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### EPJ direct C 1, 1–38

**Digital Object Identifier (DOI):**  
10.1007/s1010502c0001

Received: 19 November 2000 / Accepted: 21 December 2001 / Published online: 15 January 2002

#### Eleven years of QCD at LEP

S. Bethke

**Abstract.** Studies of hadronic final states of  $e^+e^-$  annihilations, observed at the Large Electron Positron Collider LEP at CERN, are reviewed. The topics included cover measurements of  $\alpha_s$ , hadronic event shapes and hadronisation studies, tests of asymptotic freedom and of the non-Abelian gauge structure of QCD, differences between quark and gluon jets, tests of power corrections and selected results of two-photon scattering processes. The improvements obtained at LEP are demonstrated by comparing to results from the pre-LEP era. This article consists of a reproduction of slides presented at the LEPFest in October 2000, supplemented by a short descriptive text and a list of relevant references.

### EPJ direct C 2, 1–154

**Digital Object Identifier (DOI):**  
10.1007/s1010502c0002

Received: 5 October 2001 / Accepted: 3 January 2002 / Published online: 18 January 2002

#### Dispersion approach to quark-binding effects in weak decays of heavy mesons

D. Melikhov

**PACS:** 13.20.He, 12.39.Ki, 12.39.Hg, 13.40.Hq

**Abstract.** The dispersion approach based on the constituent quark picture and its applications to weak decays of heavy mesons are reviewed. Meson interaction amplitudes are represented within this approach as relativistic spectral integrals over the mass variables in terms of the meson wave functions and spectral densities of the corresponding Feynman diagrams. Various applications of this approach are discussed: Relativistic spectral representations for meson elastic and transition form factors at spacelike momentum transfers are constructed. Form factors at  $q^2 > 0$  are obtained by the analytical continuation. As a result of this procedure, form factors are given in the full  $q^2$  range of the weak decay in terms of the wave functions of the participating mesons. The  $1/m_Q$  expansion of

the obtained spectral representations for the form factors for the particular limits of the heavy-to-heavy and heavy-to-light transitions are analysed. Their full consistency with the constraints provided by QCD for these limits is demonstrated. Predictions for form factors for  $B_{(s)}$  and  $D_{(s)}$  decays to light mesons are given. The  $B \rightarrow \gamma \ell \nu$  decay and the weak annihilation in rare radiative decays are considered. Nonfactorizable corrections to the  $B^0 - \bar{B}^0$  mixing are calculated. Inclusive weak  $B$  decays are analysed and the differential distributions are obtained in terms of the  $B$  meson wave function.

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**EPJ direct C 3, 1–45**  
**Digital Object Identifier (DOI):**  
**10.1007/s1010502c0003**

Received: 12 October 2001 / Accepted: 11 February 2002 /  
 Published online: 4 March 2002

### Renormalization of QED in an external field

Ch. Brouder

**PACS:** 12.20.-m; 11.10.Gh

**Abstract.** The Schwinger equations of QED are rewritten in three different ways as integral equations involving functional derivatives, which are called weak field, strong field, and SCF quantum electrodynamics. The perturbative solutions of these equations are given in terms of appropriate Feynman diagrams. The Green function that is used as an electron propagator in each case is discussed in detail. The general renormalization rules for each of the three equations are provided both in a non perturbative way (Dyson relations) and for Feynman diagrams.

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**EPJ direct C 4, 1–23**  
**Digital Object Identifier (DOI):**  
**s10.1007/s1010502c0004**

Received: 19 October 2001 / Accepted: 14 March 2002 /  
 Published online: 26 March 2002

### A joint analysis of the $S$ -wave in the $\pi^+\pi^-$ and $\pi^0\pi^0$ data

R. Kamiński, L. Leśniak, K. Rybicki

**PACS:** 13.60.Le; 13.75.Lb; 13.85.Hd; 14.40.Cs

**Abstract.** We use our former results on  $\pi^+\pi^-$   $S$ -wave obtained in a nearly assumption-free way from the 17.2 GeV/c data to predict the  $\pi^0\pi^0$   $S$ -wave. The predictions are compared with the recent results of the E852 experiment at 18.3 GeV/c. A good agreement is found for only one (the “down-flat”) solution while the second one (the “up-flat”) is excluded by the  $\pi^0\pi^0$  data. Thus the long-standing “up-down” ambiguity has been finally resolved in favour of the  $S$ -wave intensity which stays large and nearly constant up to the  $K\bar{K}$  threshold. A joint analysis of both sets of data leads to a reduction of errors for this solution.

