MARIKA TAYLOR

Curriculum Vitae

Personal information

Name:	Marika Maxine Taylor
Date of birth:	8 May 1974
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Employment

- 2009-: Associate professor, Institute for Theoretical Physics, Amsterdam.
- 2005-2009: Vidi assistant professor, Institute for Theoretical Physics, Amsterdam.
- 2004-2005: Maternity leave.
- 2001-2004: Postdoctoral researcher at Spinoza Institute, Utrecht.
- 1998-2001: Research fellowship, St John's College, Cambridge.
- 1999: Visiting postdoctoral position at Harvard University.

Education

- 1991-1994: B.A. (Hons) Natural Sciences, (Physics and Theoretical Physics), Cambridge University - Class I and university awards for highest examination results.
- 1994-1995: Part III Mathematics, Cambridge University - Distinction and Mayhew Prize for best performance.
- 1995-1999: Ph.D. DAMTP, Cambridge University. Advisor: Stephen Hawking. Thesis *Problems in M Theory*; Ph.D. conferred 23 January 1999.

Grants and awards

- 2010: Co-investigator for University of Amsterdam research initiative, Gravitation and Astro-particle Physics Amsterdam, GRAPPA. (Structural funds of around 300,000 Euros per annum)
- 2009: FOM program "A String Theoretic Approach to Cosmology and Quantum Matter" (with E.P. Verlinde, J. de Boer, M.M. Taylor, J.P. van der Schaar, A. Achucarro, K. Schalm, J. Zaanen, S. Vandoren, E.A. Bergshoeff) (2,200,000 Euros)
- 2009: FOM/v grant from Dutch physics council FOM (180,000 Euros)
- 2008: Election to De Jonge Akademie, KNAW. DJA elects ten young distinguished researchers every year to the Dutch Royal Society.
- 2008: Minerva Prize (5,000 Euros), from FOM (Dutch research council), for best publication by a female scientist.
- 2005-2010: Vidi grant from NWO (600,000 Euros) providing funding for myself and students.
- 2006: Van Gogh grant from NWO (10,000 Euros), for cooperation with string theory groups in France.
- 1998: Election to St John's College, Cambridge fellowship.
- 1997: Knight's essay prize (top category) for PhD research by DAMTP students.

Teaching experience

- 2010: Undergraduate course on general relativity at University of Amsterdam
- 2009-present: Undergraduate course on electromagnetism and special relativity at Amsterdam University College.
- 2006-2010: Lectures on AdS/CFT and black holes to joint French-Belgian-Dutch PhD school.
- 2005-: Teaching masters courses such as string theory, University of Amsterdam.
- PhD students:
  - Ingmar Kanitscheider,
    Precision holography and its application to black holes.
    Graduated 2009, currently a postdoc at the University of Rochester, USA.
  - Milena Smolic, expected to graduate in 2012.
  - Ricardo Caldeira-Costa, expected to graduate in 2013.
- Masters students:
  - Tony Lyons, *Supersymmetric realizations of the C-theorem*, 2007.
  - Wout Merbis, *Holographic renormalization for scalars in Lifshitz backgrounds*, 2010. Merbis is now a PhD student with Eric Bergshoeff.
- Bachelors students:
  - David Lutt, *Black hole formation in collisions*, in progress.
  - Frank van der Ploeg, *Traversible Wormholes and the Feasibility of Faster than Light Travel*, 2010.
  - Hans Wiermans, *Classical strings in anti de Sitter space*, 2010.
  - Barry Ruijter, *The decay of massive strings*, 2010.
  - Franke Buurmeijer, *Models for the acceleration of the Universe*, 2010.
  - Ellen van der Woerd, *The expansion of the universe and inflation*, 2009.
- Second year projects:
  - Vincent Dekker, Jan Koster and Barry Ruijter, *Black holes*, 2009.
- 1996-2001: Teaching assistant for postgraduate (Part III) classes in Cambridge on black holes and differential geometry in physics, and for undergraduate mathematics courses including quantum mechanics, special relativity, analysis and mathematical physics.

