

Who ordered that?

Isidor Isaac Rabi, 1936



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Science & Technology

Who Ordered the Muon?

THE HUNTING OF THE QUARK

A First History of Modern Physics

By Michael Borden

Illustrated, 200 pp. New York:
Facts/Ones/Books & Publishers,
Cloth, \$19.95. Paper, \$9.95

By Marcia Bartels

BLAME Democritus, in the fifth century B.C., that presages Greek philosophy started humbly on its search for the universe's ultimate building blocks when he suggested that all matter was made of infinitesimally small particles called atoms. In 1807, the British physicist J. J. Thomson completed the quest when he discovered the first subatomic particle, the electron. Later, others recognized the proton and neutron. An atom's nucleus gave in the next few decades, a parade of spinward particles appeared in the debris, a veritable Greek alphabet soup of boronides, sigmas and pius. "Who ordered that?" exclaimed the theorist Isidor I. Rabi when the atom was identified.

Confusion reigned until 1932, when the physicists Murray Gell-Mann and George Zweig independently suggested that many particles in the vast array were actually composites, made of different combinations of smaller, more fundamental constituents. Mr. Zweig called them "ray quarks," Mr. Gell-Mann, on the other hand, as a fit of whimsy not unusual for particle theorists, labeled them "quarks" but quickly altered the spelling when he came across a passage in James Joyce's "Finnegans Wake": "Three quarks for Muster Mark! To-day quark - gone in six 'barrows' - up, down, strange, charm, top and bottom - a collection that offers complexity to be replaced with a welcome simplicity. That was Mr. Gell-Mann's genius, wrote Michael Borden in "The Hunting of the Quark": "He could look at a pile of coal and see only diamonds."

The physicists were very reluctant to embrace their genius. It is now generally forgotten that the brilliant idea of Mr. Gell-Mann and Mr. Zweig was not one of a bewildering variety of theories then being advanced as the most basic form of matter. "It is a small miracle," Mr. Borden notes, "that particle physicists could ever agree on one terminology."

Indeed, they were often swayed by trends. In the 1950's, the most fashionable theory was the meson model, which declared that there were no elementary particles, only an ever-permeating cloud of mass energy. Sometimes this view could take a form, at other-times a neutron, it was a very democracy. With such an optimistic attitude, the concept of quarks was not greeted warmly. Mr. Gell-Mann, in fact, thought of quarks as mere mathematical abstractions. The quark's material existence was faraway, a part of the eternal conflict between idealism and realism. But the tale eventually shifted, as the supreme materialism of physics, the laws of the California Institute of Technology were described as the Croucher named the quest for subatomic particles.

In the 1960's, the revolution in physics was the search for stringing and solitons.

... a science writer living in the shadow of "Thursday's University" professors of astrophysics

members. Not an inch of attention is paid to those who drilled their hands, turning cosmic-ray accelerators into instruments, in order to prove the conjecture. Mr. Borden, a physicist affiliated with the Stanford Linear Accelerator Center, presents an authoritative account of the hunt for the muon. A certain quark matter himself, he deftly combines his technical expertise with a persistence that, personally speaking, is with many of the men and women who joined in the hunt. "Although most of us then perceived it only dimly, if at all," he says, "we had been told that it was a classic scientific revolution."

About a third and fourth century of particle physics in the first half of this century, Mr. Borden has his hands where he needs more familiar territory, particularly the pioneering experiments conducted in the late 19's and early 70's at the Stanford Linear Accelerator. "The world that stood open for subatomic world" it was here, with Mr. Borden participating as a graduate student, that the first hints of a quark's existence were uncovered, and as a machine that was considered second-rate at the time.

