

# Studying New Physics Using Ultrahigh-Energy Cosmic-Ray $\gamma$ -Family Data\*

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This paper discusses some recent developments in the study of ultrahigh-energy interactions using cosmic-ray  $\gamma$ -family data obtained with emulsion chambers at mountain altitudes. The apparent excess of the event rate at large transverse momenta with respect to the prediction based on perturbative QCD indicates new interaction mechanisms at  $E_{\text{lab}} \simeq 10^4\text{--}10^5$  TeV, an energy regime beyond the reach of existing colliders. To reconcile the data with a compositeness model of quarks, the characteristic energy scale would have to be as low as  $\Lambda_c \leq 0.1$  TeV, in conflict with the lower limit of  $\Lambda_c > 1.4$  TeV or a possible value of  $\Lambda_c \simeq 1.6$  TeV obtained by the CDF experiment at Tevatron. Possible new physics beyond the standard model, together with future experiments at the LHC, are also discussed.

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