

and educator by stating these suggestions directly—for example, “The question can be answered without integration”—rather than falling into the bad habit of using emotionally laden words like “simple,” “obvious,” or “trivial.” These adjectives unnecessarily impugn your students’ competence and make them feel defensive.

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An Early Step Toward Asymptotic Freedom

I read with appreciation Bertram Schwarzschild’s report on the richly deserved Nobel Prize won by David Gross, David Politzer, and Frank Wilczek for the discovery of asymptotic freedom (PHYSICS TODAY, December 2004, page 21). I am writing to note significant events that preceded this discovery, relating both to Murray Gell-Mann’s current algebra and to scaling.

The first sum rule to test current algebra, which depended only on the commutator of axial-vector charges,

together with the partially conserved axial current (PCAC) hypothesis, was the Adler–Weisberger sum rule, derived independently by William Weisberger and me in 1965.¹ The sum rule, which related the nucleon axial-vector beta-decay coupling g_A to pion–nucleon scattering cross sections, was in good accord with experiment and gave great encouragement to the current-algebra program. Many people entered the field, and various experimentally verified current-algebra PCAC soft-pion theorems were found. In other work on the g_A sum rule, I noted that by using my earlier observation that forward neutrino reactions couple only to the divergences of weak currents, the PCAC assumption could be eliminated. This led to relations involving cross sections for neutrino scattering with a forward-going lepton. During a visit to CERN in the summer of 1965, Gell-Mann asked me whether I could make some comparable statement about the local current algebra.

After considerable hard algebra, I discovered a sum rule² involving structure functions in deep inelastic neutrino scattering that directly tested the local Gell-Mann algebra.

This sum rule for neutrino scattering was soon converted into an inequality for deep inelastic electron scattering by James Bjorken.

Although not directly tested until many years later, the neutrino sum rule had important conceptual implications that figured prominently in later developments. First, it gave the earliest indication that deep inelastic lepton scattering could provide information about the local properties of currents, a fact that initially seemed astonishing, but which turned out to have important extensions. Second, as noted by Geoffrey Chew in remarks at the 1967 Solvay Conference and in a letter³ published shortly afterward, the closure property tested in my sum rule would, if verified, rule out the then-popular “bootstrap” hadron models, in which all strongly interacting particles were asserted to be equivalent (“nuclear democracy”). In a similar vein, Bjorken argued in his 1967 Varenna lectures that the neutrino sum rule strongly suggested the presence of hadronic constituents.

Those conceptual developments left undetermined the mechanism by which the neutrino sum rule could be saturated. In a 1966 analysis of

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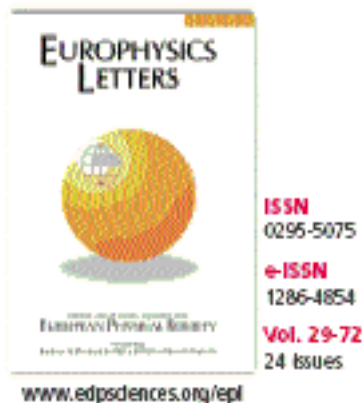
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the saturation of the neutrino sum rule for small four-momentum transfer q^2 , Frederick Gilman and I pointed out that saturation of the neutrino sum rule for large q^2 would require a new component in the deep inelastic cross section, one that did not fall off with form-factor squared behavior. Bjorken became interested in saturation of the sum rule, and he formulated several preliminary models that had hints of the dominance of a regime in which the energy transfer grows proportionately to q^2 . At the 1967 Solvay Conference, in response to questions about saturation of the neutrino sum rule, I summarized Bjorken's pre-scaling proposals. The precise saturation mechanism was clarified some months later with Bjorken's proposal⁴ of scaling, and soon afterward with the SLAC experimental work on deep inelastic scattering.

The Bjorken scaling hypothesis, and its reinterpretation using parton-model ideas inspired by Richard Feynman, led to powerful theoretical tools for analyzing deep inelastic scattering. For instance, Curtis Callan and Gross used scaling to derive a proportionality relation between two of the deep inelastic structure functions, under the assumption of dominance by spin- $\frac{1}{2}$ constituents (partons).

Wu-Ki Tung and I, and independently Roman Jackiw and Giuliano Preparata, soon showed that in perturbative quantum field theory there would be logarithmic deviations from the Callan-Gross relation. In other words, only free field theory would give exact scaling; in Gell-Mann's memorable phrase, "Nature reads the books of free field theory." That recognition, together with the proposal by William Bardeen, Harald Fritzsch, and Gell-Mann of a tripling of fractionally charged quarks,⁵ and new developments in the renormalization group, set the stage for a search for field theories that would have almost free behavior; the resulting discovery of asymptotic freedom in Yang-Mills theories gave the only case that worked.

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Physics or Politics?

Jim Dawson's piece on the election results (PHYSICS TODAY, January 2005, page 24), in which he suspects the winning party will seek revenge, was appalling, out of line with a professional journal. That some scientists supported John Kerry is their opinion. As John Marburger said, polarization during elections is part of our public process. Whether we backed one candidate or another should not affect our professional decisions or public sentiments. Otherwise, how can we maintain competence and credibility? As a self-employed consultant for more than 30 years, I have found credibility to be crucial to my practice.

The reason that national funding of academia is often limited is that academic research may be inefficient in the national scene. Few physicists heeded the message that OPEC sent to the world in 1974. The present Iraq war likely stems from that oversight. Where have the biomass fuel exponents in physics been for the last 30 years? Must the US again spend too late and too much to assure energy supplies now amid Homeland Security Department costs, simply because we didn't go green on energy needs 30 years ago, with academia leading the way?

I recall a physics class circa 1950, in which a PHYSICS TODAY representative announced the magazine's creation—a good idea, I thought. Has half a century reduced you to yellow journalism to obtain national funding of physics? Are you out of touch with the majority of Americans?

Stick to the technical facts. Just tell us what is going on today in physics and related fields, and leave the politics to others.

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Dawson replies: Science may be clean, cold, and objective, but it exists in a world that is anything but. When scientists form significant groups—the 48 Nobel laureates, for example—to endorse one candidate over another, PHYSICS TODAY should