Tevatron Searches for Excited and Exotic Leptons

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The Tevatron experiments, DØ and CDF, have searched for excited electrons and excited and exotic muons in Run II. Using 1 fb^{-1} of data, DØ has searched for excited electrons. No excess above the standard model background is observed. Choosing the scale for contact interactions to be $\Lambda = 1$ TeV, excited electron masses below 756 GeV are excluded at the 95% C.L. CDF has searched for excited and exotic muons using 371 fb^{-1} of data. Using gauge mediated models with Λ/f $= m_{\mu^*}$, exotic muons are excluded for masses below 221 GeV. For compositeness models with $\Lambda = m_{\mu^*}$, masses below 853 GeV are excluded. Using a similar size data set, DØ get similar limits.

1 Introduction

The proliferation of quarks and leptons and their mass hierarchy motivates composite models, where the quarks and leptons are composed of scalar and spin 1/2 particles leading to a spectrum of excited states e*, μ^*, and q* [2]. Their production can be described by contact interactions (CI) between quarks and leptons. Their decays can be via electroweak interactions or via contact interactions[3]. Exotic fermions with a spectrum of excited states are also predicted by extensions of the standard model such as gauge-mediated models (GM)[4].

2 DØ Search for Excited Electrons

DØ searches for e^* in the process $p\bar{p} \rightarrow e^*e$, with the e^* subsequently decaying to an electron plus photon. Using 1 fb^{-1} of data, DØ has selected two isolated electrons with high transverse energy (E_T) and one isolated high E_T photon, resulting in 259 events with an estimated standard model background of 232 ± 36 events. The background is dominated by the Drell-Yan process, DY $+ \gamma \rightarrow e^+e^-\gamma$. Since no excess is seen, DØ calculates 95% C.L. limits. The resulting limit as a function of m_{e^*} is shown in Fig. 1 together with predictions of the contact interaction model for different choices of the scale Λ. The effect of both CI and GM decays is included, unless otherwise noted. Previous limits obtained by CDF are also shown[5]. For $\Lambda = 1$ TeV ($\Lambda = m_{e^*}$), masses below 756 GeV (796 GeV) are excluded. Reference [6] has detailed information on this analysis.

3 CDF Search for Excited and Exotic Muons

CDF has searched for excited and exotic muons in 371 fb^{-1} of data. After selecting two isolated high E_T muons and one isolated high E_T photon, 17 events remain, with a background of 8.7 ± 0.9 events. The dominant background is Z γ. The data excess is predominantly in the Z $\rightarrow \mu\mu\gamma$ final state radiation region, with 5.5 events predicted and 11 candidate events observed . The resulting limit on cross section times branching fraction as a function of m_{μ^*} is shown in Fig. 2 together with predictions of the contact interaction and gauge-mediated

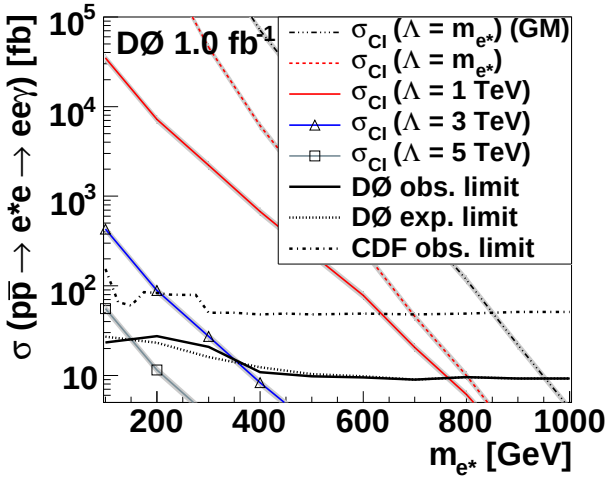

Figure 1: The DØ measured and expected limits on cross section times branching fraction, compared to the contact interaction model prediction for different choices of Λ. Also shown is the prediction under the assumption that no decays via contact interactions occur ("GM"), and the CDF result [5]. The theoretical uncertainty of the model prediction is indicated by shaded bands.

models for different choices of parameters. Using a gauge mediated model with $\Lambda/\mathrm{f} = m_{\mu^*}$, ($\mathrm{f}/\Lambda = 10^{-2}$ GeV), where f is the gauge coupling factor, exotic muons are excluded for masses below 221 GeV (410 GeV). For compositeness models with only electroweak decays and $\Lambda = m_{\mu^*}$, masses below 853 GeV are excluded. Details and 2-D exclusion regions are given in reference [7].

