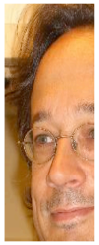
Strings and Mathematical Physics

Zeuthen, Oct 20, 2016

82th PRC meeting

The Group

VS



Joerg Teschner

As of 2016, Joerg Teschner holds joint professorship on Quantum Geometry

Elli Pomoni

2+3 postdocs

and 2+5 PhDs

Funding

Particles, Strings,
and the Early Universe
Collaborative Research Center SFB 676

Marie Curie
Actions

Research Training Group 1670
MATHEMATICS INSPIRED BY STRING THEORY AND QUANTUM FIELD THEORY

Funding

In preparation: Transregio in Mathematical Physics

with Uni HH, HU +TU Berlin, Potsdam U

Topics:

- **Geometry**
- **Integrability**
- **Amplitudes**

Submission planned for Dec 2016

DESY scientists PI s in 6 projects

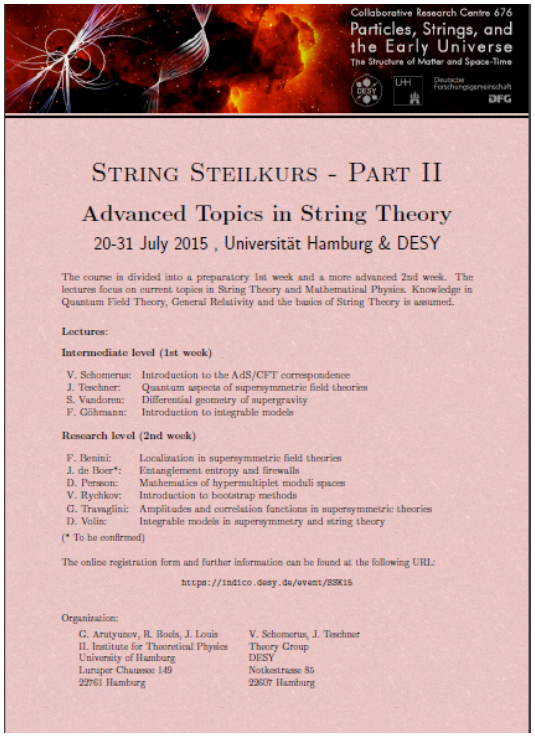
SAGEX – MC network on Amplitudes *to be submitted*

Events

SIMONSCENTER FOR GEOMETRY AND PHYSICS

Gauge Theory, Integrability, and Novel Symmetries of Quantum Field Theory

3 month program in 2014



Collaborative Research Centre 676
Particles, Strings, and the Early Universe
The Structure of Matter and Space-Time

STRING STEILKURS - PART II

Advanced Topics in String Theory

20-31 July 2015 , Universität Hamburg & DESY

The course is divided into a preparatory 1st week and a more advanced 2nd week. The lectures focus on current topics in String Theory and Mathematical Physics. Knowledge in Quantum Field Theory, General Relativity and the basics of String Theory is assumed.

Lectures:

Intermediate level (1st week)

V. Schomerus:	Introduction to the AdS/CFT correspondence
J. Teschner:	Quantum aspects of supersymmetric field theories
S. Vandoren:	Differential geometry of supergravity
F. Göhmann:	Introduction to integrable models

Research level (2nd week)

F. Benini:	Localization in supersymmetric field theories
J. de Boer*:	Entanglement entropy and firewalls
D. Persson:	Mathematics of hypermultiplet moduli spaces
V. Rychkov:	Introduction to bootstrap methods
G. Travaglini:	Amplitudes and correlation functions in supersymmetric theories
D. Volin:	Integrable models in supersymmetry and string theory

(* To be confirmed)

