

# David Berman

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## Postitions

Queen Mary College, University of London, Reader in Theoretical Physics (Faculty from 2004).

University of Cambridge (2002-2004) EPSRC Advanced Fellow (2002-2007) and Research Fellow at Clare Hall (2003-2006).

Hebrew University of Jerusalem (2000-2002), Post-Doctoral Research.

University of Groningen (1999-2000), Post-Doctoral Research.

University of Utrecht (1998-1999), Post-Doctoral Research.

## Education

University of Durham (1994-1998), Doctorate, including a year at CERN (1996-1997).

University of Manchester (1990-1994), M.Phys. First (Honours) physics with an ERASMUS year at Université Libre de Bruxelles (1992-1993).

## Grants Awarded

Primary Investigator, Isaac Newton Institute programme grant *Mathematics of strings and Branes* (2012), £310,000.

Co-investigator on the STF rolling grant *String theory* (2012-2016) of £450,000.

Co-investigator on the STFC rolling grant *String theory* (2010-2014) of £1,400,000.

Co-investigator on the PPARC rolling grant *String theory, gauge theory and gravity* (2006-2010) of £249,800.

An advanced fellowship from EPSRC for the project, *M-theory interactions* (2002-2007), £240,000.

An advanced fellowship from PPARC (in 2002) for £200,000. (This was declined since it could not be held concurrently).

Principal investigator on an EPSRC standard grant for the conference *M-theory in the city* (2006), £11,300.

Co-investigator on the EPSRC standard grant for the workshop *Fundamental Physics UK*, £6000 (2007,2008,2009).

Co-investigator on the European Union, Framework 6, Marie Curie Training and Mobility of Researchers Grant, *Superstrings*, (2004-2008) £162,000.

## Other Academic Activities

Principle organiser of the Issac Newton Institute programme “Mathematics and Applications of Branes in string and M-theory” to be held January 2012 to June 2012. (Budget of £310,000.)

Director of the conference “M-theory in the City”, November 2006.

Co-organiser of the “Fundamental Physics UK” meetings 2007, 2008, 2009, 2011.

Convenor of the string theory section of the 2007 meeting of the European physical society.

Member of the EPSRC standard grants panel and the advanced fellowships panel (2007,2011).

Member of the EPSRC peer review college (since 2006).

Referee for the Swiss Scientific funding panel (2008).

Referee for Physics Letters B, Nuclear Physics B, The Journal of High Energy Physics, Classical and Quantum Gravity, Physical Review D, Physical Review Letters, Communications in Mathematical Physics, Modern Physics Letters, Physica Scripta and the European Journal of Physics.

## Teaching Experience

*Spacetime and gravity* (2008-): a second/third year course, Course Organiser.

*Electromagnetic fields* (2005-): a first year core course with over 130 students, Course Organiser.

*Branes and strings* (2006 and 2008): a postgraduate course, Course Organiser.

Final year project supervision: *Designing a Tardis* (2010-), *Randall Sundrum models* (2010-), *Blackholes*(2009-), *Brane dynamics* (2009), *Kaluza-Klein Theories* (2008-); *Bells Inequalities* (2007); *String theory dynamics* (2005-2006); *The Cosmological Constant* (2004).

*String Theory* (2004): a postgraduate course for the Cambridge certificate in advanced mathematics, Course Organiser.

*Branes* (2005): a postgraduate course for the Cambridge certificate in advanced mathematics, Course Organiser.

Essay supervision for the Cambridge certificate in advanced mathematics, *Noncommutative Geometry in String theory* (2004) and *The Maldacena correspondence* (2005)

*Aspects of topology in field and string theory* (2002): a postgraduate course at The Hebrew University, Course Organiser.

## PhD thesis supervision

Joel Berkeley, *Applications of solution generating symmetries to Black hole/Navier Stokes duality* (2011-)

Edward Musaev, *Generalised geometry in M-theory* (2010-)

Ilya Bakhmatov, *Aspects of T-duality in string theory* (2008-2011)

Daniel Thompson, *Quantum Aspects of the doubled formalism of string theory* (2006-2010)

Laura Tadrowski, *M-theory brane deformations* (2004-2008)

Neil Copland, *Aspects of M-theory brane interactions and string theory symmetries* (2003-2007).

Second supervisor for three PhD students.

