Interfaces between Geometric Analysis and Mathematical Physics

July 2016, Scientific report

Booss-Bavnbek, Bernhelm; Lesch, Matthias; Marinescu, George; Reshetikhin, Nicolai; Vertman, Boris

Publication date:
2016

Document Version
Early version, also known as pre-print

Citation for published version (APA):
Booss-Bavnbek, B., Lesch, M., Marinescu, G., Reshetikhin, N., & Vertman, B. (2016, Jul 10). Interfaces between Geometric Analysis and Mathematical Physics: July 2016, Scientific report.

Interfaces between Geometric Analysis and Mathematical Physics, July - Scientific report

For one week, 21 experts in geometric analysis and four physicists used the *Institut Mittag-Leffler* as a laboratory of mathematical generalizations, i.e., to explain why physicists care about complicated manifolds, algebras, operators and other advanced objects of geometric analysis, and how mathematicians can make specific constructions arising from applications more intelligible by removing them from their context, be it without losing essentials of the specific situation – or, on the contrary – by opening radically new views on other segments of physics or mathematics.

The problems from physics, engineering (and finance) ranged from particle physics, quantum mechanics, scattering, quantum Hall effect, to porous media, Black-Scholes, and periodic orbits. The presented methods from geometric analysis comprised the delicacies of singular manifolds and partial differential equations, e.g., regularity studies for fractional powers of pseudo-differential operators, the interrelations between the hypoelliptic Laplacian and statistical mechanics, integral equations of complex analysis, bifurcations for mildly non-linear equations, the statistics of critical points, the standard model of particle physics as a spectral triple in non-commutative geometry, generalizations of adiabatic limits, topological field theories and semiclassical limits.

It is best seen how the three parent topics of the conference (Singular spaces, Kähler geometry and quantum field theories) are interwoven in the geometric configurations of the Integer Quantum Hall Effect. The density of states on the lowest Landau level for the particle in the magnetic field of a given total flux can be described as a Bergman kernel. Its asymptotics are generalizations of an exponential series which – by the *genius loci* – can be expressed in terms of the Mittag-Leffler functions of complex analysis (see GML, 1903 or http://mathworld.wolfram. com/Mittag-LefflerFunction.html) on the cone, the basic model of a singular space. Actually, this yields the density profile of the electrons in quantum Hall effect on the cone.

Important questions for future work were outlined and led to intense discussions, both in large and in small groups, and both between researchers with a mathematical and with a physical background.

The conference provided another significant step towards bridging eventual gaps between physicists and mathematicians towards joint research. If possible, it should become an annual or bi-annual event developing a tradition and research program on its own.