

Curriculum Vitae

Horatiu Stefan Nastase

Address: Physics Department,
Brown University,
Box 1843, 182 Hope St.,
Providence, RI-02912, USA
Phone: (401) 863 1470
e-mail: nastase@het.brown.edu

Personal data:

Citizenship: Romanian
Birth date: March 25, 1972
Marital status: Single

Education:

- PhD in Physics, 1996–2000. C. N. Yang Institute for Theoretical Physics, S.U.N.Y. Stony Brook,
Advisor: Prof. Peter van Nieuwenhuizen
PhD in May 2000, with thesis “Connections between supergravity and gauge theory from supersymmetry and string theory”
- 1994-1996 Niels Bohr Institute, Copenhagen, Denmark, exchange student (1994-1995)/ research (1995-1996).
Advisor: Prof. Poul Olesen
- 1990-1995 Licentiate’s in Physics (5 year degree), Physics Dept., Bucharest University. Last year at Niels Bohr Institute for thesis work.
Thesis title: ‘The notion of particle and spacetime geometry in superstring theories’
- 1986-1990 ‘Nicolae Balcescu High School for Physics and Mathematics’, Bucharest, Romania

Professional employment

- Assistant Professor of Physics (Research): Sept.2003- present; Brown University
- Teaching: Physics 4 (electromagnetism, optics, introduction to quantum and atomic theory; for science majors outside physics, predominantly pre-med), Summer 2004 and 2005, Brown University. Physics 4 Course Manager, Spring 2005, Brown University.
- Postdoctoral Research Associate: 2002-2003; Brown University
- Member (Postdoctoral Research Associate): 2000-2002; Institute for Advanced Study, Princeton.
- Research Assistant: 1997-2000, S.U.N.Y. Stony Brook
- Teaching Assistant: S.U.N.Y. Stony Brook
 - Fall 1996 Semester. Undergraduate introductory course in Physics: teaching lab and grading.
 - Fall 1998 Semester: (for completion of PhD requirements) Quantum Mechanics, Assistant to Prof. C.N. Yang

Academic honors and prizes:

- 2000 Max Dresden Prize for the best theoretical thesis in the Physics Department of S.U.N.Y. Stony Brook
- 1995 Graduated first in my year (out of approx. 300 students) at the Physics Dept., Bucharest University (average 9.95 out of 10)
- 1995 Scholarship from Niels Bohr Institute
- 1994 Söros Foundation Scholarship for thesis study at NBI (won in department-wide competition)
- 1990 Second Prize at the International Physics Olympiad in Groningen, Netherlands (approx. 150 High School students from over 30 countries)

Research accomplishments

Experimental predictions of string theory via QCD: the Froissart bound, the soft Pomeron and the RHIC fireball. We found that black hole production in the string theory gravity dual is mapped to the “soft Pomeron” behaviour of the total QCD cross section at large s . Heisenberg’s pion model for the saturation of the Froissart bound is mapped exactly onto the gravity dual picture, which is effectively 4 dimensional. I predict the “soft Pomeron” power law $\sigma_{tot} \sim s^\epsilon$ and test that it matches current experiments. The power law counts the extra dimensions in the gravity dual and how many of them are in AdS. The produced black hole in the Froissart regime is mapped to a pion field “soliton”, which is the fireball observed at RHIC. From this picture the general properties of the RHIC fireball are derived. The soliton dual to the black hole can be obtained in a simple scalar field model, and has an apparent singularity equivalent to the black hole horizon. Skyrme solutions stand for hadrons, whereas the boosted solutions collide and form black hole like-solitons.

String theory in flat space and pp waves from Super Yang Mills; lightcone string field theory; Matrix models We found that the string spectrum in flat space and on parallel plane gravitational waves arises from the large N ’t Hooft limit of $\mathcal{N} = 4$ Super Yang-Mills. This was the first concrete realization of the old idea of ’t Hooft that Yang-Mills theories in the large N limit should become string theories. We have found that a class of operators with large R charge has a dual description in terms of strings. We have also shown that an $\mathcal{N} = 2$ orientifold of the $\mathcal{N} = 4$ SYM has a dual description in terms of string theory with open strings interacting with the closed strings. We have started to analyze the interactions (string field theory) of the (closed and open) strings from the point of view of field theory. This has the potential of rigorously (and nonperturbatively) defining the string theory in certain backgrounds, a fact which is still lacking in string theory. We have also found a model describing (M)atrix theory on a pp wave background, that has many possible implications for (M)atrix theory. It admits fuzzy sphere solutions. The possibility of general fuzzy (noncommutative) spheres as (M)atrix theory solutions was also investigated.

