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# Dr Hari K Kunduri

Associate Professor

## General Information

Nationality Canadian.

## Research Interests

Mathematical physics: general relativity (in particular, mathematical theory of black holes), Riemannian geometry and applications.

## Education

- 2003–2007 **Ph.D. Mathematical Physics, University of Cambridge**, Department of Applied Mathematics and Theoretical Physics (DAMTP).
  - Advisor: Professor Malcolm J Perry.
- 2001–2002 **Certificate of Advanced Studies in Mathematics (Part III, Mathematics Tripos)**, DAMTP, University of Cambridge.
  - Graduated with Distinction
- 1997–2001 **BSc. (Hon) Physics and Mathematics, University of Toronto**.
  - Awarded Gold Medal in Physics (top student)

## Academic Positions

- 2017–present **Associate Professor**, Memorial University of Newfoundland, Department of Mathematics and Statistics.
- 2012–2017 **Assistant Professor (tenure track)**, Memorial University of Newfoundland, Department of Mathematics and Statistics.
- 2009–11 **Pacific Institute for the Mathematical Sciences Research Fellow**, University of Alberta.
- 2007–2009 **STFC Postdoctoral Research Fellow**, University of Cambridge, DAMTP.
- 2008–9 **Research Associate, Mathematics**, Clare College, Cambridge.
- 2006–7 **STFC Postdoctoral Research Fellow**, University of Nottingham.
- 2001 **NSERC Undergraduate Research Fellow**, University of Toronto.
- 2000 **Junior Research Fellow**, Canadian Institute for Theoretical Astrophysics.

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## Awards, External Funding and Scholarships

- 2012-18 **NSERC Discovery Grant - Individual**, Principal Investigator, Project Title: *Classification of Extremal Black Holes* (\$125 000 over 5 years ).
- 2015-17 **AARMS Collaborative Grant Holder**, Co-investigator, Project: *Theoretical and Mathematical aspects of black holes*(\$20 000 over 2 years).
- 2009–11 **Pacific Institute for the Mathematical Sciences Fellowship**, Principal Investigator (\$40 000 over 2 years).
- 2006–9 **United Kingdom Science & Technologies Facilities Council (STFC) Research Fellowship**, Principal Investigator (approx \$200 000 over 3 years).
- 2007 & 2009 & 2010 **Research Publications Highlights awards**, Classical and Quantum Gravity - see List of Publications.
- 2006–2008 **NSERC Postdoctoral Fellowship**, (Perimeter Institute, declined).
- 2002-2006 **Benefactor’s Scholarship**, St John’s College, University of Cambridge, Fully funded overseas student doctoral studentship.
- 2002 **NSERC Graduate Scholarship**, (declined).
- 2001 **James London Gold Medal in Physics**, University of Toronto.

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## Visiting Positions

- Fall 2017 **Visiting Associate Professor**, McMaster University, Department of Mathematics and Statistics.

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## Publications

### IN PRESS

- (45) A. Alae, M. Khuri and H. K. Kunduri, **Bounding Horizon Area by Angular Momentum, Charge, and Cosmological Constant in 5-Dimensional Minimal Supergravity**, (accepted by *Annales Henri Poincaré*).
- <https://arxiv.org/abs/1712.01764>.

### REFEREED PUBLICATIONS

- (44) H. K. Kunduri and J. Lucietti, **No static bubbling spacetimes in higher dimensional Einstein-Maxwell theory**, *Class. Quant. Grav.* **35** (2018) no.5, 054003.
- <https://arxiv.org/abs/1712.02668>.
- (43) A. Alae, M. Khuri and H. K. Kunduri, **Mass-Angular-Momentum Inequality For Black Ring Spacetimes**, *Phys. Rev. Lett.* **119** (2017) no.7, 071101.
- <https://arxiv.org/abs/1705.08799>.
- (42) I. Booth, H. K. Kunduri and A. O’Grady, **Unstable marginally outer trapped surfaces in static spherically symmetric spacetimes**, *Phys. Rev. D* **96** (2017) no.2, 024059.
- <https://arxiv.org/abs/1705.03063>.
- (41) G. Horowitz, H. .K. Kunduri and J. Lucietti, **Comments on Black Holes in Bubbling Spacetimes**, *JHEP* **1706** (2017) 048.
- <https://arxiv.org/abs/1704.04071>.

