IGK 1132

Conceptual foundations and mathematical structure of classical, quantum and statistical physics

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Tuesday and Wednesday, 10-12, D5-153

1. Introduction

– The Great Book of Nature (Saggiatore Galilei 1623)

– The purpose of Mathematical Physics

2. The algebraic discription of physical systems

– States and Observables

– C^*-algebras

– Representations: Why does Nature like Hilbert spaces

– Classical systems

– Quantum systems with n degrees of freedom

– Quantum systems with infinitely many degrees of freedom

– CCR: Canonical Commutation Relations

– Time evolution of closed systems

3. Quantum Theory

– Exactly solvable problems

– Many particles systems, entanglement, stability of matter

– Ideal von Neumann Measurements

– Open systems and decoherence: When Quantum and Classical meets

– Introduction to Quantum Information

– Classical and Quantum Probability

4. A tour in Statistical Physics

– Classical ensembles, Gibbs postulate, Entropy, Ising model ...

– Ergodicity

– Complexity and criticality: Phase transition and critical points, mean field structure, symmetry breaking ...

– Percolation theory

– Erdös-Renyi: Classical Random Graphs

References

[1] F. Strocchi, An Introduction to the Mathematical Structure of Quantum Mechanics, World Scientific (2005)

[2] H. Araki, Mathematical Theory of Quantum Fields, Oxford University Press (1999)

[3] G. Emch, Algebraic Methods in Quantum Statistical Mechanics and Quantum Field Theory (1972)

[4] Ph. Blanchard, E. Brüning, Mathematical Methods in Physics - Distributions, Hilbert Space Operators and Variational Methods, Birkhäuser (2003)

[5] Ph. Blanchard, M. Hellmich, Decoherence in Infinite Quantum Systems, Proceedings Durban Conference forthcoming (2011)

[6] G. Grimmett, Percolation, Second Edition, Springer (199?)

[7] Ph. Blanchard, D. Gandolfo, Percolation: Concepts, Tools and Applications to Real World Phenomena, The Sciences of Complexity, ZIF (2001)

IV Mathematics, statistics and quantum field theory. 8 Renormalization group theory: its basis and formulation in statistical physics. 89 89. Michael e. fisher.Â Obviously only those mathematical concepts that are indispensable and independent of particular formalisms, or invariant under the transformations between equivalent formalisms, have a chance to claim to be part of reality, either as a basic ontology or as derivative structures. A case in point is the status of ghosts in non-Abelian gauge theories: they have appeared in some, but not in other, empirically equivalent formalisms, and thus cannot claim to be part of physical reality.Â Initially, the indispensability of classical structures for quantum theories was forcefully argued by Niels Bohr on three related grounds. Theory of quantum computation: quantum logics, quantum automata and quantum computation. Measure theory and probability in quantum statistical mechanics #quantum symmetries and quantum groupoid representation theory. noncommutative geometry, SUSY and axiomatic quantum gravity (AQG). Literature references for mathematical physics foundations: axiomatics and categories. All Sources[edit | edit source].Â â†‘ N. P. Landsman : Mathematical topics between classical and quantum mechanics. Springer Verlag , New York, 1998. â†‘ N. P. Landsman : Compact quantum groupoidsÂ â†‘ M. A. Mostow : The differentiable space structure of Milnor classifying spaces, simplicial complexes, and geometric realizations, J. Diff. Geom. 14 (1979) 255-293. Dover Publications, 1992. - 661 Pages. Well-organized text designed to complement graduate-level physics texts in classical mechanics, electricity, magnetism, and quantum mechanics. Topics include theory of vector spaces, analytic function theory, Green's function method of solving differential and partial differential equations, theory of groups, more. Many problems, suggestions for further reading.