NON-SUSY SEARCHES AT THE TEVATRON

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We report new results on new physics searches beyond the Standard Model, on the searches for charged heavy vector boson (W'), excited fermions (μ^*, q^*), and leptoquarks at the CDF and D0 experiments in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$TeV.

1. Introduction

While the Standard Model (SM) of particle physics has been tested sucessfully with very precise measurements, there are still many questions remained open, for instance the number of lepton and quark generations, their mass hierarchy or a unified description of all gauge symmetry. The searches to new particles in high energy experiments have been performed in an attempt to resolve in a way, in which mostly done with direct comparison of data and the SM background predictions using final state signatures as hadronic jets, charged and neutral leptons. In search results so far from D0 and CDF collider experiments at Fermilab, no significant excesses have been found and we set the limit on the model dependent way.

2. Charged Heavy Vector Boson (W')

Of the existence of the extra gauge bosons, generically known W' boson is commonly predicted in left-right symmetric models [1], where can also be themselves motivated for example by SO(10) grand unified theory [2]. CDF has searched for a W' boson in the $e\nu_e$ decay mode where the neutrino is assumed to be stable and can be detected as missing energy in the detector. Event selections require an isolated electron candidate with $\mathrm{E}_T > 25$ GeV and the missing transverse energy $\not\!\!E_T > 25$ GeV. Figure 1 shows the agreement between data and the SM background predictions in the transverse mass distribution. No evidence of W' signal has been observed and

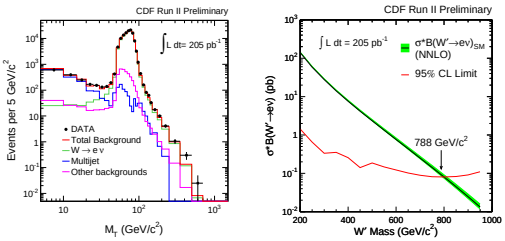

Figure 1. Comparison between data and SM predictions in transverse mass distribution (left), 95% CL limits on $\sigma \cdot B(W' \to e\nu)$ as a function of the W' mass (right).

we set the 95% confidence level (CL) limits on $\sigma \cdot B(W' \to e\nu)$ and the mass assuming SM coupling strength (see Figure 1).

3. Excited Fermions (μ^*, q^*)

A commonly proposed explanation for the three generations is a compositeness model [3] of the known leptons and quarks. Compositeness models imply a large spectrum of excited states. The coupling of excited fermions to ordinary quarks and leptons can be described by four-fermion contact interactions (CI) [4].

D0 and CDF searched for single production of an excited muon μ^* in association with a muon via four-fermion CI, with the subsequent electroweak decay of the μ^* into a muon and a photon ($\mu\mu\gamma$ channel). The largest SM background is from Drell-Yan (DY) process $p\bar{p} \to Z/\gamma^* \to \mu^+\mu^-(\gamma)$. Decays via CI contribute between a few percent of all decays for $\Lambda >> \mu^*$ and 92% for $\Lambda = \mu^*$ [4,5]. D0 considered this calculation of $B(\mu^* \to \mu\gamma)$ for the signal expectation. Using 370 pb^{-1} of data sample, in good agreement with the SM expection, D0 set 95% CL limits on the μ^* production cross section times the branching fraction into $\mu\gamma$ as function of m_{μ^*} as shown in Figure 2. CDF, assuming only electroweak decays, show the excluded region in terms of compositeness scale Λ and m_{μ^*} (Figure 2). For $\Lambda = 1$ TeV, CDF set the lower mass limit at 800 GeV/c^2 and D0 at 618 GeV/c^2.