Administrative responsibilities

- Member of committees for Dutch Research Councils NWO and FOM.
- Board member of faculty committee addressing gender disparity, Faculty of Science, University of Amsterdam.
- Mentor for women in Faculty of Science, University of Amsterdam.
- Administration of post-doctoral applications and selection, Institute for Theoretical Physics, Amsterdam.
- Referee for Chilean Research Fund Council (FONDECYT), Chile
- Referee for Engineering and Physical Science Research Council (EPSRC)

Other professional activities

- Referee for Classical and Quantum Gravity, JHEP, Nuclear Physics B, Physical Review D, Europhysics Letters and Physics Letters B.
- Conference organization:
  - Organizer of Amsterdam summer workshops, 2005, 2006, 2008 and 2010.
  - Organizer of workshop on aspects of gravity/gauge dualities in February 2006, funded by Van Gogh grant.
  - Organizer of the conference, Eurostrings 2008, June 2008.
  - Organizer of session at 12th Marcel Grossmann meeting, Paris, July 2009.
  - Organizer of session at Fysica 2011.
- Visiting fellowships at Newton Institute, Cambridge (2007); CERN (2008), Galileo Galilei Institute, Florence (2009 and 2010).
- Outreach activities:
  - Popular science movie about my research “Black holes and holography” made by movie company FastFacts, distributed online at KNAW website and through newspapers such as De Volksrant, 2010.
  - Interviews with newspapers, e.g. ”Unparticle physics” in NRC Handelsblad, July 2008.
  - Popular science lectures on quantum gravity given to Cambridge University and Harvard University summer schools, 1997-1999.

Selected recent talks

- **2010**
- December 1 2010: “Schrodinger and Lifshitz holography”, invited talk at Imperial College, London.
- September 30 2010: “Schrodinger Holography” at conference of the program “AdS4/CFT3 and the holographic states of matter” at the Galileo Galilei Institute, Florence.
- September 14 2010: “Schrodinger Holography” at conference ‘Gauge theories and the structure of spacetime” Kolymbari, Crete.
- April 16 2010: FOM/v symposium, Arnhem, Netherlands.
- April 9-15 2010: Lectures on “AdS/CFT and non-relativistic holography”, IPM Spring School, Tehran, Iran.
- **2009**
- November 18 2009: “Reconstruction of black hole microstates”, Symposium on black holes, LPTHE, Paris, France.
- November 6 2009: “Black holes”, invited seminar at University of Southampton.
- August 21 2009: “Topologically massive gravity and AdS/LCFT”, 33rd John Hopkins workshop, Goteborg, Sweden.
- August 4 2009: “Cosmological massive gravity”, Holographic cosmology workshop, Perimeter Institute, Canada.
- July 13-14 2009: “Holographic realization of general gauge mediation” and “Reconstruction of black hole microstates” at 12th Marcel Grossmann Meeting, Paris.
- May 27 2009: Colloquium on “Applications of AdS/CFT” at Aspen workshop on applications of AdS/CFT.
- May 15 2009: “Holography and its applications” at Dalfsen Dutch national theoretical physics meeting.
- May 13 2009: “Holographic realization of general gauge mediation” GGI, Florence, as part of the program “New perspectives in string theory”.
- May 11 2009: “Horava-Lifshitz gravity”, GGI, Florence, as part of program “New perspectives on string theory”.
- February 4 2009: “Are black holes really fuzzballs?”, colloquium at VU, Amsterdam.

- **2008**

- November 24 2008: “Black holes”, colloquium at Anton Pannekoek Institute, Amsterdam.

- August 2008: “Non-conformal holography”, Paris summer workshop on string theory, Ecole Normale Superieure, Paris.

- June 16-20 2008: “Precision holography for non-conformal branes” at conference “Gravitational thermodynamics and the quantum nature of space time,” ICMS, Edinburgh, U.K.