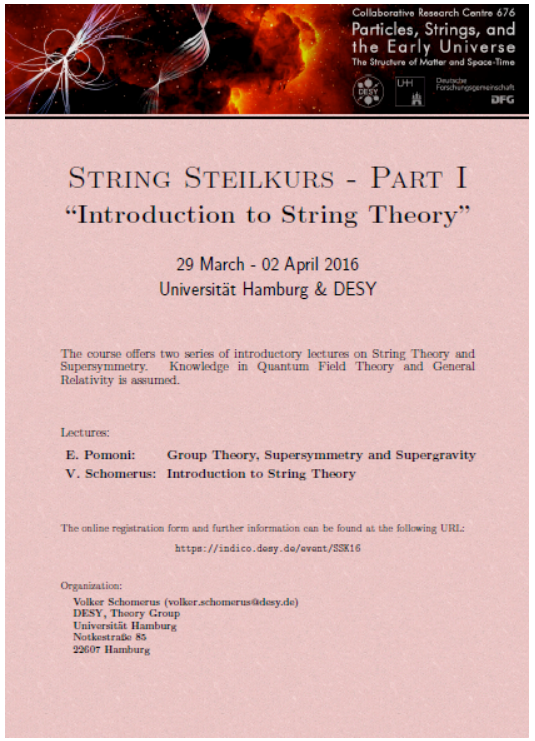
The online registration form and further information can be found at the following URL:

https://indico.desy.de/event/SSK15

Organization:

G. Arutyunov, R. Boels, J. Louis
II. Institute for Theoretical Physics
University of Hamburg
Luruper Chaussee 149
22761 Hamburg

V. Schomerus, J. Teschner
Theory Group
DESY
Notkestrasse 85
22607 Hamburg



Collaborative Research Centre 676
Particles, Strings, and the Early Universe
The Structure of Matter and Space-Time

STRING STEILKURS - PART I

"Introduction to String Theory"

29 March - 02 April 2016
Universität Hamburg & DESY

The course offers two series of introductory lectures on String Theory and Supersymmetry. Knowledge in Quantum Field Theory and General Relativity is assumed.

Lectures:

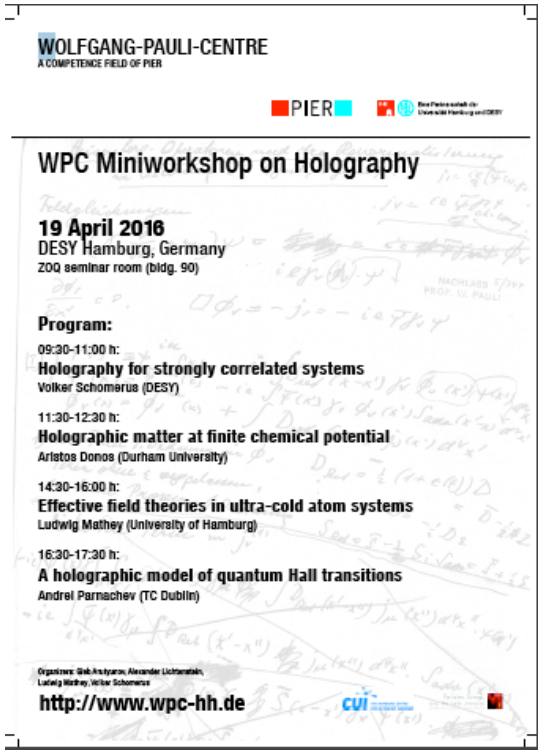
E. Pomoni: Group Theory, Supersymmetry and Supergravity
V. Schomerus: Introduction to String Theory

The online registration form and further information can be found at the following URL:

https://indico.desy.de/event/SSK16

Organization:

Volker Schomerus (volker.schomerus@desy.de)
DESY, Theory Group
Universität Hamburg
Notkestraße 85
22607 Hamburg



WOLFGANG-PAULI-CENTRE
A COMPETENCE FIELD OF PIER

PIER

WPC Miniworkshop on Holography

19 April 2016
DESY Hamburg, Germany
ZOQ seminar room (bldg. 90)

Program:

09:30-11:00 h:
Holography for strongly correlated systems
Volker Schomerus (DESY)

11:30-12:30 h:
Holographic matter at finite chemical potential
Aristos Donos (Durham University)

14:30-16:00 h:
Effective field theories in ultra-cold atom systems
Ludwig Mathey (University of Hamburg)