## Publications

With Hadi Godazgar, Malcolm Perry and Peter West, “Duality invariant actions and generalised geometry”, arXiv:1111.0459.

The theory of nonlinear realisations is used to determine the metrics for generalised geometry. The  $E_{11}$  embedding of the duality algebras is also investigated.

With Hadi Godazgar, Mahdi Godazgar and Malcolm Perry, “The local symmetries of M-theory and their formulation in generalised geometry”, arXiv:1110.3930.

The local symmetries in the duality manifest formalism are used to determine the physical section condition.

With Edvard Musaev and Malcolm Perry, “Boundary terms in Generalized Geometry and doubled field theory”, arXiv:1110.3097.

The Gibbons Hawking term is combined with the surface term present in duality invariant actions to produce a boundary term written in terms of the generalized metric.

With Hadi Godazgar and Malcolm Perry, “SO(5,5) duality in M-theory and generalized geometry”, arXiv:1103.5733.

The generalized metric and its action are developed for the SO(5,5) duality group.

With Malcolm Perry, “Generalized Geometry and M theory”. **JHEP1106:074,2011.**

M-theory is reformulated in a duality manifest way using techniques from generalized geometry.

With Malcolm J. Perry, Ergin Sezgin, Daniel C. Thompson, “Boundary Conditions for Interacting Membranes” **JHEP 1004:025,2010.**

The supersymmetric boundary conditions for interacting membranes are analysed.

With D Thompson, “Membranes with a boundary,” **Nuclear Physics B 820 (2009) 503.**

Supersymmetric membrane boundary dynamics are constructed using superspace techniques.

With J Bedford, “A note on Quantum Aspects of Multiple Membranes,” **Physics Letters B 668 (2008) 67**

The one loop corrections to Bagger Lambert theory are calculated and shown to give rise to a finite shift in the level.

With L Tadrowski and D Thompson, “Aspects of multiple membranes”, **Nuclear Physics B 795 (2008) 201.**

The boundary theory of a new theory of multiple membranes is compared with the fivebrane and possible supersymmetric deformations of the membrane theory are constructed.

With D Thompson, “Duality Symmetric Strings, Dilatons and O(d,d) effective actions”, **Physics Letters B 662 (2008) 279 .**

The two loop contribution of the dilaton to the background field equations is calculated and the background is recast in an O(d,d) invariant form.

“M-theory branes and their interactions”, **Physics Reports 456 (2008) 89-126.**

An invited review concerning the degrees of freedom on coincident branes in M-theory and how to model membrane, fivebrane interactions.

With L Tadrowski, “M-theory brane deformations”, **to appear in Nuclear Physics B 795 (2008) 201**

The Lunin Maldacena solution generating transformation is applied to the branes in M-theory to give new deformed brane solutions. The new solutions are investigated thermodynamically and via probe branes.

With N Copland and D Thompson, “The background field equations of the duality symmetric string”, **Nuclear Physics B791 (2008) 175-191**.

The background field equations of the string in the doubled formalism are derived by calculating the one loop beta function.

With N Copland, “The string partition function in Hull’s doubled formalism”, **Physics Letters B649 (2007), 325-333**.

The one loop partition function of the string in the doubled formalism is calculated and shown to be equivalent to the usual string.

With N Copland, “A Note on the M2-M5 brane system and fuzzy spheres”, **Physics Letters B639 (2006) 553-559**.

The number of degrees of freedom of the nonabelian membrane is described from point of view of fuzzy 3-spheres leading to the  $N^{3/2}$  scaling. The reduction of the Basu-Harvey equation to Nahm equation is demonstrated.

With M Perry, “M-theory and the string genus expansion”, **Physics Letters B635 (2006) 131-135**.

The origin of the string genus expansion is derived from the membrane partition function.

With N Copland, “Five-brane calibrations and fuzzy funnels”, **Nuclear Physics B723 (2005) 117-131**.

This paper generalises the Basu-Harvey equation to allow a membrane to end on a five-brane wrapped on any supersymmetric cycle.

With J Harvey, “The Self-Dual String and anomalies in the M5-brane”, **JHEP 0411 (2004) 015**.

This paper examines the anomaly cancellation mechanism for the membrane five-brane system and the degrees of freedom of the self-dual string.

With B Pioline, “Open membranes, Ribbons and deformed Schild strings”, **Physics Review D70 (2004) 045007**.

