

# Scientific Summary

The 25th Nordic and 1st British-Nordic congress of Mathematicians covers a broad variety of mathematical topics. Besides the plenary sessions, which include e.g. talks on geometric group theory, algebraic topology and K-theory, and algebraic geometry, there are a number of special sessions which bring together experts on more specialized topics.

The special session “Quantum fields and representation theory” is devoted to mathematical aspects of quantum field theory. Research in quantum field theory involves on the one hand algebraic methods from the representation theory of finite- and infinite-dimensional Lie algebras (which arise as symmetries of physical systems) and the theory of operator algebras in Hilbert spaces and, on the other hand, topological and geometric methods. Accordingly the study of problems in quantum field theory has attracted mathematicians working in representation theory, differential geometry, topology, operator algebras, and infinite-dimensional Lie algebras.

The special session will concentrate on the following aspects:

- Quantum field theory on general manifolds:

To formulate the theory on generic space-times, rather than in Minkowski space to which the standard formalism of quantum field theory is tailored, requires new concepts and tools. For instance, the ideas of a vacuum representation and of positive energy get replaced by operator algebras and by the so-called microlocal spectrum condition. The concept of covariance under a group of isometries is replaced by a characterization of quantum fields as natural transformations between different functors on a category of space-times. Other structural properties assume a natural role in the categorical framework as well. In particular, the quantum field theoretical initial value problem is related to cobordisms.

- Quantum deformation of differential structures:

Quantum analogs of various structures that are obtained via a suitable  $q$ -deformation play a role in many different contexts. In the session, the focus will be on a quantum version of the spherical transform and on the corresponding pairwise commutative invariant differential operators together and their eigenfunctions.

- Holomorphic extension of spherical representations:

This deals with the extension problem for matrix coefficients of spherical representations of a Lie group  $G$  (representations for which there exists a nontrivial vector fixed under the maximal compact subgroup  $K$  of  $G$ ). These coefficients are real analytic functions on the Riemannian symmetric space  $G/K$  and extend to holomorphic functions on a certain neighborhood of  $G/K$  in its complexification.

- Fusion rings in conformal field theory:

An important datum of a two-dimensional conformal quantum field theory is the Grothendieck ring of the relevant representation category of the chiral symmetries of the theory, which is also called a fusion ring. Of particular interest are the fusion rings of Wess-Zumino-Witten type conformal field theories, in which the symmetries are determined by an affine Lie algebra. In the session, focus will be on the fusion ring for the case of affine  $sl(n)$ . Thus turns out to be related to the quantum cohomology of the Grassmannian, and as a consequence its structure constants can be described in terms of cyclic non-commutative Schur functions.

## Abstract

This meeting deals with geometric and representation theoretic structures that arise in connection with problems in quantum field theory. The focus is on a categorical framework for quantum field theory on general manifolds, quantum deformations of differential structures, the holomorphic extension of spherical representations, and fusion rings in Wess-Zumino-Witten models of conformal quantum field theory.

# Meeting Programme

The 25th Nordic and 1st British-Nordic congress of Mathematicians takes place from Monday 8 June to Thursday 11 June 2009.

Its special session “Quantum fields and representation theory” will be in the afternoon of Monday 8 June and consist of 4 talks (14:30-15:10, 15:20-16:00, 16:30-17:10, 17:20-18:00).

The speakers will be:

O. Bershtein (Kharkov, Ukraine)

K. Fredenhagen (Hamburg, Germany)

H. Schlichtkrull (København, Denmark)

C. Stroppel (Bonn, Germany)

# Curriculum Vitae of Scientific Organiser

Name: **Jürgen Fuchs**

Date and place of birth: 19 May 1957, in Baden-Baden, Germany

Citizenship: German

Doctoral degree: Theoretical Physics (Quantum Field Theory), Heidelberg University, 1985

## Current position:

Full Professor of Theoretical Physics at Karlstad University, Sweden, since May 2002

## Previous positions:

01/2000–04/2002: Docent (Lektor) at Karlstad University

04/1999–12/1999: Scientific Associate, ETH, Zürich (Switzerland)

10/1998–03/1999: Scientific Associate, CERN, Genève (Switzerland)

10/1997–09/1998: “Wissenschaftlicher Angestellter”,  
Max-Planck-Institut for Mathematics, Bonn (Germany)

Postdoctoral work:

10/1992–09/1997: Heisenberg fellow, at NIKHEF and at DESY, Hamburg (Germany)