- April 18 2008: “Are black holes really fuzzballs?”, plenary lecture at Fysica 2008 [National Dutch Physics conference].

- April 6-11 2008: “Non-conformal holography” at Jerusalem workshop “String theory: from theory to experiment”.

- February 1-8 2008: Lectures on black holes at DRSTP school for PhD students, Driebergen.

- **2007**

- November 2007: “The fuzzball proposal”, at “Strong fields, integrability and strings” Isaac Newton Institute, Cambridge.

- August 2007: “Black holes and fuzzballs” at “Gravity meets condensed matter”, Lorentz Center workshop, Leiden.

- August 2007: “Precision holography for fuzzballs” at summer workshop on black hole physics, Ecole Normale Superieure, Paris.

- July 1-7 2007: “Holographic anatomy of fuzzballs”, Eurostrings 2007 conference, Crete.

- June 18-22 2007: “Holographic anatomy of fuzzballs”, Prestrings conference, Granada.

- April 2007: “The fuzzball proposal” at Swiss regional meeting, Neuchatel.

Publication list

- R. N. Caldeira Costa and M. Taylor, "Holography for chiral scale-invariant models," arXiv:1010.4800 [hep-th].
- M. Guica, K. Skenderis, M. Taylor and B. C. van Rees, "Holography for Schrodinger backgrounds," arXiv:1008.1991 [hep-th].
- K. Skenderis, M. Taylor and D. Tsimpis, "A consistent truncation of IIB supergravity on manifolds admitting a Sasaki-Einstein structure," JHEP **1006** (2010) 025 [arXiv:1003.5657 [hep-th]].
- K. Skenderis, M. Taylor and B. C. van Rees, "AdS boundary conditions and the Topologically Massive Gravity/CFT correspondence," arXiv:0909.5617 [hep-th], published in proceedings of the 25th Max Born Symposium: The Planck Scale, 29 Jun - 3 Jul 2009, Wroclaw, Poland.
- K. Skenderis, M. Taylor and B. C. van Rees, "Topologically Massive Gravity and the AdS/CFT Correspondence," JHEP **0909** 045,2009 [arXiv:0906.4926].
- M. Taylor, "Non-relativistic holography," arXiv:0812.0530 [hep-th], in press.
- I. Kanitscheider, K. Skenderis and M. Taylor, "Precision holography for non-conformal branes," JHEP **0809** (2008) 094 [arXiv:0807.3324 [hep-th]].
- K. Skenderis and M. Taylor, "The fuzzball proposal for black holes," Phys. Rept. **467**, 117 (2008) [arXiv:0804.0552 [hep-th]].
- M. Taylor, "Matching of extremal correlators in AdS_3/CFT_2", JHEP **0806**, 010,2008 [arXiv:0709.1838 [hep-th]].
- K. Skenderis and M. Taylor, "Anatomy of bubbling solutions," JHEP **0709**, 019 (2007) [arXiv:0706.0216 [hep-th]].
- I. Kanitscheider, K. Skenderis and M. Taylor, "Fuzzballs with internal excitations," JHEP **0706**, 056 (2007) [arXiv:0704.0690 [hep-th]].
- I. Kanitscheider, K. Skenderis and M. Taylor, "Holographic anatomy of fuzzballs," JHEP **0704**, 023 (2007) [arXiv:hep-th/0611171].
- K. Skenderis and M. Taylor, "Fuzzball solutions and D1-D5 microstates," Phys. Rev. Lett. **98**, 071601 (2007) [arXiv:hep-th/0609154].
- K. Skenderis and M. Taylor, "Holographic Coulomb branch vevs," JHEP **0608**, 001 (2006) [arXiv:hep-th/0604169].