This paper examines the low energy effective description for cylindrical open membranes in a background field to yield a deformed Schild string.

“Aspects of M-5 brane world volume dynamics”, **Physics Letters B572 (2003) 101-107**.

The scattering properties of world volume solitons on the five brane are examined and compared with probe membrane dynamics.

With E. Rabinovici, “Lectures on Supersymmetric Gauge Theories”, hep-th/0210044, in Les Houches Lectures “Unity from duality: Gravity, gauge theory and strings”.

This is an introduction and extensive review of supersymmetric gauge theories.

With M. Cederwall, U. Gran, H. Larsson, M. Nielsen, B. E. W. Nilsson and P. Sundell, “Deformation independent open brane metrics and generalized theta parameters”, **JHEP 0202 (2002) 012**.

The generalisation of open string metrics and noncommutative deformation parameters are considered for open branes in various contexts.

With P. Sundell, “AdS<sub>3</sub> OM theory and the self-dual string or membranes ending on the five-brane”, **Physics Letters B529 (2002) 171-177**.

A Maldacena style limit is considered for the self-dual string in the five brane world volume and shown to give rise to an AdS<sub>3</sub> open membrane theory.

With V. L. Campos, M. Cederwall, U Gran, H. Larsson, M. Nielsen, B. E. W. Nilsson and P. Sundell, “Holographic Noncommutativity”, **JHEP 0105 (2001) 002**.

The supergravity duals of noncommutative open string and field theories with  $\mathcal{N} = 1$  supersymmetry are constructed and studied.

With P. Sundell, “Flowing from a noncommutative (OM) five-brane via its supergravity dual”, **JHEP 0010 (2000) 014**.

A supergravity solution and decoupling procedure are given that provide a dual description of the noncommutative five brane.

With E. Bergshoeff, J. P. van der Schaar and Per Sundell, “Critical fields on the M5-brane and noncommutative open strings”, **Physics Letters B492 (2000) 193-200**.

A scaling limit for the five brane is described that provides the strong coupling limit of noncommutative open string theory in 4+1 dimensions.

With E. Bergshoeff, J. P. van der Schaar and Per Sundell, “A noncommutative M theory five-brane”, **Nuclear Physics B590 (2000) 173-197**.

The effects of including a constant background three form potential on the M theory five brane are investigated. This leads to the notion of a noncommutative loop space.

With M. Parikh, “The Thermodynamics of confinement and the AdS/CFT correspondence”, **Physics Letters B483 (2000) 271-276**.

The details of the N dependence of the phase transition and thermodynamics of SYM on  $S^3 \times S^1$  is examined using the AdS/CFT correspondence.

With M. Parikh, “Holography and Rotating AdS black holes”, **Physics Letters B 463 (1999) 168-173**.

The thermodynamics of rotating five dimensional black holes in anti de Sitter space is examined in the context of the AdS/CFT correspondence.

“M-5 on a torus and the three brane”, **Nuclear Physics B 533 (1998) 317-332**.

The equivalence is shown between the world volume theories of the M-theory five brane wrapped on a torus and the IIB D-3 brane (where one transverse dimension is a circle). Different gauge choices on the five brane correspond to the different S-dual descriptions of the D-3 brane.

“SL(2,Z) duality of Born-Infeld theory from self-dual electrodynamics in 6 dimensions”, **Physics Letters B 409 (1997) 153-159**.

This paper illustrates how the equivalent of electromagnetic duality for Born-Infeld theory may arise from considering a six dimensional non-linear two form gauge theory reduced on a torus.

“Classical duality from dimensional reduction of self dual 4-form Maxwell theory in 10 dimensions”, **Physics Letters B403 (1997) 250-256**.

This paper demonstrates how duality in simple field theories in four dimensions may arise from considering a self-dual field theory in higher dimensions (either six or ten dimensions). The geometry of these hidden extra dimensions then gives rise to the symmetry of the duality group in lower dimensions.

## Conference proceedings/presentations

Stockholm workshop on Quantum Geometry (2011) “M-theory geometry”.

Niels Bohr Institute workshop (2011), “Duality and generalised geometry”.

PICS meeting (2010), “M-theory and generalised geometry”.

Galileo Institute Florence (2010), “M-theory and generalised geometry”.

