

The background of the page is filled with white particle tracks and Feynman diagrams on a black background. At the top, there are several tracks branching out from a single point. Below that, a track splits into two, with the label 'ETC. DESIGN' written next to it. Further down, there are more complex diagrams with multiple tracks and vertices. At the bottom, there are tracks that appear to be interacting or merging. The overall aesthetic is that of a particle detector or a theoretical physics diagram.

# Elementary Particles: Yesterday, Today, and Tomorrow

by CHRIS QUIGG

**WITHIN THE LIFETIME** of my grandparents, there lived distinguished scientists who did not believe in atoms. Within the lifetime of my children, there lived distinguished scientists who did not believe in quarks. Although we can trace the notion of fundamental constituents of matter—minimal parts—to the ancients, the experimental reality of the atom is a profoundly modern achievement. The experimental reality of the quark is more modern still.

Through the end of the nineteenth century, controversy seethed over whether atoms were real material bodies or merely convenient computational fictions. The law of multiple proportions, the indivisibility of the elements, and the kinetic theory of gases supported the notion of real atoms, but it was possible to resist because no one had ever seen an atom. One of the founders of physical chemistry, Wilhelm Ostwald, wrote influential chemistry textbooks that made no use of atoms. The physicist, philosopher, and psychologist Ernst Mach likened “artificial and hypothetical atoms and molecules” to algebraic symbols, tokens devoid of physical reality that could be manipulated to answer questions about nature.

Atoms became irresistibly real when they began to come apart, with the discovery of the electron that we celebrate in

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