- K. Skenderis and M. Taylor, ”Kaluza-Klein holography”, JHEP **0605**, 057 (2006) [arXiv:hep-th/0603016].
- M. Taylor, ”General 2-charge geometries”, JHEP 0603 (2006) 009, hep-th/0507223.
- K. Skenderis and M. Taylor, “Properties of branes in curved spacetimes”, JHEP 0402:030 (2004), hep-th/0311079.
- D. Freedman, K. Skenderis and M. Taylor, “Worldvolume symmetries for branes in plane waves”, Phys. Rev. **D68**, 106001, hep-th/0306046.
- K. Skenderis and M. Taylor, “An overview of branes in the plane wave background”, Class. Quant. Grav. 20:S567-S574 (2003), hep-th/0301221.
- K. Skenderis and M. Taylor, “Open strings in the plane wave background II: superalgebras and spectra”, JHEP 0307:006 (2003), hep-th/0212184.
- K. Skenderis and M. Taylor, “Open strings in the plane wave background I: quantization and symmetries”, Nucl. Phys. B665 3-48 (2003), hep-th/0211011.
- K. Skenderis and M. Taylor, “Branes in AdS and pp-wave spacetimes”, JHEP 06 (2002) 025, hep-th/0204054.
- M. M. Taylor-Robinson, “Higher dimensional formulation of counterterms”, hep-th/0110142.
- M. M. Taylor-Robinson, “Anomalies, counterterms and the N=0 Polchinski-Strassler solutions”, hep-th/0103162.
- M. M. Taylor-Robinson, “More on counterterms in the gravitational action and anomalies”, hep-th/0002125.
- M. M. Taylor-Robinson, Review of “Classical and quantum black holes”, Contemporary Physics, **41:5**, 338 (2000).
- M. M. Taylor-Robinson, “Holography for degenerate boundaries”, hep-th/0001177.
- S. W. Hawking, C. J. Hunter and M. M. Taylor-Robinson, “Rotation and the AdS/CFT correspondence”, Phys. Rev. D **59**, 064005 (1999); hep-th/9811056.
- M. M. Taylor-Robinson, “Higher-dimensional Taub-Bolt solutions and the entropy of non compact manifolds ”, hep-th/9809041.
- M. M. Taylor-Robinson, “Instanton symmetries and the entropy of compact manifolds”, hep-th/9809040.
- M. M. Taylor-Robinson, “The D1-D5 brane system in six dimensions”, hep-th/9806132.

- S. W. Hawking and M. M. Taylor-Robinson, “Bulk charges in eleven dimensions”, Phys. Rev. D **58**, 025006 (1998); hep-th/9711042.
- M. M. Taylor-Robinson, “Absorption of fixed scalars”, hep-th/9704172.
- S. W. Hawking and M. M. Taylor-Robinson, “Evolution of near extremal black holes”, Phys. Rev. D **55**, 7680 (1997); hep-th/9702045.
- M. M. Taylor-Robinson, “Semi-classical stability of supergravity vacua”, Phys. Rev. D **55**, 4822 (1997); hep-th/9609234.

Research interests

My research interests include all aspects of string theory, gravitational physics and quantum field theory. My work as a PhD student mostly related to black holes in string theory, and included several papers on calculating the Hawking radiation rates of near BPS black holes and understanding the decay modes via the dual brane picture. One of my best known papers from this period is that on "Rotation and the AdS/CFT correspondence" written with Hawking and Hunter. This paper discusses the correspondence between rotating AdS black holes and rotating plasmas in a conformal theory; the agreement found between their thermodynamics provided (early) structural evidence for the proposed gravity/gauge theory duality. The most important result contained in this paper was new exact solutions for five-dimensional rotating AdS black holes. These black holes are widely used in the context of AdS_5/CFT_4 dualities, and as seed solutions for constructing more general charged, rotating AdS black holes.

In recent years, much of my work has been focused on holographic dualities and their implications. The famous AdS/CFT correspondence, relating string theory in negative curvature backgrounds to conformal field theories, is one example of a conjectured gravity/gauge theory duality. Other examples of holographic dualities are also known, but it is far from clear whether gravity is always holographic and whether the physics of interesting cosmological spacetimes, such as de Sitter space, can be described holographically by a non-gravitational theory. Going in the other direction, from field theory to geometry, one would like to construct geometric duals of phenomenologically interesting field theories.

