Large-N_f expansion of scalar correlators and estimates of higher order QCD corrections to Higgs $\to \bar{b}b$ decay and strange-quark-mass sum rules

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Contribution to Poster Session of ACAT 2000, Fermilab

Calculation: The contributions of a single chain of quark-antiquark bubble diagrams, to the two-point correlator of the scalar quark current $\overline{\psi}\psi$, were calculated up to 20 loops analytically and up to 100 loops numerically, for euclidean momenta, in the $\overline{\mathrm{MS}}$-scheme. Formally, these calculations determine the behaviour when N_f, the number of quark flavours, is large. They were used to analyze the correlator at leading order in the large β_0 approximation, where β_0 is the first coefficient of the QCD β-function. Large-β_0 effects of analytical continuation from the euclidean to minkowskian region were also computed.

Diagrams: The n-loop diagrams were obtained by inserting $n-2$ quark loops in the pair of two-loop skeletons for the scalar correlator. The bare contributions were evaluated by the methods of Broadhurst, Gracey and Kreimer (*Z. Phys.* **C75** (1997) 559). The infinities were removed by mass renormalization, to all orders in N_f, and by an overall minimal subtraction.

Program: The method entails recurrence relations for ${}_3F_2$ hypergeometric series, which were implemented in REDUCE. Closed expressions were developed for diagrams with arbitrary numbers of loops. These led to analytic evaluations to 20 loops, and numerical evaluations to 100 loops, in a few minutes of machine time. MAPLE was used in a study of the effects of analytical continuation to the time-like region.

Reference: D.J. Broadhurst, A.L. Kataev and C.J. Maxwell, hep-ph/0007152, to appear in *Nucl. Phys.* **B591** (2000) 1.

Motivation: The two-point correlator of the scalar quark current enters QCD-sum-rule determinations of light-quark masses and is related to the decay width of the scalar Higgs boson to quark-antiquark pairs. The calculation is of interest from the point of view of the analysis of applicability of estimates of the growth of the perturbation series.

Observations: The analysis demonstrates that one should take a twice-subtracted dispersion relation to avoid an ambiguity of order Λ^2/Q^2, even in the limit of zero quark mass. Failure to do so leads to explosion of the perturbation series. The strange-quark-mass extraction method of Becchi, Narison, de Rafael and Yndurain (*Z. Phys.* **C8** (1981) 335), extended to 4-loop order by Chetyrkin, Pirjol and Schilcher (*Phys. Lett.* **B404** (1997) 377), avoids this danger; some previous analyses of Higgs decay do not. The new large-β_0 results are used to estimate effects at 5 loops and beyond.

Results: Estimates are obtained for the as yet undetermined contributions of order α_s^4, paying particular attention to the terms in π^2 that result from analytic continuation. A procedure is formulated to resum the latter to all orders in α_s and leading order in β_0. This entails handling fractional powers of α_s that result from mass renormalization. These results are of interest in the light of theoretical studies of the role of analytical continuation effects in determinations of $\alpha_s(M_Z)$, by Shirkov (hep-ph/0003242; hep-ph/0009106), and in light-quark sum rules, by Körner, Krajewski and Pivovarov (hep-ph/0003165).

The scheme-dependence of the perturbative series for the minkowskian spectral function is analyzed.

It is concluded that the perturbative uncertainties in the extraction of the strange quark mass are mild, compared with those that result from poor knowledge of the low-energy hadronic spectral function.

Several estimation methods are used for the perturbative corrections to the decay of the Higgs boson to a $\overline{b}b$-pair, beyond the existing 4-loop analysis by Chetyrkin (*Phys. Lett.* **B390** (1997) 309), paying particular attention to significant differences between this scalar channel and previous analyses of the vector channel. In the scalar case, some of these estimators are shown to be unreliable.