Fermi National Accelerator Laboratory

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CDF

Search for Exotic Particles at CDF

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SEARCH FOR EXOTIC PARTICLES AT CDF

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ABSTRACT

CDF has searched for 2nd generation leptoquarks, new gauge bosons W' and Z', axigluons, excited quarks, color octet technirhos and E_6 diquarks. We place the most stringent limits on direct production of these exotic particles.

1. Data Sample

All searches presented use roughly 19 pb^{-1} of $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV from the 1992-93 running period of the Collider Detector at Fermilab (CDF).

2. 2nd Generation Leptoquarks

Leptoquarks[1] are color triplet particles coupling to a lepton-quark pair which appear in GUTs, compositeness, technicolor, and other extensions of the standard model. We search[2] for pair production of 2nd generation scalar leptoquarks (S_2) each of which subsequently decay to a muon and a quark with branching fraction β. We require two isolated central muons with $P_T > 20$ GeV, opposite sign, azimuthal separation $\Delta\phi < 160°$, remove Z candidates ($75 \leq M_{\mu\mu} \leq 105$ GeV/c^2), and require two jets with $E_T > 20$ GeV/c^2. We find two leptoquark candidate events, in good agreement with background expectations of 1.35 ± 0.5 events. Our 95% CL upper limits on the cross section for second generation leptoquarks are compared to theory in Fig. 1. We exclude at 95% CL 2nd generation leptoquarks of mass $M_{S2} < 133$ GeV/c^2 for $\beta = 1$ and $M_{S2} < 98$ GeV/c^2 for $\beta = 0.5$.

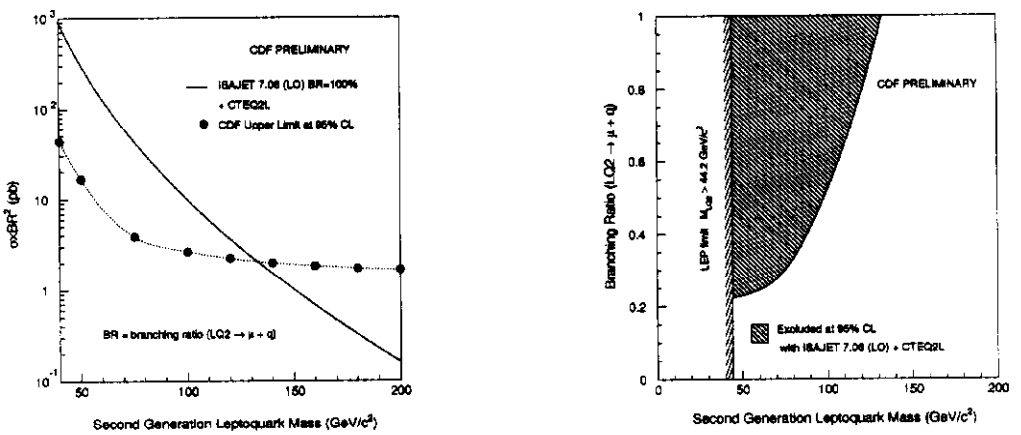

Figure 1: Limits on leptoquark cross section and branching ratio vs mass.

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3. New Gauge Bosons

New gauge bosons W' and Z' appear in left-right symmetric models, GUTs, superstring inspired E_6 models, and other extensions of the standard model. We search[3] for W' decays to one isolated central electron and one neutrino, each with $E_T > 30$ GeV, and measure the transverse mass. We search[4] for Z' decays to two isolated electrons each with $E_T > 25$ GeV. In both cases we observe the characteristic peaks of W and Z production at low mass, and fit the distributions to the standard model predictions plus a W' or Z' mass resonance at higher mass. We find no significant evidence of new gauge bosons, and the fit yields upper limits on cross section times branching ratio shown in Fig. 2. We exclude at 95% CL W' with mass less than 652 GeV/c^2 and Z' with mass less than 505 GeV/c^2. Preliminary data from the current 1994-95 running period contain a $W' \to e\nu$ candidate with uncorrected transverse mass of 420 GeV/c^2 and a $Z' \to ee$ candidate with uncorrected mass of 510 GeV/c^2.

