



LECTURE ANNOUNCEMENT

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From Mechanics to Quantum Field Theory – a Guided Tour for my Mathematical Friends

Days: 2. February – 6. February 2009

Time: 10:00–12:00 and 13:00–15:00

Place: Monday–Thursday at RISC (Schloss Hagenberg)
Friday at RICAM (HF136)

Most of our knowledge in Elementary Particle Physics is gained from confronting perturbative calculations for observables in the Quantum Field Theories forming the Standard Model with high precision measurements. Due to their high complexity, these calculations require the intense use of Computer Algebra methods both on their algebraic and analytic side. They have very close links both to numerous discrete methods as well as to analytic methods in the field of special functions and their complex analysis. The integration methods required rest both on the algebraic and the analytic side. In these lectures we attempt to describe how the special structures in Quantum Field Theories (QFTs) arise. We mainly develop the apparatus following the mathematical structures being involved. The roots of QFTs range back to canonical classical mechanics and field theory. The main aspects of Special Relativity and Quantum Mechanics will be considered. Then we study Quantum Field Theories in the weak coupling resp. high energy region and provide the theoretical background for perturbative calculations. So-called zero- and single scale quantities play a central role in present-day precision calculations. These quantities generally recruit from Feynman parameter integrals being characterized either by no other or one additional scale. In the former case they are described by multiple zeta values and their generalizations. The single scale quantities are represented by nested multiple harmonic sums and generalizations thereof. Furthermore, Poincaré-Chen iterated integrals over special alphabets are related to these quantities, leading to generalized polylogarithms. The Feynman-integrals of these classes can be traced back to higher transcendental functions related to generalized hypergeometric series and generalizations thereof, most of which still await to be unveiled. The lectures try to promote the communication between physicist and mathematicians to face the current challenges and to find further innovative solutions in a close collaboration of both communities.