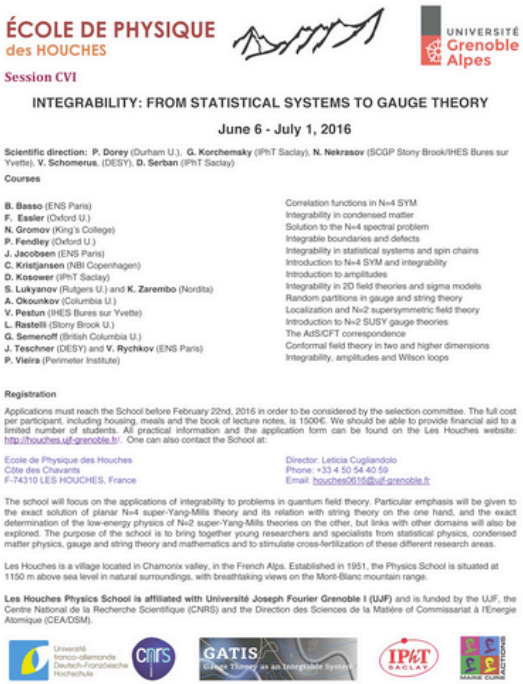
16:30-17:30 h:
A holographic model of quantum Hall transitions
Andrei Parnachev (TC Dublin)

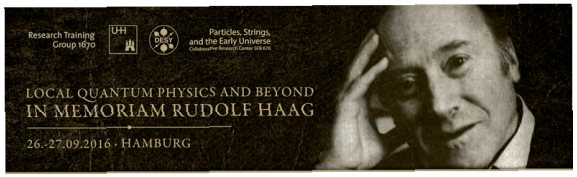
Organizers: Gleb Arutyunov, Alexander Lichtenstein, Ludwig Mathey, Volker Schomerus

http://www.wpc-hh.de

CUI

Events





Record participation

(240)

Host of StringMath 2017 + School

Network: GATIS → GATIS+

EU Funding until Dec 2016

Currently signing of MoU between 15 partners

10 nations

Includes: Mentoring program

Yearly fellow workshop

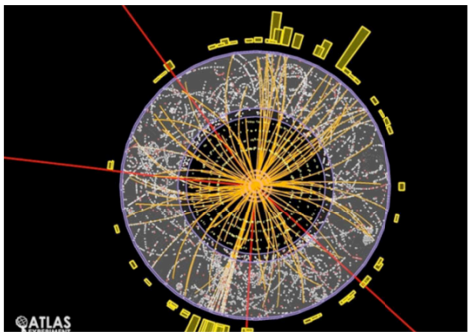
Common website

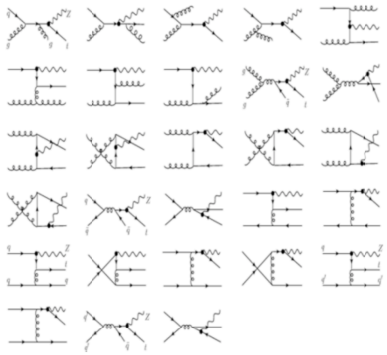
Science

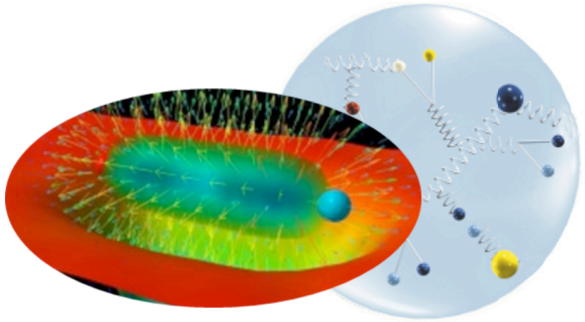
highlights

Introduction: Gauge Theory

… is universal framework to describe nature







Questions

Is string theory more efficient ?

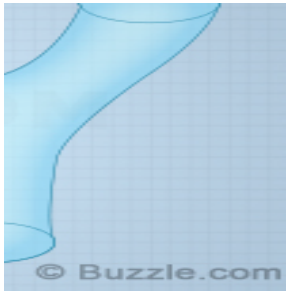
Hidden symmetries manifest

Can one access low energy physics directly ?

Rather than through microscopic description

Strings and High Energy Scattering

Strings too soft ?