4 DØ Search for Excited Muons

DØ has searched for excited muons in 380 fb^{-1} of data. The selection of at least one isolated high E_T muon, a second high E_T muon and one isolated high E_T photon, yields 90 events with a background of 65$\pm$40 events. The dominant background is Z γ. The large uncertainty in the background estimate is due to misidentified photons, which are negligible for large m_{μ^*}. The resulting limits on cross section times branching fraction, including the effect of CI decays, is shown in Fig. 3 as a function of m_{μ^*} together with predictions of the contact interaction model for different choices of the scale Λ. For $\Lambda = 1$ TeV ($\Lambda = m_{\mu^*}$), masses below 618 GeV (688 GeV) are excluded. For assumptions similar to CDF, m_{μ^*} values below 890 GeV are excluded. More information is available in reference [8].

5 Summary

DØ and CDF have searched for excited electrons and excited and exotic muons. Mass limits have been set for excited electrons of 756 GeV for $\Lambda = 1$ TeV in contact interaction models. For excited muons, mass limits up to 890 GeV have been set, depending on assumptions

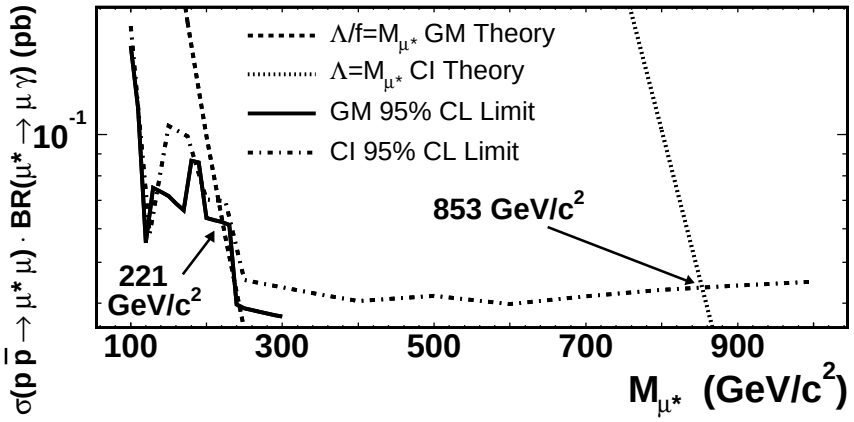

Figure 2: The CDF experimental cross section × branching ratio limits at 95% C.L. for the CI (dashed-dotted line) and GM models (solid line), compared to the CI model prediction for $\Lambda = m_{\mu^*}$ (dotted line) and the GM model prediction for $\Lambda/\mathrm{f} = m_{\mu^*}$ (dashed line). Also indicated are the mass values that are excluded by these data.

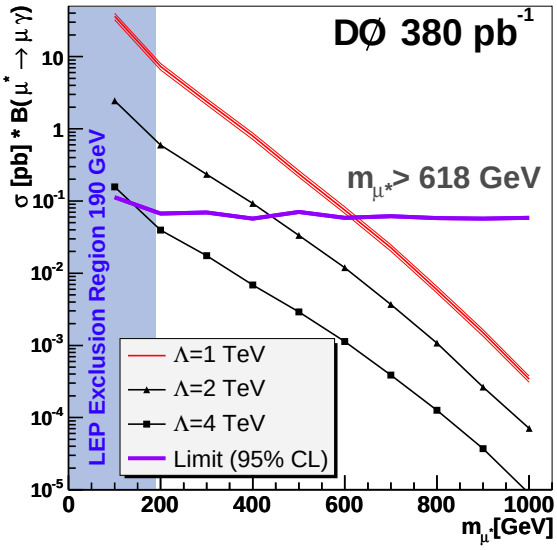

Figure 3: The DØ measured cross section × branching fraction limit, compared to the contact interaction model prediction for different choices of Λ. For the case $\Lambda = 1$ TeV, the theoretical uncertainty of the model prediction is indicated.

on Λ and decay modes. For $\Lambda/\mathrm{f} = m_{\mu^*}$, exotic muons in gauge-mediated models have been excluded for masses below 221 GeV.

6 Bibliography

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