SEARCH FOR NEW PHENOMENA IN H1

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On behalf of the H1 collaboration

A search for excited leptons and leptoquarks in H1 is reported. No evidence for excited fermion production is found and, assuming in the search for leptoquarks that an accumulation of events observed at M≃200 GeV is due to a statistical fluctuation, exclusion limits on cross-section, branching ratios and coupling constants are derived.

1 Introduction

A search for excited leptons and first and third generation leptoquarks is done using the H1 e^+p data accumulated between 1994 to 1997. It corresponds to an integrated luminosity of 37 pb^{-1}.

2 Excited leptons

H1 has searched for excited leptons decaying into a lepton and a gauge boson, covering most of the possible decays of the gauge bosons. The 11 decay channels analysed correspond to 7 distinguishable final topologies. For each of them the numbers of observed and expected events, and the mean detection efficiency is given in Table 1.

Table 1: Number of observed events and Standard Model expectation for the 11 decay channels.

Channel	Selection	Data	SM exp.	Efficiency
$e^* \to e\gamma$	2 EM clusters	223	239 ± 7	85 %
$e^* \to eZ \hookrightarrow ee$	3 EM clusters	3	1.4 ± 0.3	78 %
$e^* \to eZ \hookrightarrow \nu\bar{\nu}$	1 electron + P_t^{miss}	1	3.6 ± 0.7	70 %
$e^* \to eZ \hookrightarrow q\bar{q}$	2 jets + 1 electron	38	48 ± 3	41 %
$e^* \to \nu W \hookrightarrow e\nu$	1 electron + P_t^{miss}	1	3.6 ± 0.7	70 %
$e^* \to \nu W \hookrightarrow q\bar{q}$	2 jets + P_t^{miss}	3	3.8 ± 0.5	40 %
$\nu^* \to \nu\gamma$	1 photon + P_t^{miss}	0	1.3 ± 0.8	38 %
$\nu^* \to \nu Z \hookrightarrow ee$	2 electrons + P_t^{miss}	0	0.38 ± 0.2	40 %
$\nu^* \to \nu Z \hookrightarrow q\bar{q}$	2 jets + P_t^{miss}	3	3.8 ± 0.5	40 %
$\nu^* \to eW \hookrightarrow e\nu$	2 electrons + P_t^{miss}	0	0.38 ± 0.2	40 %
$\nu^* \to eW \hookrightarrow q\bar{q}$	2 jets + 1 electron	38	48 ± 3	41 %

In all cases the observed number of events is compatible with the expectation of the Standard Model. This agreement can be translated into limits on the excited lepton production cross section times its branching ratio for the corresponding decay channel. The most stringent limits are given by the 2 radiative decays: the $e^* \to e\gamma$ and the $\nu^* \to \nu\gamma$. The upper limit on $\sigma(e^*) * BR(e^* \to e\gamma)$ ranges between 0.4 pb to 0.1 pb for an e^* mass varying between 60 GeV to 275 GeV at 95% confidence level. For a ν^* in the same range of masses, the $\sigma(\nu^*) * BR(\nu^* \to \nu\gamma)$ has to be less than 0.2 to 0.6 pb. These results improve previous H1 published results [1] by an order of magnitude. Using a specific model [2], in which the cross section depends on coupling constants f and f' for the gauge groups $SU(2)$ and $U(1)$, and a substructure scale Λ, and assuming relations between f and f', constraints on these parameters can be derived. On figure 1 limits on the ratio $\frac{f}{\Lambda}$ are given. Results obtained by the LEP experiments on this ratio are more stringent but are limited to excited leptons masses below 180 GeV.

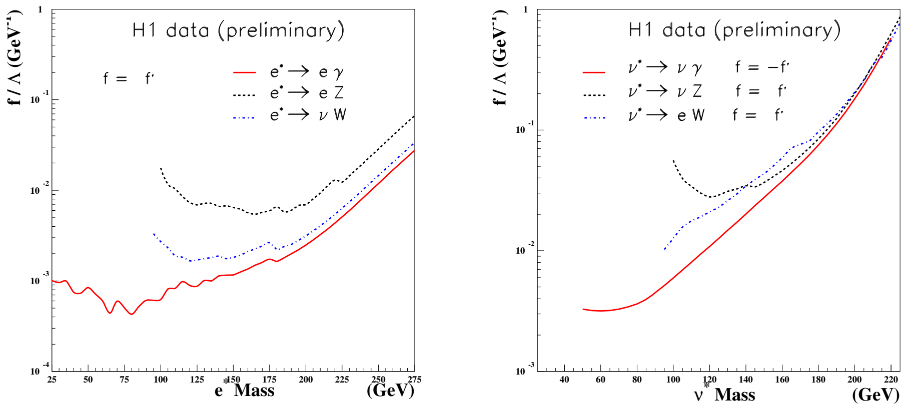

Figure 1: Exclusion limits at 95% CL for excited leptons as a function of the mass: (left) for e^*, (right) for ν^*. The areas above the lines are excluded.

