ATTACHMENT K (FOR PART I)

DESCRIPTION/ABSTRACT

The project covered a wide area of current research in theoretical high-energy physics. This included Standard Model (SM) as well as physics beyond the Standard Model. Specific topics included supersymmetry (SUSY), perturbative quantum chromodynamics (QCD), a new weak interaction for the third family (called topflavor), neutrino masses and mixings, topcolor model, Pade approximation, and its application to perturbative QCD and other physical processes. In supersymmetry, a detailed study was made for the prospects of discovering SUSY in the gauge mediated supersymmetry breaking scenario (GMSB). A new signal associated with the observation of final states containing four tau lepton (together with large missing energy) at the LEP2 collider was proposed. This signal comes from the production of the lightest neutralino pair, and the subsequent decays of each neutralino to a tau and a scalar tau, and finally the decay of the scalar tau to a tau and a gravitino. The gravitinos will escape detector, and give rise to the missing energy in the event. The data are now being analyzed to look for such events by the LEP 2 collaborations. We also proposed that in the GMSB scenario, the dominant signal for the discovery of supersymmetry at the Tevatron Run 2 will be the observation of events containing high P_T tau leptons together with large missing transverse energy. This has been one of the major areas of interest in the Supersymmetry Run 2 Workshop at Fermilab. This signal is due to the productions of the chargino pair or the chargino-neutralino, and their subsequent decays to scalar tau and finally producing tau, neutrino and gravitinos. The topic of neutrino masses and mixings were also investigated in the framework of SO(10) Grand unified Theory (GUT). A new bottom up approach was proposed to determine the neutrino mass matrix textures. Our theory can accommodate both the large mixing for the atmospheric neutrino experiment, as well as small mixing for the MSW explanation of the solar neutrino deficit. Regarding the top quark physics, a new weak interaction for the third family (called the top-flavor) was introduced, and several interesting implications, which can be tested in the upcoming Tevatron Run 2 and LHC, were discussed. Topcolor theory predicts the existence of massive colored gauge bosons called the colorons. In this project, we studied the prospect of observing such a particle via its dominant decay to top antitop pairs at the upgraded Tevatron and LHC. In the area of perturbative QCD, four loop calculations for the total cross section for electron positron annihilating to hadrons, for the decay width of the tau lepton to hadrons, as well as four loop calculation for the QCD beta function were performed. In addition, Pade approximation techniques were extensively used to predict the higher order coefficients for the perturbative calculations of many physical processes.
DECLARATION

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
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ATTACHMENT A4 (FOR PART I)

RESEARCH PUBLICATIONS BY THE PI (S. NANDI) AND OTHER PROJECT PERSONNEL: (M.A. SAMUEL)

PUBLICATIONS BY DR. S. NANDI


PUBLICATIONS BY DR. M.A. SAMUEL


34. "The QCD Coupling Constant from Tau Decays", OSU RN 328 (1997).

35. "$Z \to b \bar{b}$ and $Z \to c \bar{c}$ as Tests of the Standard Model and the Mass of the Higgs Boson", Nuclear Physics B (Proc. Suppl) 55A, 184 (1997).


39. "$Z \to b \bar{b}$ and $Z \to c \bar{c}$ as Tests of the Standard Model and the Mass of the Higgs Boson," Physics Letters, B397, 241 (1997).


47. "$Z \rightarrow b \bar{b}$ and $Z \rightarrow c \bar{c}$ as Tests of the Standard Model,” Int. J. Theo. Phys. 36, 119 (1997).


ATTACHMENT A5 (FOR PART I)

ACCOMPLISHMENT REPORT

A new signal for the potential discovery of supersymmetry: four tau leptons plus large missing energy events at the LEP 2 collider (publication #12).
Two students (supported in part by this project) completed their thesis and received their Ph.D. degree during this project period. The details are given below.

1. Bhaskar Dutta  
   Thesis Advisor: Professor S. Nandi  
   Title of Ph.D. thesis: Beyond the Standard Model  

2. Eric Steinfeld  
   Thesis Advisor: Professor M.A. Samuel  
   Title of Ph.D. thesis: Perturbative quantum field theory and other physical perturbations + going to higher order with analytical and approximative schemes  
   Final thesis defense: Fall, 1997
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