My work on holography encompasses both foundational issues (the holographic dictionary between gravitational and gauge theory physics) and applications of holography to black hole physics, phenomenology and condensed matter systems. Let me first describe my work on developing the holographic dictionary. A primary goal in gravity/gauge dualities is to understand the precise holographic relationship between all gravity and gauge theory quantities. Such a holographic dictionary must operate in both directions: one must show both how field theory data, such as correlation functions and expectation values of Wilson loops, can be extracted from the geometry and in reverse how this field theory data reconstructs the geometry, in particular global features such as horizons.

Substantial progress has been made on these issues in the context of AdS/CFT: the method of *holographic renormalization* provides a precise map between the near boundary behavior of an asymptotically AdS spacetime and (renormalized) field theory one point functions. Functionally differentiating this relation with respect to sources generates all higher correlation functions, and thus this map provides the basis for precise holographic calculations. A significant part of my work in recent years has been devoted to developing and extending this holographic dictionary.

In particular, in a series of papers with Skenderis we understood how the entire ten-dimensional geometry is encoded in gauge theory data. Our method of Kaluza-Klein holography provides a map which reconstructs not just the AdS part of the geometry, but also the compact spherical part too. In an earlier paper in 2002, we showed that adding branes to the AdS geometry corresponds to adding defects or flavors in the field theory. Our paper is highly cited since such generalized dualities are widely used in holographic models for QCD and condensed matter systems.

As mentioned above, a key issue in holography is to understand spacetimes with different asymptotics. Recently we have been developing tools to extract precise field theory data from geometries which are not related to anti-de Sitter but which nonetheless have conjectured field theory duals. For example, we have set up precision holography for Dp-brane backgrounds with $p \neq 3$, for which the dual theories are not conformal. Our work provides structural evidence for these dualities, but again also has many applications: it will allow holographic models for QCD such as the Witten-Sakai-Sugimoto model to be developed much further than was previously possible.

Another class of geometries with conjectured holographic duals is backgrounds which are scale invariant and admit the same symmetries as non-relativistic quantum field theories. Such non-relativistic gauge/gravity dualities could potentially be useful for understanding strongly coupled phenomena in condensed matter systems, and certainly merit exploration. In work with Monica Guica (from Paris) and students Balt van Rees and Ricardo Caldeira-Costa, we have systematically explored holography for Schrödinger spacetimes. We provide evidence that such spacetimes are dual to a non-local field theories in one less dimension, which are consistent with being null dipole theories. These theories have qualitatively different features from the non-relativistic condensed matter systems the Schrödinger spacetimes were intended to model, and it will be interesting to use our results to explore what features of the condensed matter systems can be well captured by the holographic models.

Despite the progress discussed above many key foundational questions remain on holography and these are one focus of my current and future research. For example, little progress has been made on how *global* spacetime structure such as a horizon is captured by the field theory. Promising directions which may shed light on this include developing the connection between bulk singularity theorems and RG flows in the field theory. Another interesting question is how holography works from the string worldsheet perspective, which is poorly understand even in the case of AdS_3 for which string quantization is possible.

Let me now turn to my work on applications and implications of holography. Gravity/gauge theory dualities are also clearly profoundly important in understanding black hole physics. The key result of microscopic counting of black hole entropy due to Strominger and Vafa can be stated as an immediate corollary of the AdS/CFT correspondence. More recently, AdS/CFT has led to an interesting proposal for black hole physics, the so-called *fuzzball proposal*. According to this proposal of Mathur, for each microstate of the black hole there is a horizon-free, non-singular geometry which approaches the black hole geometry at large distances but differs in the interior. The black hole geometry emerges upon coarse-graining over these geometries.