3 Leptoquarks

3.1 Search for first generation leptoquarks

A search for first generation leptoquarks is performed by searching in high Q^2 deep inelastic scattering (DIS) Neutral Currents events, for an accumulation of events in the lepton quark invariant mass spectra. It is possible to improve significantly the signal to background ratio using the fact that the $y = \frac{1+\cos\theta_e^*}{2}$ distributions are different (flat in case of scalar leptoquarks , in $\frac{1}{y^2}$ for DIS at fixed mass). A lower y cut is then optimized as a function of the mass, given the expected DIS background. (e.g. y_{cut}=0.4 for M=200 GeV). In this way 312 events are selected for an expected background of 306 events. The shape of the invariant mass distribution is found in agreement with the expectation of the Standard Model, except for a significant accumulation at M$\simeq$200 GeV which was discussed in a previous paper [3]. The excess is treated here as a statistical fluctuation.

As the leptoquark cross section depends on both an unknown Yukawa coupling constant λ and the branching ratio of the leptoquark in an electron plus a jet (β_e), the results could then be presented either giving constraints on λ in function of the leptoquark mass for fixed β_e values or the reverse : constraints on β_e for different fixed λ values. In the first case a specific model[4] is used. This model distinguishes 7 scalar leptoquarks , each of them having a β_e value equal to 1 or 0.5. The best limits are obtained for leptoquarks coupling to valence quarks. In the case, for λ values $\simeq \sqrt{4\pi\alpha_{em}}$, masses up to 275 GeV can be excluded at 95% confidence level. This result improves earlier H1 results [5] by approximately a factor of 3.

Limits on β_e for λ equal to 0.1 or 0.05 is shown on the left part of figure 2 when the leptoquark couples to e^+ plus a u quark. On the plot the limit given by the D0 experiment is also displayed. The picture shows that for λ=0.1, which is a rather small value as it corresponds to 1/10 of the electromagnetic coupling, H1 limit extends far above the D0 result, especially for small β_e.

3.2 Search for third generation leptoquarks

A search for leptoquarks, coupling to both e and τ leptons, is also performed by looking for excess of events in the τ + jet channel. The selection requires events with 2 jets , one possessing attributes of a τ lepton in it's hadronic decay modes. The background consists in Neutral Current DIS events when the electron is uncorrectly identified, and photoproduction events with one low multiplicity jet. No candidate is found while the Standard Model predicts 0.8 ± 0.3 event. The mean efficiency of this selection ranges between 10% for a leptoquark mass of 100 GeV to 25% for a leptoquark mass above 200 GeV. The limits obtained in the plane λ versus the leptoquark mass are shown on the right part of figure 2 for different β_e assumptions. For $\beta_e \simeq 10\%$ and high β_τ H1 limits extend far above the exclusion domain of TeVatron.

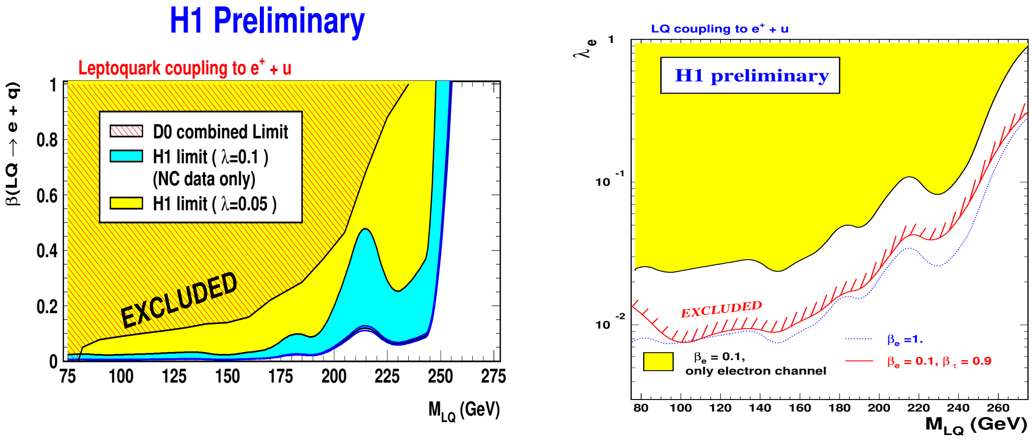

Figure 2: Exclusion limits at 95% CL for leptoquarks as a function of the mass: (left) first generation leptoquarks, (right) third generation leptoquarks.

4 Conclusion

No evidence for excited leptons has been found in the channels described above. Therefore upper limits on the cross section times the decay branching ratio are given. These limits are converted in limits on coupling constants and compositeness scale in the scheme of a specific model. The exclusion domain in the plane $\frac{f}{\Lambda}$ versus the excited lepton mass extends above the one excluded by the LEP experiments.
The searches for first and third generation leptoquarks show no strong evidence for new particule production and rejection limits are derived. The H1 experiment excluded domain extends far above the existing limits.

References

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