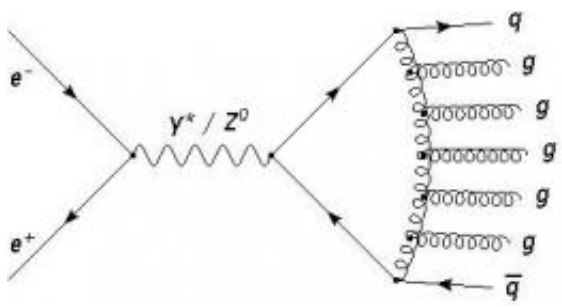
German researchers set world record in one-loop computations

December 5 2011



One-loop Feynman diagram. Credit: THEP

Professor Dr. Stefan Weinzierl of the Institute of Physics of Johannes Gutenberg University Mainz (JGU, Germany) and his group recently published a numerical computation of jet rates for the process e+e- -> n jets with up to n = 7 at next-to-leading order (NLO) accuracy in the strong coupling and in the leading color approximation.

Precision calculations in particle physics rely on the computation of higher order terms within perturbation theory. At the second order of perturbation theory, virtual one-loop Feynman diagrams - like the one shown here - occur. As the number of external particles increases, these diagrams become more and more difficult to calculate.

In fact, with standard textbook methods the complexity increases stronger than doubling the number of grains of rice on each new field of

a chess-board. Professor Weinzierl and his group invented a new algorithm which leads to a much slower growth. With this new algorithm the growth is only polynomial and goes like n4 as the number n of external particles increases. With this new method they were able to calculate a physical observable depending on a one-loop eight-point function for the first time ever.

Technically, the new algorithm is based on the extension of the subtraction method to virtual one-loop diagrams, a suitable deformation of the one-loop integration contour and the efficient use of recursion relations. All integrals are performed numerically by Monte Carlo integration on a high-performance cluster at JGU.

The members of Professor Weinzierl's group are Sebastian Becker, Daniel Götz, Christian Reuschle and Christopher Schwan - all of them Ph.D. students - who are working on various aspects of the numerical and automatized evaluation of high-energy precision physics observables.

More information: S. Becker, et. al., *NLO* results for five, six and seven jets in electron-positron annihilation, arXiv:1111.1733v1 [hep-ph], 7 November 2011. arxiv.org/abs/1111.1733

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