- (40) A. Alaei, M. Khuri, and H. K. Kunduri, **Relating Mass to Angular momentum and charge in five-dimensional minimal supergravity**, *Annales Henri Poincaré* **18** (2017) no.5, 1703.  
• <https://arxiv.org/abs/1608.06589>.
- (39) S. Gunasekaran, U. Hussain and H. K. Kunduri, **Soliton mechanics**, *Phys. Rev. D* **94** (2016) no.12, 124029.  
• <https://arxiv.org/abs/1609.08500>.
- (38) H. K. Kunduri and J. Lucietti, **Black lenses in string theory**, *Phys. Rev. D* **94** (2016) no.6, 064007.  
• <https://arxiv.org/abs/1605.01545>.
- (37) A. Alaei, M. Khuri, and H. K. Kunduri, **Proof of the mass-angular momenta inequality for  $U(1)^2$  invariant black holes with spherical topology**, *Adv. Theor. Math. Phys.* **20** (2016) 1397.  
• <https://arxiv.org/abs/1510.06974>.
- (36) U. Hussain, I. Booth and H. K. Kunduri, **Master equation as a radial constraint**, *Phys. Rev. D* **93** (2016) no.12, 123001.  
• <https://arxiv.org/abs/1512.00723>.
- (35) A. Alaei and H. K. Kunduri, **Remarks on mass and angular momenta for  $U(1)^2$ -invariant initial data**, (*J. Math. Phys.* **57**, no. 3, 032502 (2016)).  
• <https://arxiv.org/abs/1508.02337>.
- (34) I. Booth, M. Hunt, A. Palomo-Lozano and H. K. Kunduri, **Insights from Melvin-Kerr-Newman spacetimes**, *Class. Quant. Grav.* **32** (2015) 23, 235025  
• <https://arxiv.org/abs/1502.07388>.
- (33) A Alaei and H. K. Kunduri, **Proof of the local mass-angular momenta inequality for  $U(1)^2$  invariant black holes**, *Class. Quant. Grav.* **32** (2015) 16, 165020  
• <https://arxiv.org/abs/1503.03370>.
- (32) A Alaei and H. K. Kunduri, **Small deformations of extreme five dimensional Myers-Perry black hole initial data**, *Gen. Rel. Grav.* **47** (2015) 2, 13  
• <https://arxiv.org/abs/1407.0988>.
- (31) A. Alaei and H. K. Kunduri, **Mass functional for initial data in 4+1 dimensional space-time**, *Phys. Rev. D* **90** (2014) 124078  
• <https://arxiv.org/abs/1411.0609>.
- (30) H. K. Kunduri and J. Lucietti, **Supersymmetric Black Holes with Lens-Space Topology**, *Phys. Rev. Lett.* **113** (2014) 21, 211101  
• <https://arxiv.org/abs/1408.6083>.
- (29) H. K. Kunduri and J. Lucietti, **Black hole non-uniqueness via spacetime topology in five dimensions**, *JHEP* **1410** (2014) 82  
• <https://arxiv.org/abs/1407.8002>.
- (28) A. Alaei, H. K. Kunduri and E. Martinez-Pedroza, **Notes on maximal slices of five-dimensional black holes**, *Class. Quant. Grav.* **31** (2014) 055004  
• <https://arxiv.org/abs/1309.2613>.
- (27) H. K. Kunduri and J. Lucietti, **The first law of soliton and black hole mechanics in five dimensions**, *Class. Quant. Grav.* **31** (2014) 032001 (Fast Track Communication)  
• <https://arxiv.org/abs/1310.4810>.
- (26) H. K. Kunduri, J. Lucietti, **Classification of near-horizon geometries of extremal black holes**, *Living Rev. Rel.* **16** (2013) 8  
• <https://arxiv.org/abs/1306.2517>.