Noncommutative theory, cosmology and faster than light solitons I found that a constant H field antisymmetric tensor, H_{123} , even if it is within cosmological bounds, can still have an effect on particle physics, by creating noncommutative solitons (with noncommutativity $\theta^{ij} = \epsilon^{ijk} x^k$) that move faster than the speed of light. They are the analogs of the Hashimoto-

Itzhaki faster than light solitons for constant noncommutativity. The non-commutative background doesn't break spontaneously more Lorentz invariance than the cosmological FRW ansatz already does.

S matrices on pp waves from SYM We have made a proposal of how to derive S matrices on pp waves from SYM correlators. S matrices on nontrivial spaces are interesting on their own, but this proposal could also lead to a nonperturbative definition of the string theory in the pp wave background via SYM.

Planckian scattering effects, black hole production and high energy QCD We have analyzed the cross-section for black hole production in low M_{Pl} scenarios via scattering of Aichelburg-Sexl-type shockwaves in the corresponding gravitational backgrounds, following earlier work of Eardley and Giddings. We have found that the geometric cross-section is still a good approximation. We then applied this scattering methods via AdS-CFT duality, a la Polchinski-Strassler to calculate effects of high energy scattering in QCD. We have proven more rigorously the appearance of the Froissart bound, as suggested originally by Giddings. The formalism for high energy gravitational scattering in AdS-like backgrounds was also extended to more general backgrounds.

Towards a Chern-Simons M theory of $OSp(1|32) \times OSp(1|32)$ I have suggested that one could have a Chern-Simons supergravity in 11 dimensions (a Chern-Simons gauge theory of the supergroup $OSp(1|32) \times OSp(1|32)$) as an extension of the usual 11d Cremmer-Julia-Sherk supergravity. I have explored the possible connection to M theory. The Chern-Simons theory has a cosmological constant already in 11d which could explain the observed cosmological constant, giving an extra justification for the theory, together with interesting cosmologies.

Towards a holographic dual of QCD and braneworld models I have identified a way to keep only fundamental fermions and no adjoint fermions in the gravity-gauge holography. A holographic dual of a nonsupersymmetric theory with fundamental fermions and no adjoint fermions was found, and a candidate QCD dual was described (although the gravity solution was not found). This construction offers new ideas for braneworld constructions of the Standard Model.

Matrix model for massive IIA string theory Matrix theory gives a nonperturbative definition of string/M theory in certain backgrounds. The prototype is flat space M theory in discrete lightcone quantization, put forward by BFSS. All string theories in flat space were described in this way

(together with some compactifications and some nontrivial spaces), except massive IIA. We found that the Matrix model of massive IIA is a D3 brane theory with spacetime noncommutativity, interesting in its own right. Massive IIA is also a laboratory to analyze outstanding problems like de Sitter space in string theory.

Gravity dual of 3d N=1 Super Yang-Mills We analyzed various phenomena in a nonconformal gauge theory using gravity duals. The theory, arising via NS5 branes wrapped on a three-sphere, exhibits dynamical susy breaking, confinement and mass gap in various regimes. It gives a handle on the study of nonperturbative phenomena in more realistic models.

A 'new' AdS-CFT correspondence We gave a new type of relation between a string theory in AdS_5 and a field theory in 4d. The Feynman diagrams of the field theory correspond to discretized worldsheets of the string. In the bosonic case, we obtain a ϕ^4 field theory, in the supersymmetric case we obtain a nonlocal N=4 superfield action for a YM-like theory.

The AdS-CFT correspondence, consistent truncations and gauge invariance; correlators involving p-forms in AdS-CFT The existence of consistent truncations implies that we have to use a modified prescription for the AdS-CFT correspondence. We gave evidence for it, and then computed certain p-form correlators in the AdS-CFT correspondence as a first step to definitely prove the new prescription.

Consistent nonlinear KK truncation of 11-d supergravity on $AdS_7 \times S_4$ and selfduality in odd dimensions - We were the first to find the explicit ansatz and to show consistency of the Kaluza-Klein reduction (truncation to the supergravity multiplet) of the usual 11d supergravity on a nontrivial compact space, namely S_4 . The existence of a consistent truncation was used to eliminate an ambiguity in the formulation of the AdS-CFT correspondence. We also found a mechanism for obtaining 'selfduality in odd dimensions' by KK reduction from higher dimensions.

R current correlators in N=4 SuperYang-Mills theory from Anti-de Sitter supergravity - We used Maldacena's (recently conjectured) AdS-CFT correspondence, in the formulation of Gubser-Klebanov-Polyakov-Witten, to compute three point functions of R current operators in the $SU(N_C)$ SuperYang-Mills theory at large N_C and large 't Hooft coupling, $g^2 N_C$. This provided a nontrivial check of the correspondence, since on the SuperYang-Mills side we could compute them also. The calculation was done in momentum space, as opposed to other x-space calculations in the literature.

