

Graeme Wilkin - Curriculum Vitae

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		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

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)

Preprints

19. V. Mathai, G. Wilkin, *Fractional quantum numbers via complex orbifolds*, submitted.
Arxiv: [1811.11748](https://arxiv.org/abs/1811.11748)
20. 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)
Institute 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*
- *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*.