D0 also searched for heavy resonances in the Z+jet channel as signal of the existence of excited quarks. The main background to the signal is inclusive Z boson production in the SM. In comparison between data and the background prediction, no significant peak was observed in the M_{Zj_1} data distribution. D0 determined the upper limit of the production cross section of the excited quark as a function of its mass at 95% CL and the

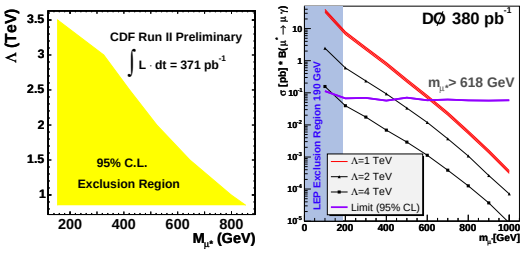

Figure 2. Compositeness scale Λ versus m_{μ^*} exclusion region (left). The measured cross section $\times$ branching ratio limit, compared to the contact interaction model prediction for different choices of Λ (right).

mass values below 520 GeV/c^2 has been excluded (Figure 3).

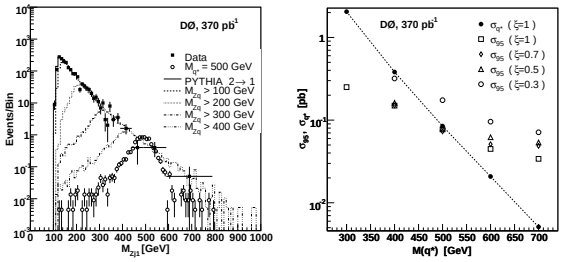

Figure 3. Invariant mass distribution of the Z and of the leading jet (left). Upper limit of the resonance cross sections at 95% CL (right).

4. Leptoquarks

Leptoquarks (LQ), as new bosons coupling to a lepton-quark pair, are predicted in many extensions of the SM [6]. These particles can be scalar (spin = 0) or vector (spin = 1). In most models LQ are expected to couple only to fermions of the same generations because of non obsevation of flavor changing neutral currents. The decay into a quark and a charged lepton are varied by a branching fraction β. D0 recently has updated the search results on scalar leptoquarks in $\nu\nu jj$ channel for $\beta = 0$ using a data sample of 310 pb^{-1}. In event selections, for two central jets, P_T is greater than 60 GeV for leading jet, 50 GeV for the second. The $\not\!\!E_T$ is required above 80 GeV. CDF also has analyzed in the same channel using 190 pb^{-1} of data

with looser selection cuts which are two central jets $P_T > 40, 25$ GeV and $\not\!\!E_T > 60$ GeV. No excess of the signal was observed at both D0 and CDF, D0 set the lower mass limit at 136 GeV/c^2 and CDF at 117 GeV/c^2 at 95% CL. CDF has performed a search for third generation LQ (for both vector and scalar, denoted as VLQ3 and SLQ3) in the $\tau\tau jj$ channel ($\beta = 1$), where one tau decays to leptonically and the other to hadronically, using 320 pb^{-1} of data. The consistency between data and the background expectations derives 95% CL upper limit on the VLQ3 pair production cross section of 77fb, and set a lower limit on the VLQ3 mass of 344 GeV/c^2. As for SLQ3, the signature is the same with R-parity violating scalar top quark search analysis. The limit results also can be applicable to SLQ3. The upper limit on the production cross section has been set at 95% and the lower mass limit is 151 GeV/c^2 (see Figure 4).

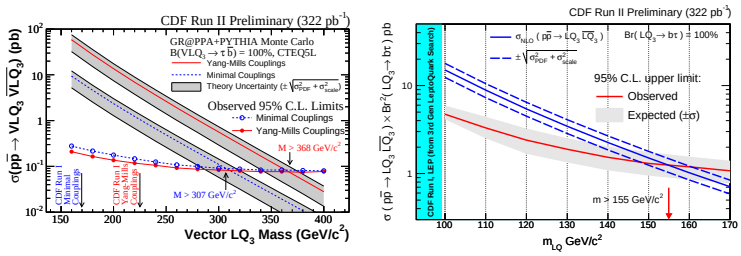

Figure 4. The pair production cross section as a function of VLQ3 mass (left), and of SLQ3 (right).

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