Topological boundary conditions, the BPS bound, and elimina-

tion of ambiguities in the quantum mass of solitons We computed the quantum corrections to the mass of a two dimensional soliton ('the kink'). We used these methods for an N=1 supersymmetric model to see whether the Bogomoln'yi bound for the soliton mass, saturated at the classical level, remains saturated at the quantum level. The methods were tested for an N=2 model, where we did not find any corrections, in agreement with general ideas. A new physical principle (the use of the 'topological boundary conditions') was used.

E-prints

1. *Horatiu Nastase*
'Constant H field, cosmology and faster than light solitons,' hep-th/0601182
2. *Horatiu Nastase*
'DBI Skyrmion, high energy (large s) scattering and fireball production,' hep-th/0512171
3. *Horatiu Nastase*
'The RHIC fireball as a dual black hole,' hep-th/0501068.
4. *Horatiu Nastase*
'The soft Pomeron from AdS-CFT,' hep-th/0501039.
5. *Antal Jevicki and Horatiu Nastase*
'Towards S matrices on flat space and pp waves from SYM,' hep-th/0501013.
6. *Horatiu Nastase*
'On fuzzy spheres and (M)atrix actions,' BROWN-HET-1425 and hep-th/0410137
7. *Horatiu Nastase*
'On high energy scattering inside gravitational backgrounds,' BROWN-HET-1424 and hep-th/0410124
8. *Horatiu Nastase*
'Towards a Chern-Simons M theory of $Osp(1|32) \times OSp(1|32)$,' hep-th/0306269
9. *Horatiu Nastase*
'On Dp-Dp+4 systems, QCD dual and phenomenology,' hep-th/0305069
10. *David Berenstein and Horatiu Nastase*
'On lightcone string field theory from Super Yang-Mills and holography,' hep-th/0205048
11. *David Berenstein, Edi Gava, Juan Maldacena, K.S. Narain and Horatiu Nastase*
'Open string on plane waves and their Yang-Mills duals,' hep-th/0203249
12. *Horatiu Nastase and Diana Vaman*
'The AdS/CFT correspondence, consistent truncations and gauge invariance,' hep-th/0004123
13. *Horatiu Nastase*
A possible solution of the black hole information paradox through quantum gravity unified with other interactions, hep-th/9601042, NBI-HE-96-02.

Published works

1. *Kyungsik Kang and Horatiu Nastase*
'High energy QCD from Planckian scattering in AdS and the Froissart bound,' **Phys. Rev. D** 72:106003, 2005 and hep-th/0410173
2. *Kyungsik Kang and Horatiu Nastase*
'Heisenberg saturation of the Froissart bound from AdS-CFT,' **Phys. Lett. B** 624:125-134, 2005 hep-th/0501038.
3. *Kyungsik Kang and Horatiu Nastase*
'Planckian scattering effects and black hole production in low M_{Pl} scenarios,' **Phys. Rev. D** 71:124035, 2005 and hep-th/0409099
4. *David Lowe, Horatiu Nastase and Sanjaye Ramgoolam*
'Massive IIA string theory and Matrix theory compactification', **Nucl. Phys. B** 667 (2003) 55, hep-th/0303173
5. *David Berenstein, Juan Maldacena and Horatiu Nastase*
'Strings in flat space and pp waves from N=4 Super Yang-Mills', **AIP Conf. Proc.** 646 (2003) 3
6. *David Berenstein, Juan Maldacena and Horatiu Nastase*
'Strings in flat space and pp waves from N=4 SuperYang-Mills', **JHEP** 0204 (2002) 013, hep-th/0202021
7. *Juan Maldacena, Horatiu Nastase*
'The supergravity dual of a theory with dynamical supersymmetry breaking', **JHEP** 0109 (2001) 024, hep-th/0105049
8. *Horatiu Nastase, Warren Siegel*
'A new AdS/CFT correspondence', **JHEP** 0010:040, 2000, hep-th/0010106
9. *Iosif Bena, Horatiu Nastase and Diana Vaman*
'Propagators for p-forms in AdS(2p+1) and correlation functions in the AdS(7)/(2,0) CFT correspondence', **Phys. Rev. D** 64:106009, 2001, hep-th/0008239
10. *Horatiu Nastase*
'Connections between supergravity and gauge theory from supersymmetry and string theory', PhD Thesis, UMI-99-74922-mc (microfiche) (2000)
11. *Horatiu Nastase, Diana Vaman*
'On the nonlinear KK reductions on spheres of supergravity theories', **Nucl. Phys. B** 583:211-236, 2000, hep-th/0002028
12. *Horatiu Nastase, Diana Vaman and Peter van Nieuwenhuizen,*
'Consistency of the $AdS_7 \times S_4$ reduction and self-duality in odd dimensions', **Nucl. Phys. B** 581:179-239, 2000, hep-th/9911238
13. *Horatiu Nastase, Diana Vaman and Peter van Nieuwenhuizen,*

