Graeme Wilkin - Curriculum Vitae

Position Lecturer
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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, Arxiv: 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
3. G.Daskalopoulos, R.Wentworth, G.Wilkin, *Cohomology of SL(2,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, Arxiv: 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
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
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
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
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
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
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
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
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
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
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

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

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

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

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

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

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

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

Preprints

22. G. Wilkin, *Local behaviour of an analytic function near the unstable set of a critical point*, submitted.
Arxiv: 1904.08045

23. G. Wilkin, *Convolution for quiver varieties via cup product on a Morse complex*, submitted.
Arxiv: 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)
Insitute 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* $\mathsf{U}(2,1)$ *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"
Instituo 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

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

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: *Branes in the moduli space of Higgs bundles*
Currently employed as an Instructor at the National University of Singapore

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

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

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 Americal 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*.