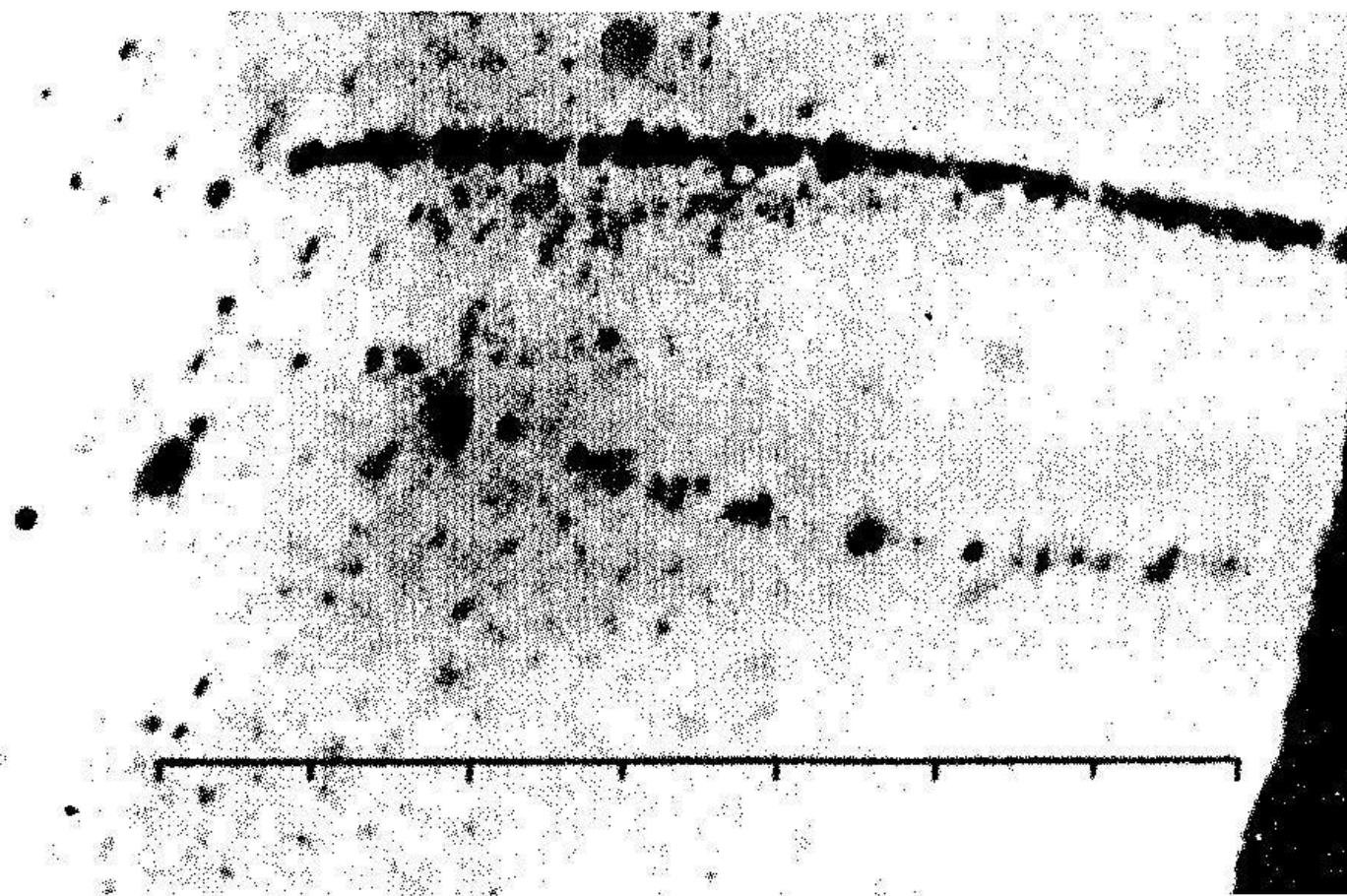
According to Mr. Borden, he and his colleagues were like blind men playing dominoes. Experimentalists couldn't see in "see" a quark - however trapped in a subatomic prison - but they could search for its distinctive signature amid particle rain, scaling velocities and energy patterns. Proof would come in the way an electron, hurled down a narrow tube miles long at speeds near that of light, slammed into a proton and recoiled from the fatal collision.

Mr. Borden provides us with a riveting climax when he recounts how the research teams - and at Brookhaven National Laboratory as Long Island, the other in Stanford - in a phone booth seized the most valuable catch of the era: the J/psi, a particle that revealed the elusive fourth quark, charm. Here are the missed opportunities, blind alleys and narrow rivulets that almost always precede a triumph - and a Nobel Prize, for the American physicists Burton Richter and Samuel C. C. Ting.