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**EPJ direct C 5, 1–16**  
**Digital Object Identifier (DOI):**  
**10.1007/s1010502c0005**

Received: 19 March 2002 / Accepted: 31 March 2002 /  
 Published online: 8 April 2002

### Effects of jet algorithms from higher order QCD in $W^\pm$ mass determinations at LEP2

E. Maina, S. Moretti

**Abstract.** We analyse the impact of systematic effects due to the scale dependence of QCD corrections in combination with the use of different jet clustering algorithms in the measurement of the  $W^\pm$  mass in the fully hadronic decay mode of  $W^+W^-$  pairs produced at LEP2. We consider higher order contributions induced by both virtual and real gluon radiation onto the electroweak CC03 and CC11 channels through  $\mathcal{O}(\alpha_s)$  at the parton level. We find that the associated uncertainties can be of order 100 MeV, thus competitive with those possibly arising in the non-perturbative regime and indeed above the current experimental estimates.

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**EPJ direct C 6, 1–14**  
**Digital Object Identifier (DOI):**  
**10.1007/s1010502c0006**

Received: 5 December 2001 / Accepted: 22 March 2002 /  
 Published online: 16 April 2002

### Hodge-type self(anti)self-duality for general p-form fields in arbitrary dimensions

M. Botta Cantcheff

**Abstract.** It is often claimed [1] that the (Hodge type) duality operation is defined only in even dimensional spacetimes and that self-duality is further restricted to twice-odd dimensional spacetime theories. The purpose of this paper is to extend the notion of both duality symmetry as well as self-duality. By considering tensorial doublets, we introduce a novel well-defined notion of self-duality based on a duality Hodge-type operation in arbitrary dimension and for any rank of these tensors. Thus, a generalized Self-Dual Action is defined such that equations of motion are the claimed generalized self-duality relations. We observe in addition, that taking the proper limit on the parameters of this action, it always provides us with a master-action, which interpolates models well-studied in physics; by considering a particular limit, we find an action which describes an interesting type of relation, referred to as semi-self-duality, which results to be the parent action between Maxwell-type actions. Finally, we apply these ideas to construct manifest Hodge-type self-dual solutions in a (2+1)-dimensional version of the Maxwell’s theory.

EPJ direct C N1, 1–61

Digital Object Identifier (DOI):  
10.1007/s1010502cn001

Received: 12 October 2001 / Accepted: 13 December 2001  
/ Published online: 6 March 2002

*Scientific Note:*

**High transverse momentum physics at the large hadron collider**

The ATLAS and CMS Collaborations

Edited by

J.G. Branson, D. Denegri, I. Hinchliffe, F. Gianotti,  
F.E. Paige, P. Sphicas

**Abstract.** This note summarizes many detailed physics studies done by the ATLAS and CMS Collaborations for the LHC, concentrating on processes involving the production of high mass states. These studies show that the LHC should be able to elucidate the mechanism of electroweak symmetry breaking and to study a variety of other topics related to physics at the TeV scale. In particular, a Higgs boson with couplings given by the Standard Model is observable in several channels over the full range of allowed masses. Its mass and some of its couplings will be determined. If supersymmetry is relevant to electroweak interactions, it will be discovered and the properties of many supersymmetric particles elucidated. Other new physics, such as the existence of massive gauge bosons and extra dimensions can be searched for extending existing limits by an order of magnitude or more.

EPJ direct C N2, 1–13

Digital Object Identifier (DOI):  
10.1007/s1010502cn002

Received: 16 January 2002 / Accepted: 8 March 2002 /  
Published online: 19 March 2002

*Scientific Note:*

**Observation potential of the decays  $B_{s,d}^0 \rightarrow J/\psi\eta$  in the ATLAS experiment at the LHC**

C. Driouichi, P. Eerola, M. Melcher, F. Ohlsson-Malek,  
S. Viret

**PACS:** 13.25 Hw

**Abstract.** The observation potential of the decays  $B_{s,d}^0 \rightarrow J/\psi\eta$  with the ATLAS detector at the LHC is described in this paper. At present there exist only upper limits for the branching fractions, but at LHC, a clear signal for the decay mode  $B_s^0 \rightarrow J/\psi\eta$  is expected. The branching fraction of this decay mode can thus be measured, and other parameters such as  $B_s^0$  lifetime can be measured as well. The decay mode  $B_s^0 \rightarrow J/\psi\eta$  is analogous to the mode  $B_s^0 \rightarrow J/\psi\phi$ , which has been studied extensively in view of CP violation measurements. In these two decay modes, the CP asymmetry predicted by the Standard Model is very small, and the observation of a sizeable effect would be a signal of physics beyond the Standard Model. The decay mode  $J/\psi\eta$  constitutes thus a cross-check for the mode  $J/\psi\phi$ . Furthermore, the former final state is a CP-eigenstate and no angular analysis is thus needed. The reconstruction of  $\eta$ -mesons at LHC experiments has not been addressed before, and therefore the study presented here can also be regarded as an example of the physics prospects with  $\eta$ -mesons at the LHC.