Korean Institute for advanced study conference on string theory (2008), “Interacting membranes”

Eurostrings08, RTN network meeting, Varna (2008), “Interacting membranes”.

Brussels Triangle one day meeting (2008), “M-theory branes and their interactions”.

Noncommutative geometry and physics (2008), Shonan Kokusaimura in Kanagawa, “M-theory and noncommutative geometry”.

Ascona Strings Meeting (2007) “String theory in the doubled formalism”.

Eurostrings07, RTN meeting, Crete “Fuzzy Geometries in M-theory”.

Conference on noncommutative geometry in physics, Isaac Newton Institute (2006), “Non-commutative geometry in string and M-theory”.

Niels Bohr Institute summer workshop (2006), “Fuzzy Geometries in M-theory”.

Eurostrings06, RTN network meeting, Cambridge (2006), “M-theory and the string genus expansion”.

Beyond the horizon, KITP Santa Barbara (2006), “M-theory origin of string perturbation theory”.

The 10th Marcel Grossmann meeting, Rio (2003), “Aspects of M5 world volume dynamics”, in proceedings.

Gursey conference in Istanbul (2000) in proceedings, with E. Bergshoeff, J. P. van der Schaar and P. Sundell, “The M5-brane and non-commutative loop space,” *Class. Quant. Grav.* **18** (2001) 3265 and “The M5-brane and non-commutative open strings,” *Class. Quant. Grav.* **18** (2001) 3259.

The Triangle meeting on Nonperturbative effects in string and field theory, Copenhagen (2000) “Open membranes and noncommutative five branes”.

The Fradkin Memorial conference, Moscow (2000) “Critical fields on the five brane and non-commutative open strings”, in proceedings.

Quantum Aspects of Gauge theories, Supersymmetry and Unification, Paris (1999) “Holography and rotating black holes”, in proceedings, JHEP.

6th Wigner Symposium, Istanbul (1999) “Aspects of rotating black holes in AdS”, in proceedings.

Quantum Aspects of Gauge theories, Supersymmetry and Unification, Corfu (1998) “The M-five brane on a torus”, Proceedings, edited by A. Cersole, C. Kounnas, D. Lust, S. Theisen. Berlin, Germany, Springer-Verlag, 1999. 534p. (Lectures Notes in Physics, Vol. 525)

## Seminars

I have given invited seminars on my research at the following places:

*M-theory and generalised geometry*

Brussels (2011)

Oxford (2011)

Amsterdam (2011)

Kings College London (2011)

Cambridge (2010)

*Fermionic T-duality*

Cooks branch meeting (2010)

*Recent progress in String theory*

University of Kent (2010)

*Aspects of interacting multiple membranes*

Perimeter institue, Canada (2009)

Cooks branch meeting, Texas (2009)  
 Kings College London (2009)  
 DAMTP, Cambridge (2008)  
 Niels Bohr Institute (2008)  
 Jerusalem (2008)  
 Brussels (2008)  
*String Theory and the doubled formalism*  
 Tokoyo (2008)  
 Edinburgh (2008)  
 Rome Tor Vergata (2007)  
 Texas A&M (2007)  
*Noncommutativity in string and M-theory*  
 Rome Tor Vergata (2007)  
 Texas A&M (2007)  
 University of Oxford (Department of Mathematics) (2007)  
*M-theory and the string genus expansion*  
 University of Durham (2006)  
 ICTP Trieste (2006)  
 University of Cambridge (2006)  
 University of Sussex (2005)  
*Self-dual string Anomalies*  
 CERN Theory division (2004)  
 University of Amsterdam (2004)  
 Niels Bohr Institute Copenhagen (2004)  
 Harvard University (2004)  
 MIT (2004)  
 University of Chicago (2004)  
 University of Michigan (2004)  
*Membranes, Ribbons and Schild Strings*  
 Imperial College London (2004)  
*M five-brane dynamics*  
 Kings College, University of London (2004)  
 University of Cambridge (2003)  
 University of Durham (2003)  
 University of Swansea (2003)  
 University of Michigan (2003)  
 University of Chicago(2003)  
*Open Membanes*  
 Humbolt University, Berlin (2002)  
 University of Uppsala (2002)  
*AdS<sub>3</sub> OM-theory*  
 Princeton University (2001)