- (25) H. K. Kunduri and J. Lucietti, **Degenerate horizons, Einstein metrics, and Lens space bundles**, *J. Geom. Phys.* **86** (2014) 571  
• <https://arxiv.org/abs/1210.1268>.
- (24) H. K. Kunduri and J. Lucietti, **Extremal Sasakian horizons**, *Phys. Lett. B* **713** (2012) 308  
• <https://arxiv.org/abs/1204.5149>.
- (23) H. K. Kunduri, **Electrovacuum Near-horizon Geometries in Four and Five Dimensions**, *Class. Quant. Grav.* **28** (2011) 114010  
• <https://arxiv.org/abs/1104.5072>.
- (22) H. K. Kunduri and J. Lucietti, **Constructing near-horizon geometries in supergravities with hidden symmetry**, *JHEP* **1107** (2011) 107  
• <https://arxiv.org/abs/1104.2260>.
- (21) H. K. Kunduri and J. Lucietti, **An infinite class of extremal horizons in higher dimensions**, *Commun. Math. Phys.* **303** (2011) 31  
• <https://arxiv.org/abs/1002.4656>.
- (20) H. K. Kunduri and J. Lucietti, **Static near-horizon geometries in five dimensions**, *Class. Quant. Grav.* **26** (2009) 245010  
• <https://arxiv.org/abs/0907.0410>.
- (19) D. Kubiznak, H. K. Kunduri and Y. Yasui, **Generalized Killing-Yano equations in D=5 gauged supergravity**, *Phys. Lett. B* **678** (2009) 240  
• <https://arxiv.org/abs/0905.0722>.
- (18) H. K. Kunduri and J. Lucietti, **Uniqueness of near-horizon geometries of rotating extremal AdS(4) black holes**, *Class. Quant. Grav.* **26** (2009) 055019  
• <https://arxiv.org/abs/0812.1576> - Received 'Research Highlights' distinction.
- (17) H. K. Kunduri and J. Lucietti, **A classification of near-horizon geometries of extremal vacuum black holes**, *J. Math. Phys.* **50** (2009) 082502  
• <https://arxiv.org/abs/0806.2051>.
- (16) P. Figueras, H. K. Kunduri, J. Lucietti and M. Rangamani, **Extremal vacuum black holes in higher dimensions**, *Phys. Rev. D* **78** (2008) 044042  
• <https://arxiv.org/abs/0803.2998>.
- (15) G. Niz, A. Padilla and H. K. Kunduri, **Braneworld Isotropization and Magnetic Fields**, *JCAP* **0804** (2008) 012  
• <https://arxiv.org/abs/0801.3462>.
- (14) H. K. Kunduri and J. Lucietti, **Near-horizon geometries of supersymmetric AdS(5) black holes**, *JHEP* **0712** (2007) 015  
• <https://arxiv.org/abs/0708.3695>.
- (13) H. K. Kunduri, J. Lucietti and H. S. Reall, **Near-horizon symmetries of extremal black holes**, *Class. Quant. Grav.* **24** (2007) 4169  
• <https://arxiv.org/abs/0705.4214> - Received 'Research Highlights' distinction.
- (12) H. K. Kunduri, J. Lucietti and H. S. Reall, **Do supersymmetric anti-de Sitter black rings exist?**, *JHEP* **0702** (2007) 026  
• <http://arxiv.org/abs/hep-th/0611351>.
- (11) H. K. Kunduri, J. Lucietti and H. S. Reall, **Gravitational perturbations of higher dimensional rotating black holes: Tensor Perturbations**, *Phys. Rev. D* **74** (2006) 084021  
• <http://arxiv.org/abs/hep-th/0606076>.