'Consistent nonlinear KK truncation of 11-d supergravity on $AdS_7 \times S_4$ and selfduality in odd dimensions', *Phys. Lett. B* 469:96-102, 2000, hep-th/9905075

14. *Gordon Chalmers, Horatiu Nastase, Koenraad Schalm and Ruud Siebelink*, 'R current correlators in N=4 SuperYang-Mills theory from Anti-de Sitter supergravity', **Nucl. Phys. B** 540:247-270, 1999, hep-th/9805105

15. *Horatiu Nastase, Misha Stephanov, Peter van Nieuwenhuizen and Anton Rebhan* 'Topological boundary conditions, the BPS bound, and elimination of ambiguities in the quantum mass of solitons', **Nucl. Phys. B** 542:471-514, 1999, hep-th/9802074

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Review work

- Member of selection panel- peer reviewing the “Young researchers competition in honor of John Archibald Wheeler”, January 2002

Research talks

- Black hole production, the Froissart bound, the soft Pomeron and the RHIC fireball from AdS-CFT, given at
 - Chicago University, January 2005
 - YITP, SUNY Stony Brook, January 2005
 - Nuclear Theory group, Brookhaven National Lab, January 2005
 - Rochester University, February 2005
 - Princeton University, February 2005
 - Brown University, February 2005
 - MIT, February 2005
 - KITP, UC Santa Barbara, February 2005
 - Rutgers University, March 2005
 - University of Wisconsin, Madison, March 2005
 - University of Michigan, Ann Arbor, March 2005
 - Yale University, September 2005
- High energy QCD and the Froissart bound from AdS scattering, Miami 2004 (Key Biscayne and Corral Gables), December 2004
- High energy scattering and black hole production, given at
 - PASCOS 2004 (Northeastern University) plenary talk, August 2004
 - Brown University, September 2004
- String theory from gauge theory and vvs., Texas A& M, April 2004
- String theory on pp waves from SYM, Rochester U, April 2004
- String theory and gravity in extra dimensions, Complexity and dimensionality workshop, March 2004, Brown Univ.

- On Dp-D(p+4) systems, QCD dual and phenomenology, given at
 - Brown University, September 2003
 - Harvard University, October 2003
 - University of New Hampshire, November 2003
- Towards a Chern-Simons M theory of $OSp(1|32) \times OSp(1|32)$, given at
 - Brown University, June 2003
 - SUNY Stony Brook, October 2003
- Massive IIA string theory and Matrix theory compactification, given at
 - U Wisconsin at Madison, February 2004
 - Brown University, April 2003
 - MIT, April 2003
- Matrix models and pp waves, Duke University, October 2002
- String interactions and holography in pp wave backgrounds, Brown University, June 2002
- String and matrices in flat space and pp waves from supersymmetric gauge theories, given at:
 - ITP, University of California at Santa Barbara, March 2002
 - Caltech-USC Institute for Theoretical Physics, March 2002
 - State University of New York at Stony Brook, March 2002
 - Rockefeller University, March 2002
 - Ohio State University, April 2002
 - Rutgers University, April 2002
- A 3d gauge theory with dynamical susy breaking and its supergravity dual, Princeton University, June 2001
- Consistent nonlinear KK reductions on spheres and the AdS-CFT correspondence, given at:
 - University of Michigan at Ann Arbor, December 1999

-Syracuse University, January 2000

-Brown University, January 2000

Informal talks

At the Institute for Advanced Study;

- 'Random strings and the AdS-CFT correspondence', February 2001
- 'Superembeddings', October 2000.

At the YITP Stony Brook:

- 'P-brane solutions of the supergravity equations of motion', Spring 1998
- 'Introduction to Seiberg-Witten theory', Spring 1997
- 'Introduction to D-branes', Fall 1996

Professional references

-Prof. Antal Jevicki, Physics Dept., Box 1843, Brown University, Providence RI-02912, USA

email: antal@het.brown.edu

phone: (401) 863 2624

-Prof. Kyungsik Kang, Physics Dept., Box 1843, Brown University, Providence RI-02912, USA

email: kang@het.brown.edu

phone: (401) 863 1468

-Prof. Juan Maldacena, I.A.S., Princeton NJ 08540, USA

email: malda@ias.edu

phone: (609) 734 8307

-Prof. Peter van Nieuwenhuizen, YITP, S.U.N.Y. Stony Brook, NY-11974-3840, USA

email: vannieu@insti.physics.sunysb.edu

phone: (631) 632 7972

-Prof. Martin Roček, YITP, S.U.N.Y. Stony Brook, NY-11974-3840, USA

email: rocek@insti.physics.sunysb.edu

phone: (631) 632 7965