STUDY OF FOUR-FERMION NEUTRAL CURRENT PROCESSES IN THE DELPHI EXPERIMENT AT LEP*

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The four-fermion neutral current processes were studied in DELPHI experiment at LEP collider. The results are based on data collected in 1997–2000 at the energy range 183 GeV–209 GeV. The final results for ZZ pair production, $Z\gamma^*$, single Z/γ^* production and study of anomalous triple neutral boson couplings are already published. Within the experimental uncertainties, the results confirm the predictions of the electroweak theory.

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1. Introduction

The study of neutral current four-fermion processes (NC4F) became increasingly important in the second phase of LEP where the higher energy of e^+e^- collisions enabled for production of two massive intermediate vector bosons (IVB). The main goal of the study was to verify the Standard Model (SM) predictions. Moreover, such processes form an important background to Higgs boson or new particle searches. The standard definition of different NC4F graphs is shown in Fig. 1. The full set of diagrams must be considered but particular topologies receive their dominant contribution from a subset of them. The DELPHI Collaboration performed studies of double resonant ZZ production, single Z production and $Z\gamma^*$ production. The results became the ingredients of the analysis of the anomalous triple gauge couplings (ATGC) of the neutral IVBs. The details of the analyses can be found in several DELPHI papers [1].

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2. Experimental results

The ZZ and $Z\gamma^*$ production is dominated by the diagrams which belong to the Conversion class shown in Fig. 1(a). The measurement of the cross section was performed for the set of final states: $q\overline{q}q\overline{q}$, $q\overline{q}\nu\overline{\nu}$, $q\overline{q}l^+l^-$, $l^+l^-l^+l^-$, $l^+l^-\nu\overline{\nu}$ at various collision energies. The dedicated analyses were performed to deal with the specific signal topology and different background characteristics for each type of final state (jets, leptons, presence of $\nu\overline{\nu}$).

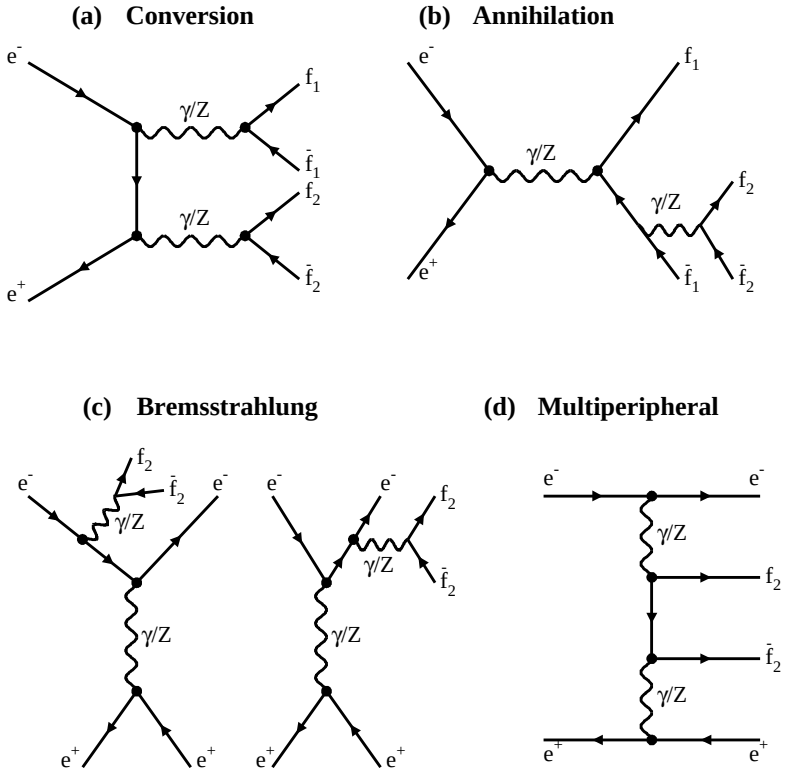

Fig. 1. Four classes of Feynman diagrams for NC4F processes in e^-e^+ collisions.

In the case of single Z production the dominant contribution comes from the Bremsstrahlung diagrams (Fig. 1(c)). The cross-section was measured for leptonic ($Z \to \mu^+\mu^-$) and hadronic ($Z \to q\overline{q}$) final states.

The overall compatibility with the SM predictions in the whole energy range can be expressed in terms of the ratio of measured to predicted values of the cross-sections $R = \sigma^{\text{measured}}/\sigma^{\text{predicted}}$. The procedure yielded: $R_{ZZ} = 0.91 \pm 0.08(\text{stat.}) \pm 0.02(\text{syst.})$, $R_{Z\gamma^*} = 1.04^{+0.13}_{-0.12}(\text{stat.}) \pm 0.04(\text{syst.})$ and $R_{\text{single}\,Z} = 1.03 \pm 0.11\ (\text{stat.}) \pm 0.05\ (\text{syst.})$.

In the SM the couplings of neutral IVB are forbidden at tree level. The expected contribution of higher order effects are at the level of 10^{-4}. It opens the possibility to search for the effects from the processes beyond SM by looking at the deviations from SM prediction. The total cross-sections and selected angular distributions for the ZZ, $Z\gamma^*$ and single Z were used to set limits on the ATGC. DELPHI Collaboration for the first time extended the analysis for the case of two off-shell neutral IVB using $Z\gamma^*$ final states.

Within measurement uncertainties all results from the NC4F study at DELPHI turned out to be in good agreement with SM predictions.

REFERENCES

[1] J. Abdallah *et al.* [DELPHI Collaboration], *Eur. Phys. J.* **C30**, 447 (2003); **C45**, 273 (2006); **C51**, 503 (2007); **C51**, 525 (2007).