10/1990–09/1991 & 04/1992–09/1992: Fellow at CERN, Genève (Switzerland)

09/1988–09/1990 & 10/1991–03/1992: Postdoc at NIKHEF, Amsterdam (Netherlands)

02/1987–08/1988: Postdoc at Heidelberg University, Heidelberg (Germany)

09/1985–01/1987: Postdoc at Princeton University, Princeton (NJ, USA)

## Other information:

■ *Heisenberg fellowship* from the Deutsche Forschungsgemeinschaft (1992–1997)

■ *Recent long-term research visits:*

2007: Visitor at Hamburg University (2 months)

2006: Visitor at Oslo University ( $1\frac{1}{2}$  months)

2004: Senior Research Fellow at ESI (Erwin Schrödinger Institute), Vienna ( $2\frac{1}{2}$  months)

2002: Professeur invité at Université Paris VII (1 month)

2001: Associate at ESI, Vienna (1 month)

2001: Professeur invité at Université Paris VI (1 month)

■ *Board memberships:*

Steering Committee of the ESF research network “Interactions of Low-Dimensional  
Topology and Geometry with Mathematical Physics” (ITGP), 2009–2014

Scientific Board of the Baltic-Nordic Workshop Network “Algebra, Geometry and  
Mathematical Physics” (AGMF), since 2005

Advisory Board for the *Concise Encyclopedia of Supersymmetry* (Kluwer, 2004)

■ *Recent and future invitations as plenary speaker at international conferences:*

- 04/2010: ESI, Vienna, Austria, “Quantum Field Theory on Curved Space-Times”  
09/2009: Maresias, Brazil, “WAGP09 Workshop on Algebraic Geometry and Physics”  
08/2009: Córdoba, Argentina, “Hopf Algebras, Quantum Groups and Tensor Categories”  
06/2009: Prague, Czech Republic, “Integrable Systems and Quantum Symmetries”  
05/2009: Zürich, Switzerland, “Logarithmic Conformal Field Theory”  
04/2009: Glasgow, UK, “Categorification and Geometrisation from Repres. Theory”  
04/2008: Luminy, France, “Groupes Quantiques Dynamiques et Catégories de Fusion”  
12/2007: Ringberg, Germany, “Mini-Symposium on Topological Quantum Computation”  
10/2006: Lund, Sweden, “Algebra, Geometry, and Mathematical Physics”  
06/2006: Strasbourg, France, “Knots and Physics”  
03/2006: Cairo, Egypt, “Algebras and Coalgebras - tools for Geometry, Physics and Computer Science”  
2005: Tallinn, Estonia; Sydney, Australia; St.Petersburg, Russia; Raleigh, NC, USA;  
Bonn, Germany

■ *Recent and future events coorganized:*

- 10/2009: Conference “Algebra, Geometry, and Mathematical Physics”, Bedlewo (Poland)  
06/2009: Special session “Representation Theory and Quantum Fields”  
at the 25th Nordic and 1st British-Nordic Congress of Mathematicians, Oslo  
07/2008: Conference “Noncommutative Structures in Mathematics and Physics”, Brussels  
07/2008: Minisymposium “Representation Theoretical Methods and Quantization”  
at the 5th European Congress of Mathematics, Amsterdam  
10/2007: Conference “Algebra, Geometry, and Mathematical Physics”, Göteborg  
07/2004: Conference “Non-commutative Geometry and Representation Theory in  
Mathematical Physics”, Karlstad University  
06–07/2004: Program on *Tensor Categories in Mathematics and Physics*, ESI, Vienna

■ *Referee for various international journals in Physics and Mathematics:*

e.g. for Communications in Math. Physics, Contemporary Mathematics, Journal of High Energy Physics, Journal of Math. Physics, Journal of Physics A, Journal of Algebra, Nuclear Physics B, Physics Letters B, Representation Theory, Reviews in Math. Physics, SIGMA

■ *External referee panel for research grants:*

Alexander von Humboldt Foundation, Canadian Natural Sciences and Engineering Research Council, Austrian Science Fund FWF, German-Israeli Minerva Foundation, Swiss National Science Foundation

