A DISORIENTED CHIRAL CONDENSATE SEARCH AT THE FERMILAB TEVATRON

by

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Abstract

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MiniMax (Fermilab T-864) was a small test/experiment at the Tevatron designed to search for disoriented chiral condensates (DCC) in the forward direction.

Relativistic quantum field theory treats the vacuum as a medium, with bulk properties characterized by long-range order parameters. This has led to suggestions that regions of "disoriented vacuum" might be formed in high-energy collision processes. In particular, the approximate chiral symmetry of QCD could lead to regions of vacuum which have chiral order parameters disoriented to directions which have non-zero isospin, i.e. disoriented chiral condensates. A signature of DCC is the resulting distribution of the fraction of produced pions which are neutral.

The MiniMax detector at the C0 collision region of the Tevatron was a telescope of 24 multi-wire proportional chambers (MWPC's) with a lead converter behind the eighth MWPC, allowing the detection of charged particles and photon conversions in an acceptance approximately a circle of radius 0.6

in pseudorapidity–azimuthal-angle space, centered on pseudorapidity $\eta \approx 4$. An electromagnetic calorimeter was located behind the MWPC telescope, and hadronic calorimeters and scintillator were located in the upstream antiproton direction to tag diffractive events.

The use of standard Monte Carlo simulations for high-energy collisions of elementary particles (PYTHIA) and for interactions of particles in the detector (GEANT) is described, along with the simulation created by the MiniMax Collaboration to generate DCC domains.

A description of the data analysis software is given, including detailed studies of its performance on data from the simulations.

A set of robust observables is derived. These are insensitive to many efficiencies and to the details of the modeling of the parent pion production mechanisms, yet have distinguishable values for DCC and generic charged-neutral distributions. Simulations show that the robust observables are insensitive to detector efficiencies and to systematic errors in the data analysis software.

The resulting values for robust observables for approximately 1.5×10^6 events are shown to be consistent with production by only generic mechanisms. Results from samples of diffractive-tagged events and of high-multiplicity events also show no evidence for DCC.

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