DEEP-INELASTIC MUON-SCATTERING EXPERIMENTS

K. W. Chen

The strikingly simple character of deep-inelastic electron scattering led to a scaling hypothesis of the structure of the nucleon as a composite of structureless entities. The existence of structureless entities implies that the structure function \( vW_2(W_1) \) must be a function of a single scaling variable, say \( \omega = 2Mv/q^2 \), where \( M \) is the mass of the nucleon, \( v \) is the energy transferred by the proton to the electron, and \( q^2 = 2EE'(1 - \cos \theta) \), where \( \theta \) is the scattering angle. The structure function is related to the total cross section for a proton to absorb the virtual photon exchanged by the electron and proton. Without scaling, structure functions should, in general, depend on both \( v \) and \( q^2 \). Before 1973, a series of electron-scattering experiments performed at SLAC and DESY for \( q^2 \) from 1-15 GeV\(^2\) and \( v \) up to 20 GeV had confirmed the "scale-invariance" picture to a remarkable consistency. Data from low-energy muon-proton scattering experiments at BNL and SLAC were also consistent with this scale invariance. These observations led to an avalanche of theoretical work which, among other things, laid the basis for the "quark-parton" model.

Beginning in 1973, tests of scale-invariance in muon scattering began at Fermilab with Experiment 26, a collaboration of Cornell, Michigan State, and the University of California. The experiment used an iron target to maximize the luminosity in order to reach high values of \( q^2 \) (~50 GeV\(^2\)/c\(^2\)).

* On leave from Michigan State University
available in 1978 at the CERN SPS. Two active muon-scattering experiments, NA2 and NA4, are currently under construction.

References

10. For example, I. Karliner and J. D. Sullivan, Urbana Preprint, 1977.
11. For example, D. Schildknecht and F. Steiner, Phys. Lett. 56B, 36 (1975).
The Muon Laboratory. Since 1973 a series of deep inelastic muon-scattering experiments has been performed here. Scaling tests, hadron final states, and multimunon studies have been conducted. The neutrino detector building is shown on the left. The Main Ring is shown in the background.

(Photo by Fermilab Photo Unit)
Installation of the first of six "energy fountains" at Service Building B1. This device will be ringed with hanging wires when complete. Its purpose is to dissipate the energy stored in the superconducting magnet ring in the event of a quench.

(Photo by Fermilab Photo Unit)