■ *List of five most relevant publications during the last five years:*

1. with S. Hwang, A.M. Semikhatov and I.Yu. Tipunin:  
Nonsemisimple fusion algebras and the Verlinde formula.  
Communications in Mathematical Physics 247 (2004) 713–742
2. with J. Fröhlich, I. Runkel and C. Schweigert:  
Correspondences of ribbon categories.  
Advances in Mathematics 199 (2006) 192–329
3. with J. Fjelstad, I. Runkel and C. Schweigert:  
TFT construction of RCFT correlators V: Proof of modular invariance and factorisation.  
Theory and Appl. of Categories 16 (2006) 342-433
4. with J. Fjelstad, I. Runkel and C. Schweigert:  
Uniqueness of open/closed rational CFT with given algebra of open states.  
Advances in Theoretical and Mathematical Physics 12 (2008) 1281-1373
5. with C. Schweigert and K. Waldorf:  
Bi-branes: Target space geometry for world sheet topological defects.  
Journal of Geometry and Physics 58 (2008) 576-598

## Provisional list of proposed speakers/participants

For the list of speakers at the special session see the *Meeting Programme* above.

A list of registered participants of the 25th Nordic and 1st British-Nordic congress of Mathematicians is supplied below. There is no separate list for prospective participants of any of the special sessions. However, those persons marked by an asterisk in the list below can be expected to be particularly interested in the special session “Quantum fields and representation theory”.

	Aanderaa, Stål	University of Oslo	Norway
*	Alekseevsky, Dmitri	Edinburgh University	United Kingdom
	Alfsen, Erik	University of Oslo	Norway
	Archbold, Robert	University of Aberdeen	United Kingdom
	Aslaksen, Helmer	National Univ. of Singapore	Singapore
*	Baas, Nils	NTNU	Norway
	Ball, John	University of Oxford	United Kingdom
*	Bartels, Arthur	Universität Münster	Germany
	Bartolini, Gabriel	Linköpings universitet	Sweden
	Bedos, Erik	University of Oslo	Norway
	Beggs, Edwin	Swansea University	United Kingdom
	Behrndt, Jussi	TU Berlin	Germany
	Boman, Jan	Stockholm University	Sweden
	Borge, Christin	University of Oslo	Norway
*	Bratteli, Ola	University of Oslo	Norway
	Breda d’Azevedo, Antonio	University of Aveiro	Portugal
	Bridson, Martin	Oxford University	United Kingdom
	Broman, Erik	Chalmers University of Technology	Sweden
	Brown, Gavin	University of Kent	United Kingdom
	Brun, Morten	Universitetet i Bergen	Norway
*	Bujalance, Emilio	UNED	Spain
	Cairns, Andrew	Heriot-Watt University	United Kingdom
	Carlsen, Toke Meier	NTNU	Norway
	Carocca, Angel	P. Universidad Catolica de Chile	Chile
	Chen, Gui-Qiang	Northwestern University	United States
	Christensen, Erik	University of Copenhagen	Denmark
	Christiansen, Snorre	University of Oslo	Norway
	Coquand, Thierry	University of Gothenburg	Sweden
	de Snoo, Hendrik	University of Groningen	Netherlands
	Dencker, Nils	Lund University	Sweden
	Di Nunno, Giulia	University of Oslo	Norway
*	Di Rocco, Sandra	Royal Institute of Technology (KTH)	Sweden
	Diaz, Raquel	Univ. Complutense	Spain
	Digernes, Trond	NTNU	Norway
	Djehiche, Boualem	Royal Institute of Technology (KTH)	Sweden
	Dunajski, Maciej	University of Cambridge	United Kingdom
*	Durhuus, Bergfiinnur	Copenhagen University	Denmark
	Dutkay, Dorin	University of Central Florida	United States