- (10) H. K. Kunduri, J. Lucietti and H. S. Reall, **Supersymmetric multi-charge AdS(5) black holes**, JHEP **0604** (2006) 036  
 • <http://arxiv.org/abs/hep-th/0601156>.
- (9) P. Davis, H. K. Kunduri and J. Lucietti, **Special symmetries of the charged Kerr-AdS black hole of D = 5 minimal gauged supergravity**, Phys. Lett. B **628** (2005) 275  
 • <http://arxiv.org/abs/hep-th/0508169>.
- (8) H. K. Kunduri and J. Lucietti, **Three charge supertubes in type IIB plane wave backgrounds**, JHEP **0509** (2005) 014  
 • <http://arxiv.org/abs/hep-th/0506222>.
- (7) H. K. Kunduri and J. Lucietti, **Notes on non-extremal, charged, rotating black holes in minimal D = 5 gauged supergravity**, Nucl. Phys. B **724** (2005) 343  
 • <http://arxiv.org/abs/hep-th/0504158>.
- (6) H. K. Kunduri and J. Lucietti, **Integrability and the Kerr-(A)dS black hole in five dimensions**, Phys. Rev. D **71** (2005) 104021  
 • <http://arxiv.org/abs/hep-th/0502124>.
- (5) H. K. Kunduri and J. Lucietti, **Electrically charged dilatonic black rings**, Phys. Lett. B **609** (2005) 143  
 • <http://arxiv.org/abs/hep-th/0412153>.
- (4) A. Kumar and H. K. Kunduri, **Gravitational wave solutions in string and M-theory AdS backgrounds**, Phys. Rev. D **70** (2004) 104006  
 • <http://arxiv.org/abs/hep-th/0405261>.
- (3) S. Hervik, H. K. Kunduri and J. Lucietti, **Homogeneous plane-wave spacetimes and their stability**, Class. Quant. Grav. **21** (2004) 575  
 • <http://arxiv.org/abs/gr-qc/0310013>.

#### CONFERENCE PROCEEDINGS

- (2) H. K. Kunduri, J. Lucietti, **Infinite classes of degenerate horizon geometries in higher dimensions**, Proceedings of the Twelfth Marcel Grossmann Meeting on General Relativity, World Scientific, Singapore, 2013.
- (1) H. K. Kunduri, J. Lucietti and H. S. Reall, **Gravitational Perturbations of Higher Dimensional Rotating Black Holes**, Proceedings of the Eleventh Marcel Grossmann Meeting on General Relativity, edited by H. Kleinert, R.T. Jantzen and R. Ruffini, World Scientific, Singapore, 2008.

#### DISSERTATION

- (1) H. K. Kunduri, **Black Holes in Anti de Sitter spacetime, Black Rings, and Plane Waves**, University of Cambridge Ph.D Thesis, accepted October 2006, St John's College, 240 pp.

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## Teaching

2011-present **Memorial University of Newfoundland.**

- 2013,2018 *MATH 6111: Calculus on Manifolds*  
2017 *MATH 6230: Differentiable Manifolds and Riemannian Geometry*  
2012, 2016 *MATH 4130: General Relativity*  
2011-12, 2015 *MATH 3202: Vector Calculus*  
2015 *MATH 4230: Differential Geometry*  
2013-2015 *MATH 4310: Complex Function Analysis*  
2014,2016 *MATH 3161: Ordinary Differential Equations II*  
2014,2017 *MATH 2260: Ordinary Differential Equations I*  
2013, 2016 *MATH 6110: Advanced General Relativity*  
2012 *MATH 2000: Multivariable Calculus*  
2012 *MATH 1001: Integral Calculus*

2008-2009 **Mathematics College Tutor, Clare College, University of Cambridge.**

Responsible for 1<sup>st</sup> and 2<sup>nd</sup> year undergraduate tutoring in applied mathematics. Duties include marking assignments, weekly tutorials, preparing detailed evaluations

2003-6, **Teaching assistant, DAMTP, University of Cambridge.**

2007-2009 Responsible for graduate courses in i) Black Holes and ii) General Relativity. Duties include bi-weekly tutorials (groups of 10-15 students), preparing detailed solutions and student evaluations, and mentoring students' theses projects

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## Research Supervision

### Graduate Supervision.

Andrew Rose	MSc.	<i>Static Weyl solitons</i>	2018
Sharmila Gunasekaran	Ph.D	<i>Linear stability of black holes</i>	2020 (co-supervised)
Uzair Hussain	Ph.D	<i>Title</i>	2017 (co-supervised)
Aghil Alaei	Ph.D	<i>Geometric inequalities for initial data with symmetries</i>	2015 (co-supervised)