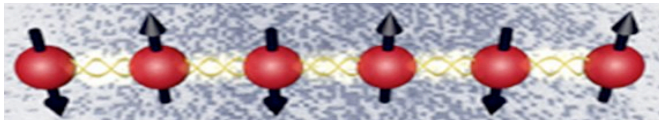


2 → 2 gluon scattering in planar N = 4 SYM

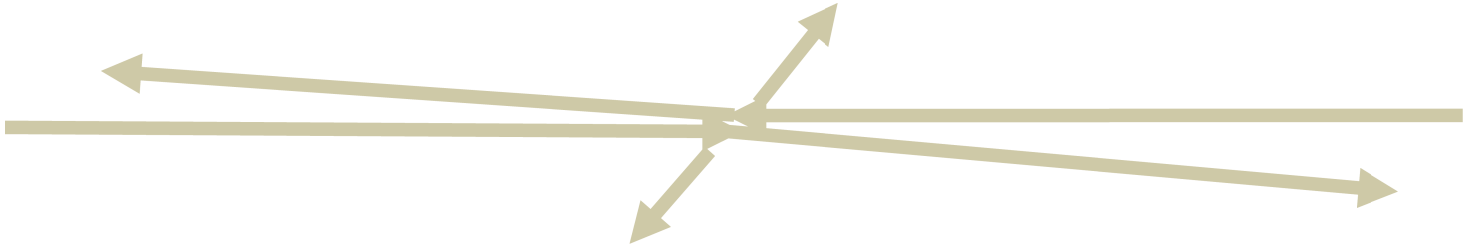
Gluon Regge trajectory computed:

- **with `standard' techniques to 4 orders**
- **at strong coupling through holography**
- **N^kLLA through integral eqn. for any k !**

= vacuum energy of spin chain

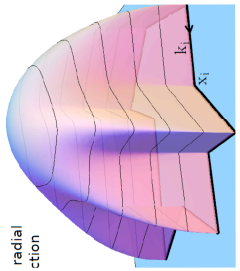


Strings and High Energy Scattering



2 → 4 production amplitude in planar N = 4 SYM

- **In (N)LLA using BFKL technology**
- **at strong coupling through holography**
- **N^kLLA by BCS equation for any k!**



[Bartels, Kotanski, Sprenger, VS, 2010-]

Sums infinite no of Feynman diagrams (also in QCD)

Strings and Gauge Theory

Extensions to string based precision calculations with

higher multiplicities

less SUSY

Wilson coefficients

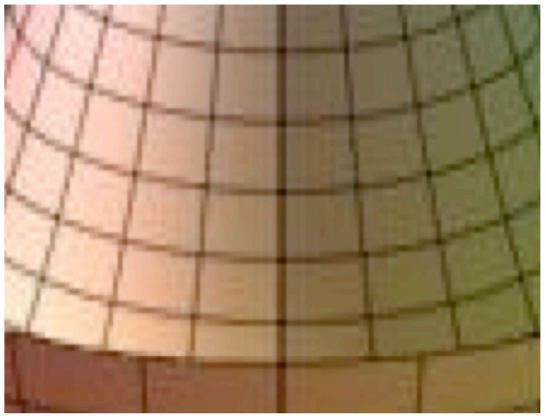
in collobaration with J. Bartels, S. Moch & E. Pomoni,

+ 2 postdocs, 3 PhD students

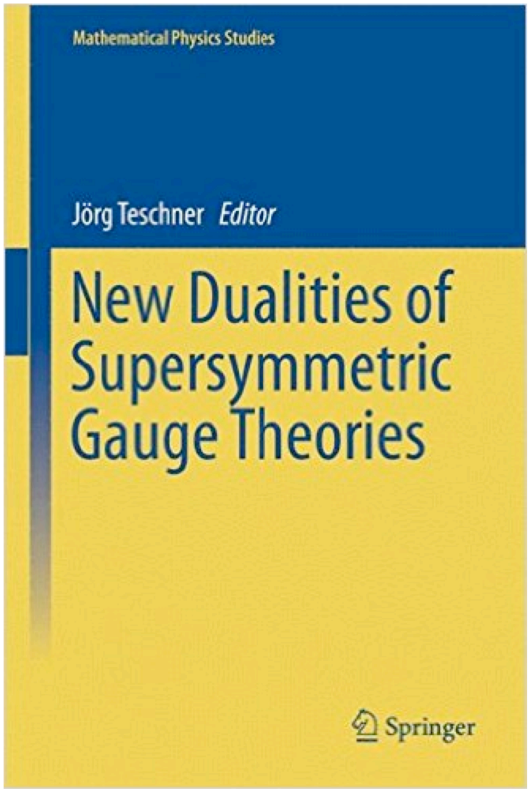
Supersymmetric Gauge Theory

Special observables can be computed non-perturbatively for a large class of theories

