ESI **The Erwin Schrödinger International Institute for Mathematical Physics**

Boltzmanngasse 9/2
A-1090 Vienna, Austria

ZVR 298034776

Workshop on "Quanta and Geometry"

October 8 - October 9, 2009

Organized by Alan Carey, Joachim Schwermer, Jakob Yngvason

- Thursday, October 8, 2009

  Erwin Schrödinger Lecture:

  5 p.m. – 6 p.m.: **Vincent Rivasseau** (Paris, Orsay): Renormalization, an enduring love story between quanta and geometry

  Reception in the ESI Common Room

- Friday, October 9, 2009

  10:00 a.m. – 11:00 a.m.: **Fritz Gesztesy** (Missouri): Fredholm indices, the spectral shift function, and relative trace class perturbations

  coffee

  11:30 a.m. – 12:30 a.m.: **Dorothea Bahns** (Göttingen): The Shuffle Hopf algebra in stringtheory and noncommutative field theory

  2:30 p.m. – 3:30 p.m.: **Krzysztof Gawedzki** (Lyon): Gerbes and field theory

  coffee

  4:00 p.m. – 5:00 p.m.: **Volker Schomerus** (Hamburg): The harmonics of gauge theory

  All lectures take place in the ESI Boltzmann Lecture Hall

Abstracts

Vincent Rivasseau: Renormalization, an enduring love story between quanta and geometry

We shall wander through several aspects of renormalization, from ordinary quantum field theory to the more recent examples of noncommutative field theories and of group field theories in which renormalization becomes an essential tool to blend together in a new way classical geometry and the quantum theory.

Fritz Gesztesy: Fredholm indices, the spectral shift function, and relative trace class perturbations

We compute the Fredholm index of the operator $\mathbb{D}_A = d/dt + \mathbb{A}$ on $L^2(\mathbb{R}; \mathcal{H})$ with the operator path $\mathbb{A} = \{A(t)\}_{t\in\mathbb{R}}$, via the spectral shift function of the asymptotic operators $A_\pm = A(\pm\infty)$ on the separable, complex Hilbert space $\mathcal{H}$, in the case when $A(t)$ is an unbounded (relatively trace class) perturbation of the unbounded self-adjoint operator A_-.
We also derive an extension of a trace formula due to Pushnitski relating the spectral shift functions of the operators A_+ and A_-, and the spectral shift functions of the operators $\mathbb{D}_{A^*}\mathbb{D}_A$ and $\mathbb{D}_A\mathbb{D}_{A^*}$.

This is based on joint work Y. Latushkin, K. A. Makarov, F. Sukochev, and Y. Tomilov.

Dorothea Bahns: The Shuffle Hopf algebra in stringtheory and noncommutative field theory

The Shuffle algebra appears in very different contexts in mathematical physics. I will explain two such occurrences and give an idea as to why it turns out to be so effective in describing combinatorial aspects of physical theories.

Krzysztof Gawedzki: Gerbes and field theory

Gerbes are geometric structures behind higher degree holonomies contributing to Feynman amplitudes of topologically non-trivial higher-form fields. I shall discuss the example of Wess-Zumino-Witten and Chern-Simons theories with non-simply-connected Lie groups whose subtle relations are clarified with the use of gerbes.

Volker Schomerus: The harmonics of gauge theory

Gauge field theories play a central role in our description of nature. Over the last few decades, the list of applications has grown to impressive length. But in spite of such successes, gauge theories continue to present major computational and conceptual challenges to modern theoretical physics. About ten years ago, the first examples of so-called gauge-string dualities have opened an entirely new approach to these issues. It provides an intriguing geometrization of quantum gauge theory.
In my talk I will explain how to reinterpret quantities in (planar) gauge field theories through a string theoretic generalization of harmonic analysis. Within this framework, some selected recent developments are reviewed.