### Undergraduate Supervision.

Anna O'Grady	<i>Perturbing black holes and cosmological horizons</i>	2016 (co-supervised)
Riley Brooks	<i>Geometric inequalities of black holes in general relativity</i>	2016
Peter Rielly	<i>Energy conditions for null fluids</i>	2014 (co-supervised)
Adam Gardner	<i>A combinatorial Positive mass theorem</i>	2014 (co-supervised)
Matthew Hunt	<i>Phase space of extremal Kerr-Newmann black holes</i>	2014 (co-supervised)
Chen Wei	<i>Geodesics of Topological Anti de Sitter black holes</i>	2013 (co-supervised)
Mitchell Sullivan	<i>Geodesics of Topological Anti de Sitter black holes</i>	2012 (co-supervised)
Catherine Leonard	<i>Constructing horizons of extremal black holes using hidden symmetries of the Einstein-Maxwell equations</i>	2012

### NSERC USRA supervision.

Riley Brooks	<i>Geometric inequalities and charged black holes</i>	2015
Adam Gardner	<i>Higher-genus black holes</i>	2013

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## Conference Organization

- 5/2017 *Atlantic General Relativity Workshop and Conference*, Memorial University of Newfoundland (with I. Booth)
- 12/2016 *Geometric PDEs, Einstein's equations, and Mathematical relativity* Special session of the Canadian Mathematical Society 2016 Winter Meeting, Niagara Falls (with E Woolgar)
- 7/2012 *14<sup>th</sup> Canadian Conference on General Relativity and Relativistic Astrophysics*, Memorial University of Newfoundland (with I Booth)

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## Scholarly Activities

Referee for the Journal of Mathematical Physics, Physical Review Letters, Physical Review D, Physics Letters B, Classical and Quantum Gravity, Journal of High Energy Physics, Progress in Theoretical Physics, General Relativity and Gravitation.

- 6/2016 External examiner (Wilson Brenna, Ph.D), University of Waterloo.
- 22015, 2016 External grants referee for the Netherlands Foundation for Fundamental Research on Matter and the Polish National Science Centre (Narodowe Centrum Nauki)
- 2013 Invited review monograph for *Living Reviews in Relativity* (with J Lucietti).
- 2012-present Affiliate member, Perimeter Institute for Theoretical Physics, Waterloo.
- 2007-present Junior Member, Isaac Newton Institute of the Mathematical Sciences.

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## Outreach and Public Engagement

- 2/2016 Plenary talk 'Black hole no-hair theorems and why they are important' at the Atlantic Universities Undergraduate Physics and Astronomy Conference, Memorial University.
- 7/2014-2017 Public Lectures 'Gravity's Dark side', for high-school students participating in the Shad Valley Program at Memorial University.
- 5/2015 Panelist answering audience questions at the public event 'Gravity: Recognizing 100 years of Einstein's relativity' hosted by the University of New Brunswick.
- 5/2014 Blundon seminar lecture 'Dark Side of the Universe', delivered as part of the annual Blundon Seminar for high school students, Memorial University.
- 10/2012 Interviewed on CBC Radio St John's *Morning Show* to discuss Professor Neil Turok's Massey Lecture.

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## Selected Seminar and Conference talks

- 6/2018 **Geometric inequalities for axisymmetric black holes**, Canadian Conference on General Relativity and Relativistic Astrophysics, University of Alberta, Edmonton.
- 6/2018 **No static solitons in Einstein-Maxwell theory**, Atlantic General Relativity Meeting, St Francis Xavier University, Antigonish.
- 10/2017 **Extreme black holes and Anti de Sitter spacetimes**, Workshop on General Relativity and AdS/CFT, Fields Institute, Toronto (invited).

