Mark Strovink

Professor
Particle Experiment

Mark Strovink, Ph.D. 1970 (Princeton). Joined UC Berkeley faculty in 1973 (Professor since 1980). Elected Fellow of the American Physical Society; served as program advisor for Fermilab (chair), SLAC (chair), Brookhaven, and the U.S. Department of Energy; served as D-Zero Physics Coordinator (1997 & 1998).

Research Interests

I am interested in experiments using elementary particles to test discrete symmetries, absolute predictions and other fundamental tenets of the Standard Model. Completed examples include early measurement of the parameters describing charge parity (*CP*) nonconservation in *K* meson decay; establishment of upper limits on the quark charge radius and early observation of the effects of gluon radiation in deep inelastic muon scattering; and establishment of stringent limits on right-handed charged currents both in muon decay and in proton-antiproton collisions, the latter via the search for production of right-handed *W* bosons in the D-Zero experiment at Fermilab.

After the discovery in 1995 by CDF and D-Zero of the top quark, we measured its mass with a combined 3% error, yielding (with other inputs) a stringent test of loop corrections to the Standard Model and an early hint that the Higgs boson is light. If a Higgs-like signal is seen, we will need to measure the top quark mass more than an order of magnitude better in order to determine whether that signal arises from the SM Higgs.

Current Projects

A continuing objective is to understand better how to measure the top quark mass. Top quarks are produced mostly in pairs; each decays primarily to $b + W$. The *b*'s appear as jets of hadrons. Each *W* decays to a pair of jets or to a lepton and neutrino. For top mass measurement the most important channels are those in which either one or both of the *W*'s decay into an electron or muon. For the single-lepton final states, we developed in 1994-96 and applied in 1997 a new technique that suppresses backgrounds (mostly from single *W* production) without biasing the apparent top mass spectra. For the dilepton final states, where backgrounds and systematic errors are lower but two final-state neutrinos are undetected rather than one, a likelihood *vs.* top mass must be calculated for each event. During 1993-96 we developed a new prescription for this calculation that averages over the (unmeasured) neutrino rapidities, and we used it in 1997 to measure the top mass to ~7% accuracy in this more sparsely populated channel. In both channels, further improvements to measurement technique as well as accumulation of larger samples will be necessary.

While studying data from the 1992-1996 CDF and D-Zero samples that contain both an electron and a muon, we became aware of three events that cannot easily be attributed either to top quark decay or to backgrounds. Generally this is because the transverse momenta of the leptons (electrons, muons, and neutrinos as inferred from transverse momentum imbalance) are unexpectedly large. We anticipate confirming data *e.g.* from the D-Zero run that began in 2001.

Transverse momentum imbalance is a broad signature for new physics. For example, in many supersymmetric models, *R*-parity conservation requires every superparticle to decay eventually to a lightest superparticle that, like the neutrino, can be observed only by measuring a transverse momentum imbalance. Reliable detection of this signature is one of the severest challenges for collider detectors. D-Zero's uniform and highly segmented uranium/liquid argon calorimeter yields the best performance achieved so far. Building on that, we have developed a new approach to analysis of transverse momentum imbalance that, for a given efficiency, yields up to five times fewer false positives.

Recently we have grappled with the long-standing problem of searching with statistical rigor for new physics in samples that should be describable by Standard Model processes – when the signatures for new physics are *not* strictly predefined. We have identified plausible methods for performing this type of analysis, and have exercised them on D-Zero data, but the methods involve sacrifices in sensitivity that we are still working to mitigate.

Selected Publications

S. Abachi *et al*. (D-Zero Collaboration), "Search for right-handed *W* bosons and heavy *W'* in proton-antiproton collisions at $\sqrt{s}$ = 1.8 TeV," *Phys. Rev. Lett*. **76**, 3271 (1996).

S. Abachi *et al*. (D-Zero Collaboration), "Observation of the top quark," *Phys. Rev. Lett*. **74**, 2422 (1995).

B. Abbott *et al*. (D-Zero Collaboration), "Direct measurement of the top quark mass," *Phys. Rev. Lett*. **79**, 1197 (1997); *Phys. Rev*. **D 58**, 052001 (1998).

B. Abbott *et al*. (D-Zero Collaboration), "Measurement of the top quark mass using dilepton events," *Phys. Rev. Lett*. **80**, 2063 (1998); *Phys. Rev*. **D 60**, 052001 (1999).

V.M. Abazov *et al*. (D-Zero Collaboration), "A quasi-model-independent search for new high p_T physics at D-Zero," *Phys. Rev. Lett*. **86**, 3712 (2001); *Phys. Rev*. **D 62**, 092004 (2000); *Phys. Rev*. **D 64**, 012004 (2001).

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