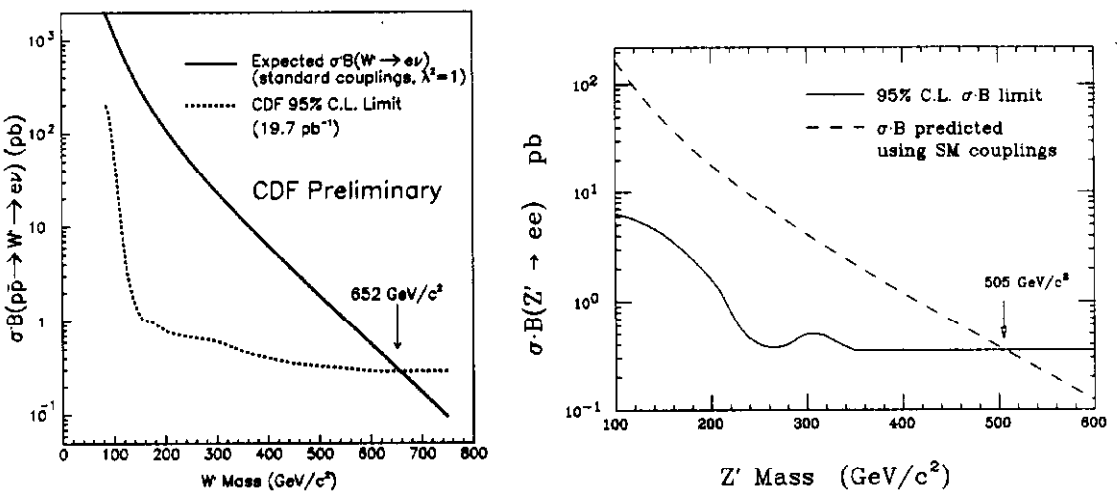

Figure 2: Limits on $W' \to e\nu$ and $Z' \to ee$ cross section vs mass.

4. New Particles Decaying to Dijets

We search[5] for dijets from decays of the following singly produced particles: axigluons[6] from chiral QCD ($A \to q\bar{q}$), excited states[7] of composite quarks ($q^* \to qg$), color octet technirhos[8] ($\rho_T \to g \to q\bar{q}, gg$), new gauge bosons ($W'$,$Z' \to q\bar{q}$), and scalar E_6 diquarks[9] ($D \to \bar{u}\bar{d}$ and $D^c \to ud$). We find the two highest P_T jets and require that they have pseudorapidity $|\eta| < 2$ and a CMS scattering angle $|\cos\theta^*| < 2/3$. In Fig. 3 we compare the mass of the two jets to a QCD simulation normalized to the data, a parameterization fit to the data, and simulated q^* signals. There is no significant evidence for a new particle. We fit the data to the background parameterization plus the q^* signal: this models any new particle with half-width significantly less than the

CDF dijet mass resolution ($\sigma/M \sim 0.1$). From the fit we obtain 95% CL upper limits on new particle cross section times branching ratio. In Fig. 3 we compare our cross section limits to theoretical predictions and exclude axigluons for $200 < M_A < 870$ GeV/c^2, excited quarks for $200 < M^* < 560$ GeV/c^2, and color octet technirhos for $320 < M_\rho < 480$ GeV/c^2. The excited quark limit from dijets is combined with published CDF limits in the γ+jet and the W+jet channel[10] thereby excluding excited quarks in the mass range $80 < M^* < 570$ GeV/c^2 at 95% CL.

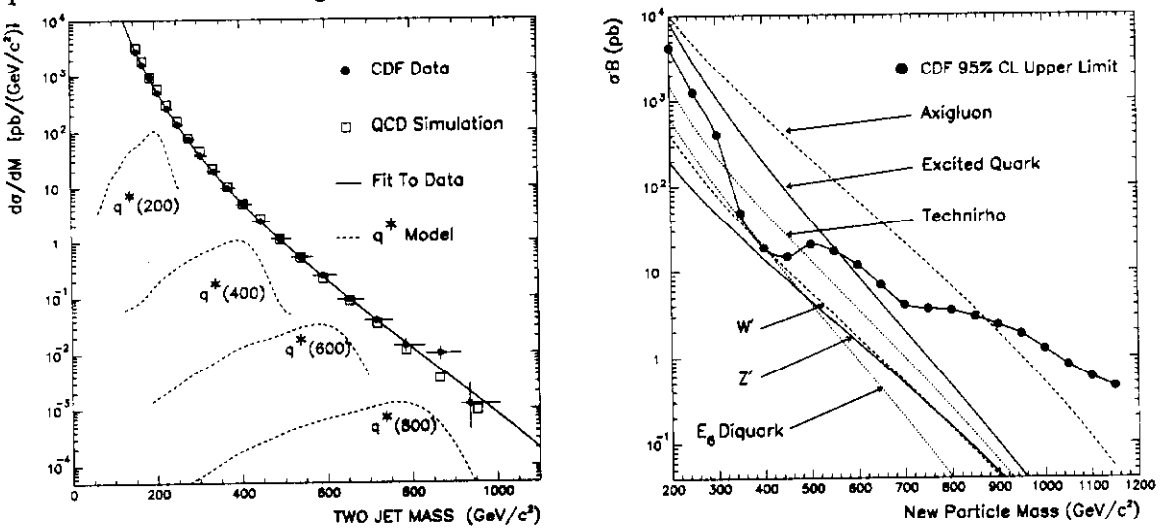

Figure 3: The dijet mass distribution and upper limits on a new particle signal.

5. Conclusions and Future Prospects

With increasing luminosity CDF can find or exclude new particles with mass approaching 1 TeV: a previously unexplored scale at which new physics may emerge. Although we currently find no evidence for many classes of new particles, and have placed the most stringent limits on their direct production, we remain optimistic that further luminosity will reveal new physics beyond the standard model.

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