- 09/2017 **Geometric inequalities for black hole initial data**, Geometry and Topology Seminar, McMaster University, Hamilton (invited).
- 07/2017 **Mass-angular momentum inequalities for axisymmetric black holes**, Mathematica Physics Seminar, University of Edinburgh, Edinburgh, UK (invited).
- 06/2017 **Black holes in bubbling spacetimes**, Atlantic General Relativity Meeting, Memorial University, St John's.
- 07/2016 **Black hole non-uniqueness from spacetime topology**, 21st International Conference on General Relativity and Gravitation, Columbia University, New York, USA (invited).
- 05/2016 **Black Lenses in string theory**, Atlantic General Relativity Meeting, Dalhousie University, Halifax.
- 04/2016 **Geometric inequalities in higher dimensions**, American Mathematical Society Winter Sectional Meeting, Stony Brook University, New York, USA (invited).
- 07/2015 **New Black holes in five dimensions**, International Conference on Black Holes, Fields Institute, Toronto, Canada.
- 06/2015 **Mass-angular momenta inequalities in five dimensions**, Constraint equations and mass-momentum inequalities, Fields Institute, Toronto Canada.
- 10/2014 **Black Hole non-uniqueness via spacetime topology**, American Mathematical Society Sessional Meeting, Dalhousie University, Halifax, Canada.
- 06/2014 **Black holes in the Extreme**, Canadian Association of Physics Annual Conference, Sudbury, Canada (theory section invited plenary talk).
- 05/2014 **First Law of Black hole and soliton mechanics**, 15th Canadian General Relativity and Relativistic Astrophysics Conference, University of Winnipeg, Canada.
- 07/2013 **Topology of slices of five-dimensional black holes**, 20th International Conference on General Relativity, Warsaw, Poland.
- 05/2013 **Maximal slices of vacuum black holes**, 10th Canadian Workshop on Black Holes: Mathematical and Theoretical Aspects, University of Saskatchewan, SK, Canada.
- 06/2012 **Extremal black hole horizons**, 14th Canadian Conference on General Relativity and Relativistic Astrophysics, St John's NL, Canada (invited plenary talk).
- 04/2012 **Inhomogeneous Einstein metrics on sphere bundles**, Atlantic General Relativity Meeting, Fredericton NB, Canada.
- 05/2011 **Extremal Black Holes in Supergravity Theories with Hidden Symmetries**, Black Holes VIII: Mathematical and Theoretical Aspects, Niagara Falls, ON, Canada.
- 12/2010 **Classification of Extremal Black Holes**, Department of Mathematics, Memorial University, St John's NL, Canada (invited).
- 11/2010 **The Black Hole Classification Problem**, Geometry and Physics Seminar, University of Alberta, Edmonton AB, Canada (invited).
- 07/2010 **Electrovacuum near-horizon geometries in four and five dimensions**, 19<sup>th</sup> International Conference on General Relativity and Gravitation, Mexico City, Mexico.
- 06/2010 **A New Infinite Class of Extremal horizons**, Canadian Mathematical Society Summer Meeting, University of New Brunswick, Fredericton, NB, Canada.
- 05/2010 **Higher-dimensional Black holes**, Department of Mathematics and Statistics, Dalhousie University, Halifax, NS, Canada, (invited).
- 06/2009 **Extremal Black Holes**, Department of Physics, University of Porto, Porto, Portugal (invited).
- 05/2009 **Classifying Extremal Vacuum Black holes in five dimensions**, Black Holes VII: Mathematical and Theoretical Aspects, Banff, AB, Canada.
- 07/2008 **Near-horizon geometries**, Departments of Physics and Mathematical and Statistical Sciences, University of Alberta, AB, Canada (invited).



- 11/2007 **Near-horizon symmetries of Extremal Black Holes**, Relativity Seminar, DAMTP, University of Cambridge, UK (invited).
- 06/2007 **Near-horizon geometries of Extremal Black Holes**, Perimeter Institute of Theoretical Physics, Waterloo, ON, Canada.
- 05/2007 **Near horizons and Anti-de Sitter Black Holes**, Black Holes VI: Mathematical and Theoretical Aspects, White Point, NS, Canada.
- 03/2007 **Anti de Sitter Black Holes**, 7<sup>th</sup> British Gravity Meeting, Cambridge, UK.
- 02/2007 **Supersymmetric Black Holes in Anti-de Sitter space**, Department of Mathematical and Statistical Sciences, Durham University, Durham, UK (invited).
- 11/2006 **Higher-dimensional Black Holes: Recent Progress**, Particle Theory Group, University of Nottingham, Nottingham, UK (invited).
- 06/2006 **Supersymmetric Multi-Charge Black Holes**, Perimeter Institute of Theoretical Physics, Waterloo, ON, Canada.
- 05/2006 **New Supersymmetric AdS<sub>5</sub> Black Holes**, DAMTP, University of Cambridge, Cambridge, UK (invited).