarship](#)

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

2017-2018	Chu Khoo 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>

Departmental and other service to the mathematical community

- I have written 29 reviews for Mathematical Reviews.
- I have organised the Topology and Geometry seminar at the National University of Singapore from August 2013-June 2018.
- I have co-organised the graduate seminar at Brown University from 2003-2004.

Refereeing

I have refereed for a number of journals, including

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