Columbia University, New York (2001)  
Les Houches School (2001)  
University of Utrecht (2001)  
University of Groningen (2001)  
Neve Shalom Centre of Excellence meeting, Israel (2001)  
*A noncommutative five brane*  
Humbolt University, Berlin (2001)  
Queen Mary College (2000)  
Landelijk meeting Amsterdam (2000)  
University of Goteborg (2000)  
University of Utrecht (2000)  
University of Cambridge (2000)  
*Black hole thermodynamics and AdS/CFT*  
University of Leuven (2000)  
Landelijk Meeting Amsterdam (1999)  
*Branes and dualities*  
University of Groningen (1998)  
*An introduciton to D-branes*  
University of Manchester (1998)

## **Nonspecialist lectures, publications**

The Science Museum, Dublin “Theoretical Physics”, December (2011), part of Ignite Dublin series.

The Octagon at Queen Mary, “Understanding eleven dimensions”, art/music event, with compositions and improvisation based on my research, played by an ensemble of 8 musicians.

The Dana Centre “String theory and unification” November (2011), sell out crowd of 200.

Discussion Panel for Stephen Hawking Evening at Texas A & M University with an audience of 2500, April (2011)

Core Gallery Salon event ”Unified theories” (2011)

Tate Modern, Turbine Hall talk “Black Holes” (2010)

New Scientist, “Art-Science Collaboration” Issue: 8th May (2010)

String theory tours at the London Frieze art fair as part of the Cartier award winning work with Jordan Wolfson (2009)

Interview for Wired magazine (2009)

The Institute of Contemporary Art “String Theory” (2008)

Curated the exhibition *Images in Theoretical Physics* as part of *the Bigdraw* at Queen Mary (2007) and at *Clare Hall* in Cambridge (2008).

Article for *Plus+*, a magazine for schools, “String Theory” (2007)

Invited contribution to the Tech-Mac-Mayacom exhibition Book (2007)

The Royal College of Art: “String theory” (2006)

Article for *Fusion* magazine: “Unification in Science” (2006)

Invited submission to the Royal Academy summer exhibition (2004) “Membranes ending on a fivebrane”

*Nicky Shaw Public Understanding of Science lectures*, (typically an audience of 200):

“From Newton to Einstein” (2003)

“Introducing strings” (2004)

Talks organised by the *Millenium Maths Project* to schools or teacher groups:

“An introduction to string theory” (2004);

“From particles to strings” (2005);

“What have mathematicians done for us?” (2005);

“String theory for beginners” (2005);

“Particles and Beyond” (2006).

“Newton to Einstein” (2006)

“String Theory and beyond” (2005, 2006 and 2007)

Videoconference presentation to schools, organised by *motivate*, part of the Millenium Maths project. These link several schools around the country for a day covering a central topic:

“Relativity for beginners” (2005,2006 and 2008)

“The mathematics of quantum mechanics” (2007)

For Trinity Science Society:

“Unification in Theoretical Physics” (2005 and 2007)

For Cambridge summer school in Science (2007)

“String theory and unification”

For postgraduate students (2004,2008,2009,2011) and now art of the synaptic physics module:

“How to give a seminar”

## **Administrational, Outreach and Recruitment work**

### **Director of Graduate studies for SEPnet.**

SEPnet is a consortium of seven physics departments in the south east of England. The role of director of graduate studies for the consortium includes: overseeing joint grant applications; graduate student recruitment; administration of joint courses; organising events and conferences; maintaining quality of graduate training; and developing consortium strategy in the short, medium and long terms.

### **Director of cultural outreach**

This involves the organisation of knowledge exchange with the arts community. This has led to the artist in residence programme for the physics department (supported by a Westfield trust grant of £10,000). The development of other art, music collaborations based on the research at Queen Mary, supported by an EPSRC pathways to impact award of £7,000. The Henry Moore foundation has provided support for work with Turner prize winner Grenville Davey £1,500 to work with David Berman.

### **Member of Graduate Degrees Committee**

Postgraduate student selection and recruitment for the string group: interviewing; organising grants for international students; and attracting good students through advertising and contacting the relevant departments.

### **Other work**

A major contributor to the planning, organisation and application of the new approach to outreach in the physics department since 2004 (in conjunction with Prof. Spence). This has included: teacher days; workshops and masterclasses for school students; and school visits with a Queen Mary focus.

Interviewing of potential undergraduate students.