This interesting proposal has the potential to resolve long standing black hole issues, such as the information loss paradox. AdS/CFT provides evidence for the proposal, since according to the general framework pure states in the CFT should have a geometric dual with no horizon, whilst mixed states should be dual to geometries with horizons. In a recent series of papers, Skenderis and I have provided detailed evidence for this picture, by matching data extracted from fuzzball geometries with CFT data of black hole microstates, for certain supersymmetric black hole systems. We recently wrote an invited Physics Report summarizing the status of this proposal. Currently we are working on extensions to more general supersymmetric and near extremal black holes, in particular addressing the question of what features the microstate geometries should have, and how a non-extremal microstate could decay in such a way as to mimic Hawking radiation. A more ambitious goal would be to quantify how a typical microstate of an astrophysical black hole would differ from the black hole geometry itself.

Apart from these specific directions, my research interests include string theory, relativity, supersymmetric field theory and more generally beyond the standard model physics. I have one PhD student, Milena Smolic, working on the use of NPI methods in quantum field theory to understand thermalization of plasmas. This project interfaces with my work on black holes, as in holography plasma thermalization is dual to black hole formation, but the methodology should also be of wider interest. In other work we are using holographic methods to compute correlators in a strongly coupled hidden sector of a gauge mediated supersymmetry breaking model. The idea is to explore how a strongly coupled hidden sector could change the resulting phenomenology in the visible sector; the method of computing correlators uses heavily the holographic toolbox discussed above.

More generally, in anticipation of experimental results from LHC and from experiments such as Planck, I am increasingly following both phenomenology and cosmology. As cosmological data, in particular, improves, I believe that formal theory will become more closely connected to cosmology and that holographic approaches to cosmology may play an important role.

Statement of teaching philosophy

I believe that the main aim of a physics class should be to teach the students to think and reason like physicists. This includes learning how the world can be described in the language of mathematics and how complicated physical systems can be modeled by simplified mathematical models. Both students who continue in physics and those who move into other disciplines, such as medicine or finance, should be able to use and understand physical reasoning in their work and appreciate the underlying mathematical and physical structure all around them.

I feel it is important for courses to emphasize the context of the material and connections between different ideas so that students obtain a good overview of the subject. Thinking back to my own undergraduate experience, different courses often seemed completely disconnected from each other when in fact the subjects were deeply interrelated. One of the most memorable courses I have ever attended was taught at the end of my first undergraduate year by somebody with enormous enthusiasm, who showed us how all the pieces of the jigsaw fit together. For example, we realized how the mathematics we had been learning was going to be used throughout physics. We also started to appreciate how and why modern physics, quantum mechanics and relativity, was born.

A clear lesson from this particular professor was the difference that enthusiasm makes to a class. Equally important, however, is that the teacher is responsive to the level of the class, reiterating important points if necessary; frequently students struggle in science classes because they did not fully understand the earlier material. To gauge the students understanding in my own classes, I find it useful to have discussion sessions and involve the whole class in answering questions. I also think that working collaboratively in small groups is enormously beneficial to students. Not only do they share their knowledge, but they also learn how others reason and how to solve problems together.

I notice amongst the students I teach that they often find it difficult to process what they have learned and to apply it. To some degree this is because they rely too much on memorization rather than understanding; they can apply what they have learned to similar problems but not to those that initially look different. In my own classes I deliberately give problems which need a little manipulation and always encourage students to explain the principles underlying their calculations. I try and help them appreciate precisely what they do and do not understand, aiming to develop their own critical self appraisal. I also want them to learn how to check that their answers are sensible.

Given the declining interest in many university science courses, I think outreach programs are of crucial importance. My own research field of high energy physics is captivating for both adults and school students, but for many physics is too intimidating a discipline to consider studying. Public lectures, visits to high schools and other outreach activities can capitalize on the interest that many have and encourage students to consider studying physics at university. Moreover I would hope that I can encourage more women to pursue exact sciences. For me physics is a profound and exciting subject which has fascinated me since childhood. As a teacher I hope to convey my love of the subject and to help students develop their understanding as much as possible.

Referees

- **Professor S. W. Hawking**

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