	Eilers, Søren	University of Copenhagen	Denmark
*	Evans, David E	Cardiff University	United Kingdom
	Fels, Mark	Utah State University	United States
	Fenstad, Jens Erik	University of Oslo	Norway
	Ferapontov, Evgeny	Loughborough University	United Kingdom
	Fill, James Allen	The Johns Hopkins University	United States
	Fournais, Soeren	University of Aarhus	Denmark
*	Fredenhagen, Klaus	Universität Hamburg	Germany
*	Fuchs, Jürgen	Karlstads universitet	Sweden
	Fuertes, Yolanda	Universidad Autonoma de Madrid	Spain
	Gesztesy, Fritz	University of Missouri	United States
	Giordano, Thierry	University of Ottawa	Canada
	Girondo, Ernesto	Universidad Autonoma de Madrid	Spain
	Godoy, Mauricio	Universitet i Bergen	Norway
	Gohm, Rolf	Aberystwyth University	United Kingdom
	Gonzalez-Diez, Gabino	Universidad Autonoma de Madrid	Spain
	Grbic, Jelena	University of Manchester	United Kingdom
	Greenlees, John	University of Sheffield	United Kingdom
	Gregersen, Thomas	University of Oslo	Norway
	Grodal, Jesper	University of Copenhagen	Denmark
	Gromadzki, Grzegorz	Gdansk University	Poland
	Grønbæk, Niels	University of Copenhagen	Denmark
	Grubb, Gerd	Copenhagen University	Denmark
	Häggsström, Olle	Chalmers University of Technology	Sweden
	Harvey, William	Kings College	United Kingdom
	Hassi, Seppo	University of Vaasa	Finland
	Henderson, Vicky	University of Oxford	United Kingdom
	Hidalgo, Ruben	UTFSM	Chile
	Hitching, George Harry	Høgskolen i Vestfold	Norway
	Hofmann, Andrea	University of Oslo	Norway
	Holmström, Andreas	University of Cambridge	United Kingdom
	Huggett, Stephen	London Mathematical Society	United Kingdom
	Hyland, Martin	University of Cambridge	United Kingdom
	Izquierdo, Milagros	Linköpings universitet	Sweden
	Jahren, Bjørn	University of Oslo	Norway
	Jakobsen, Espen R.	NTNU	Norway
*	Jakobsen, Hans Plesner	University of Copenhagen	Denmark
*	Jantzen, Jens Carsten	Aarhus Universitet	Denmark
	Jensen, Anders	Georg-August-Universität Göttingen	Germany
	Jenssen, Kris	Penn State University	United States
	Jonasson, Johan	Chalmers University of Technology	Sweden
	Jones, Gareth	University of Southampton	United Kingdom
	Jørgensen, Niels Peter	Newcastle	United Kingdom
*	Jorgensen, Palle	University of Iowa	United States
*	Joyce, Dominic	Oxford University	United Kingdom

	Kaasalainen, Mikko	University of Helsinki	Finland
	Kaipio, Jari	University of Auckland	New Zealand
	Kapustka, Michal	University of Oslo	Norway
	Karlsen, Kenneth	University of Oslo	Norway
	Karlsson, Anders	Royal Institute of Technology (KTH)	Sweden
*	Kirwan, Frances	Oxford University	United Kingdom
	Knudsen, Kim	Technical University of Denmark	Denmark
	Knutsen, Andreas Leopold	University of Bergen	Norway
	Knutson, Inger Johanne	University of Agder	Norway
	Kozowska-Walania, Ewa	University of Gdansk	Poland
*	Kozlov, Vladimir	University of Linköping	Sweden
*	Krähmer, Ulrich	University of Glasgow	United Kingdom
	Kragh, Thomas	University of Oslo	Norway
	Kro, Tore August	Høgskolen i Østfold	Norway
	Kruglikov, Boris	University of Tromsø	Norway
*	Kupiainen, Antti	Helsinki University	Finland
	Kurasov, Pavel	LTH Lund	Sweden
	Kurula, Mikael	Åbo Akademi University	Finland
	Kurylev, Yaroslav	University College London	United Kingdom
	Landstad, Magnus	NTNU	Norway
	Langer, Matthias	University of Strathclyde	United Kingdom
	Larsen, Nadia S.	University of Oslo	Norway
	Lassas, Matti	University of Helsinki	Finland
	Lima, Åsvald	University of Agder	Norway
	Linic, Vlada	Université de Provence	France
	Lindstrøm, Tom	University of Oslo	Norway
	Lokka, Arne	London School of Economics	United Kingdom
	Luger, Annemarie	Centre for Mathematical Sciences	Sweden
*	Lychagin, Valentin	University of Tromsø	Norway
	Maclagan, Diane	University of Warwick	United Kingdom
*	Madsen, Ib	University of Copenhagen	Denmark
	Magnus, Robert	University of Iceland	Iceland
	Marletta, Marco	Cardiff University	United Kingdom
	Matomäki, Pekka	Turku School of Economics	Finland
	McKay, Benjamin	University College Cork	Ireland
	Mehl, Christian	University of Birmingham	United Kingdom
	Möller, Rögnvaldur	University of Iceland	Iceland
*	Natanzon, Sergey	Independent University of Moscow	Russia
	Neshveyev, Sergey	University of Oslo	Norway
	Nolan, Clifford	University of Limerick	Ireland
	Normann, Dag	University of Oslo	Norway
	Øksendal, Bernt	University of Oslo	Norway
	Omland, Tron	NTNU	Norway
	Orsted, Bent	Aarhus University	Denmark
	Østvær, Paul Arne	University of Oslo	Norway