e.g. Wilson loops, (Higgs) effective potential



many scalars, rich spaces of vacua



Supersymmetric Gauge Theory

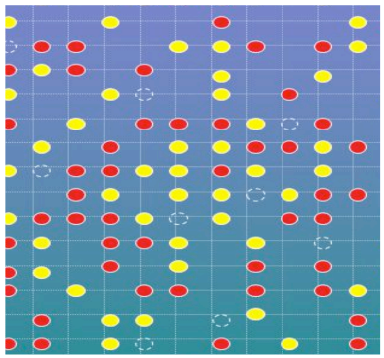
New results on quantization of spaces related to 2D surfaces

space of constant curvature metrics..

. [Aghaei, Coman-Lohi,

. Teschner]

Exact solutions of important 2D critical systems



[Isachenkov, Mitev, Pomoni]

Ongoing work Pomoni, Teschner with 1 postdoc, 3 PhDs

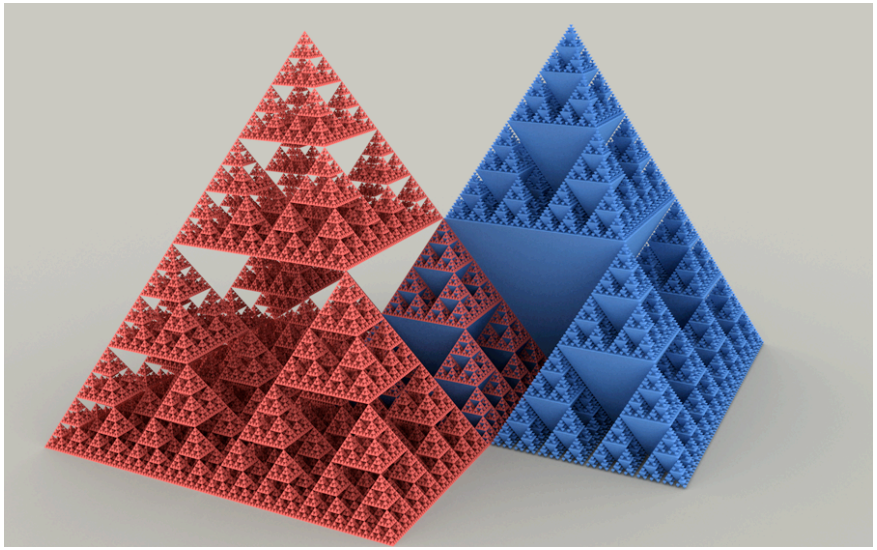
Conformal Field Theory

Scale invariant/conformal field theories describe infrared behavior of many quantum systems

often strongly coupled

QCD depending on no of fermion flavors

Heisenberg spin chain depending on spin S [Haldane]



Conformal Bootstrap

Program to provide direct access to infrared physics for large class of models (with and without SUSY)

Designed in early 1970s **[Polyakov] [Ferrara et al] [Mack]**

Atomic physics: Wigner's theory of symmetries + eqns for (dynamical) reduced matrix elements

Relevant theoretical background was not developed

Recent numerical studies of dynamical eqns provide results for critical exponents with record precision

Conformal Bootstrap

Relevant input from group theory of conformal symmetry

related to study of 1D solvable Schroedinger problems!

Poeschel-Teller -> Calogero, Sutherland, Moser
(early 1970s)
[Isachenkov, VS]

Opens the door for analytical computation

of critical exponents in d > 2 (e.g. 3D Ising)

In addition pursue implications of conformal bootstrap on dynamics of supersymmetric field theories

2 postdocs, 1 PhD student

Concluding Remarks

Group maintains a research profile with strong links to

High Energy Physics

Mathematics

Condensed Matter

Well embedded into local and international environment

healthy and stimulating

Relation with Mathematics is consolidated

There are new opportunities with CondMat