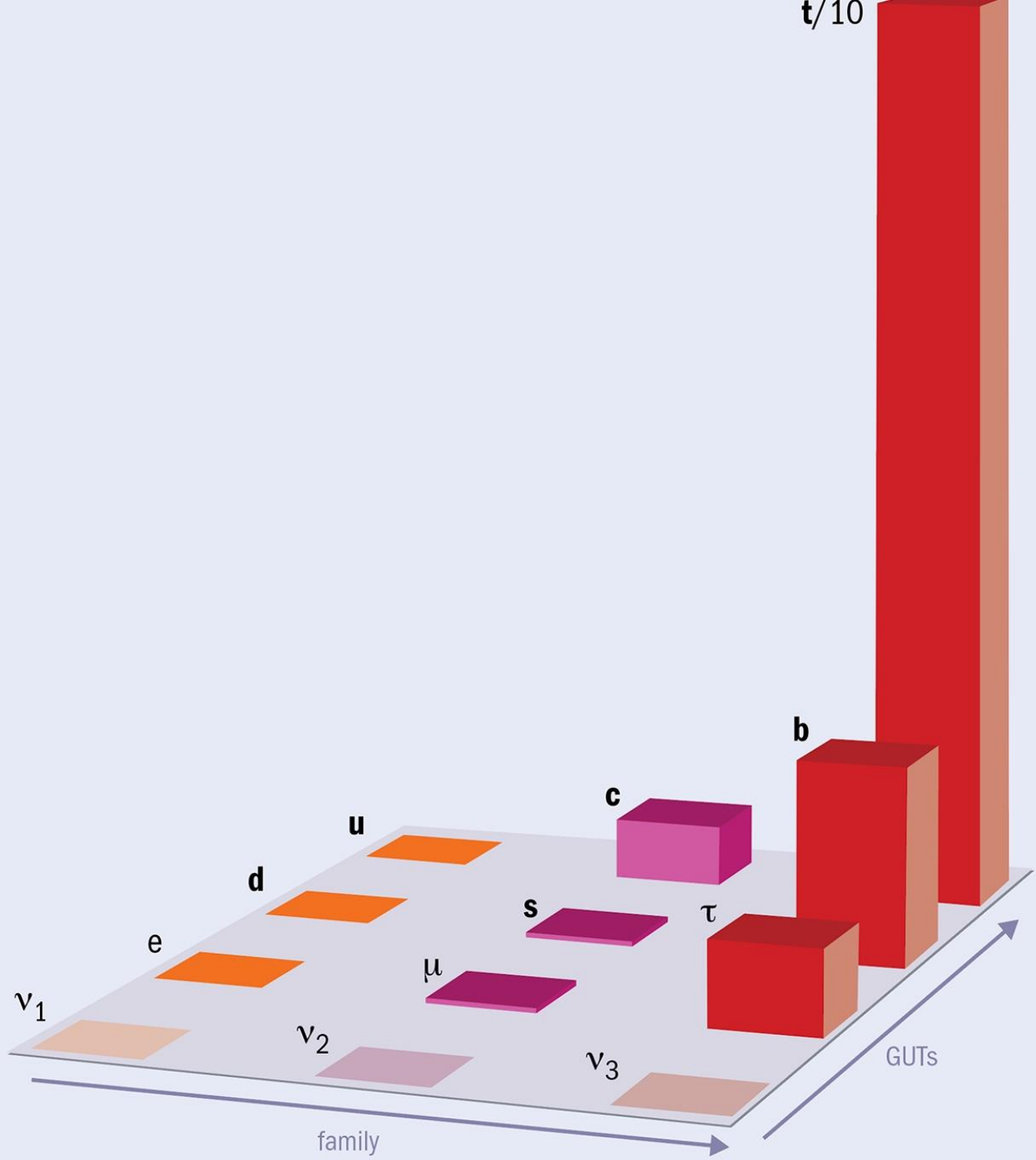
FOh those flames in the language of this author's text. "The Hunting of the Quark" is a rugged and lively portrayal of the varied trials that finally led to acceptance of the quark as a basic life particle. Mr. Borden has a knack for the original analogy: probability waves in quantum mechanics are compared to ripples waves, while the reaction of particles out of nothingness, a standard trick of the microwave, is likened to a grand slam of baseball.

For the uninitiated, however, the author's casual references to current theories, Feynman diagrams and broken symmetries can be overwhelming at times. Readers who are unfamiliar with such jargon will assuredly flounder, perhaps because particle physicists must deal with certain ideas - for example, Planck's constant, fractional electric charge and non-commutative principles - that have no equivalents in our everyday world. The quark's story, Mr. Borden points out, "isn't quarky at heart, if you try to examine one too closely. It keeps away from your scrutiny. Discreetly evaporates into a mystical sigh." Yet even with this difficulty, Mr. Borden makes us behold exactly how physicists work and the tortuous paths that experimentalists must travel to gain just a scrap of insight into the puzzling laws of nature.

Readers who never felt Mr. Borden address the possibility that deeper investigations into the heart of matter - the "vacuum state," as he puts it - may go on endlessly. From whispers of something called a proton, an even smaller hypothetical building block, can already be found in physics department corridors. What has Democritus wrought?



"The other double trace of the same type (figure 5) shows closely together the thin trace of an electron of 37 MeV, and a much more strongly ionizing positive particle with a much larger bending radius. The nature of this particle is unknown; for a proton it does not ionize enough and for a positive electron the ionization is too strong. The present double trace is probably a segment from a "shower" of particles as they have been observed by Blackett and Occhialini, i.e. the result of a nuclear explosion".



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<https://www.forbes.com/sites/startswithabang/2021/02/03/why-the-unexpected-muon-was-the-biggest-surprise-in-particle-physics-history/>