	Palma, Rui	University of Oslo	Norway
	Palmgren, Erik	Uppsala University	Sweden
	Penrose, Mathew	University of Bath	United Kingdom
	Piaskowska, Katarzyna	Warsaw University of Technology	Poland
	Piene, Ragni	University of Oslo	Norway
	Pohjanpelto, Juha	Oregon State University	United States
	Putnam, Ian	University of Victor	Canada
	Randal-Williams, Oscar	University of Oxford	United Kingdom
	Ranestad, Kristian	Oslo University	Norway
	Reichelt, Yngvar	University of Oslo	Norway
	Restorff, Gunnar	University of Faroe Islands	Faroe Islands
	Risebro, Nils Henrik	University of Oslo	Norway
	Rodriguez, Rubi	P. Universidad Catolica de Chile	Chile
*	Rognes, John	University of Oslo	Norway
	Roitzheim, Constanze	University of Glasgow	United Kingdom
	Rojas, Anita	Universidad de Chile	Chile
	Rørdam, Mikael	University of Copenhagen	Denmark
	Rosenberger, Gerhard	TU Dortmund	Germany
	Ross, Julius	University of Cambridge	United Kingdom
	Røysland, Kjetil	University of Oslo	Norway
	Rustad, Simen	University of Oslo	Norway
	Rydh, David	UC Berkeley	United States
	Salo, Mikko	University of Helsinki	Finland
	Sangha, Amandip	University of Oslo	Norway
	Sankaran, Gregory	University of Bath	United Kingdom
	Schlein, Benjamin	Cambridge University	United Kingdom
*	Schlichtkrull, Henrik	University of Copenhagen	Denmark
	Segtnan, Sigurd	University of Oslo	Norway
	Selberg, Sigmund	NTNU	Norway
	Shultz, Fred	Wellesley College	United States
	Siedentop, Heinz	Ludwig-Maximilians-Universität München	Germany
	Sigurdsson, Johann	University of Iceland	Iceland
	Sigurdsson, Ragnar	University of Iceland	Iceland
*	Silvestrov, Sergei	Lund University	Sweden
	Simpson, Alex	University of Edinburgh	United Kingdom
	Skau, Christian	NTNU	Norway
*	Sletsjøe, Arne B.	University of Oslo	Norway
*	Sobolev, Alexander	University College London	United Kingdom
	Somersalo, Erkki	Case Western Reserve University	United States
	Sorensen, Thomas	Imperial College London	United Kingdom
	Sottinen, Tommi	University of Vaasa	Finland
	Spronk, Nico	University of Waterloo	Canada
	Staffans, Olof	bo Akademi	Finland
	Steffensen, Mogens	University of Copenhagen	Denmark
*	Steif, Jeffrey	Chalmers University of Technology	Sweden
	Stolz, Martin	Universitet i Bergen	Norway

* Størmer, Erling	University of Oslo	Norway
Strauss, Michael	University of Strathclyde	United Kingdom
* Stroppel, Catharina	Universität Bonn	Germany
Suli, Endre	University of Oxford	United Kingdom
Szafraniec, Franciszek	Uniwersytet Jagiellonski	Poland
Teschl, Gerald	University of Vienna	Austria
Thaule, Marius	NTNU	Norway
Thomas, Richard	Imperial College London	United Kingdom
Thomassen, Carsten	DTU	Denmark
Thorbjørnsen, Steen	University of Aarhus	Denmark
Thorisson, Hermann	University of Iceland	Iceland
Trunk, Carsten	TU Ilmenau	Germany
Turbek, Peter	Purdue University Calumet	United States
* Turowska, Lyudmila	Chalmers University of Technology	Sweden
Tverberg, Helge	University of Bergen	Norway
Tyszkowska, Ewa	University of Gdask	Poland
Volkov, Stanislav	University of Bristol	United Kingdom
Weaver, Anthony	City University of New York	United States
Whitehouse, Sarah	University of Sheffield	United Kingdom
Williams, Bruce	University of Notre Dame	United States
Winter, Wilhelm	University of Nottingham	United Kingdom
* Wolfart, Jürgen	Frankfurt University	Germany
Wootton, Aaron	University of Portland	United States
Ylinen, Kari	University of Turku	Finland
* Yngvason, Jakob	University of Vienna	Austria
Zemanek, Jaroslav	Polish Academy of Science	Poland