The Quest for Quarks

STRANGE BEAUTY:
Murray Gell-Mann and the Revolution in Twentieth-Century Physics.
By George Johnson. Knopf. 434 pp. $30.

by Gregg Easterbrook

Who was the top scientific mind of the late 20th century? Many would name Stephen Hawking—unmistakably an important thinker, but within the world of science his achievements are seen as somewhat overstated, at least relative to the publicity he receives. Others might say Stephen Jay Gould or E. O. Wilson, but both are renowned for writings and cogitations rather than discoveries. Some would suggest the late physicist Richard Feynman, one of the pioneers of "quantum electrodynamics," and others the physicist Steven Weinberg, architect of the "electroweak" theory of subatomic interaction. James Watson and Francis Crick, the biologists who discovered the double helix, would be considered, as would the geneticist Joshua Lederberg. So much is going on in science that there could be many more candidates, all working at the same time.

Then there is the physicist Murray Gell-Mann. In 1963 he theorized the existence of the quark; he and the physicist Yuval Ne'eman independently developed the Eightfold Way, a sort of Periodic Table of Elements for the subatomic world. Gell-Mann won a Nobel Prize in 1969, and many would name him the postwar era's best theorist, wide ranging and consistently brilliant. His times, theories, and occasionally insufferable ego are the subject of *Strange Beauty*, a fascinating, skillfully composed, and entertaining biography by the science writer and *New York Times* contributor George Johnson. If the quirks of quarks are your interest, *Strange Beauty* is a book for you.

Gell-Mann, the child of Austrian Jewish immigrants, was a prodigy who enrolled at Yale University at age 15; he would show gifts in mathematics, languages, and other fields. (The household arrived in the United States as Gelman: Murray's father changed the spelling to give it an aristocratic timbre.) Heading to graduate school at the Massachusetts Institute of Technology in the late 1940s, Gell-Mann was drawn into the domain of elementary particle physics, at the time a subject of public and intellectual fascination. The atomic bomb had just been exploded, the hydrogen bomb was not far behind, and the atom was seen as the gateway to the next age.

Albert Einstein had revolutionized the way people thought about the largest aspects of the cosmos; Niels Bohr and others then revolutionized thought about the smallest aspects, the quantum world. Einstein's ideas regarding light and gravity were easier to swallow than quantum thinking, which holds that the closer you look into the subatomic realm, the fuzzier and less certain everything becomes. In the 1910s and '20s, Bohr, Werner Heisenberg, and others spun out theories holding that the smallest subatomic units were neither wave nor particle, impossible to fully know, popping in and out of existence, seeming to rely on nonsensical infinities, in the end barely even there.

By the time Gell-Mann arrived on the scene, large particle accelerators—"atom smashers"—were being built as part of a quest to quantify exactly what resided in the subatomic world. Some nations funded particle accelerators in the belief that the machines would produce information of military value. To researchers, though, learning about reality at levels far smaller than the electron was always a pursuit whose "sole purpose was intellectual," rooted in "imaginary realms of pure abstraction," Johnson writes. To Gell-Mann, there was no pure intellectual pursuit more engaging than discerning what matter itself is composed of. Thinkers had been obsessed with that question at least since the Greeks.

Add to that an intense rivalry among researchers of the early postwar period. Theories about the inner realm of matter were flying in all directions, and competing physicists were acutely aware that academic fame and even public celebrity would come to those who explicated the enchanted quantum realm. The young Gell-Mann, Johnson reports, was hooked both by the scientific challenge and the intellectual Super Bowl aspect. He dove in and quickly distinguished himself, winning important faculty assignments and working with many of the great postwar physicists, among them Feynman and George Zweig, who shared with Gell-Mann the initial postulation of the quark.

Strange Beauty is at least as much a history of postwar physics as it is a biography. (The title refers to the properties of quantum units, beautiful yet so outlandish that Gell-Mann named an important quantum phenomenon "strangeness.") Johnson provides several fun tidbits. One is that Gell-Mann spent years saying quarks should be understood as mathematical constructs, not actual things—then the particles were actually discovered, confounding those who had predicted them. Johnson also reports that even scientists say the best thing about quark theory is its name. In addition to echoing the wonderful bagatelle "three quarks for Muster Mark" in James Joyce's *Finnegan's Wake*, *quark* means "nonsense" in German slang.

Johnson orders his story around the progression of theories and discoveries in quantum thinking, providing an extraordinary wealth of detail on such recondite topics as particle parity, mathematical renormalization, isospin, and quantum chromodynamics. He documents the contentions of postwar physics well and seems to possess a near omniscient sense of which researcher was thinking what in which year.

He tries to render the science accessible with metaphor. Explaining, for instance, how the electrons of an atom almost mystically reflect the expected conservation of charge, he deftly writes, "It is as if all the people on the earth were free to set their clocks any way they wished, but an invisible field would arise twisting the hands on the dials ensuring it is always three hours later in New York City than in Pasadena." Still, many readers will find that *Strange Beauty* tells more about the details of particle physics—especially about early ideas that were rejected—than they care to know. Other excellent books, such as Charles Mann and Robert Crease's *Second Creation* (1983), have already covered much of the same ground.

As an abstract intellectual matter, it is amazing that human beings are able to survey structures far smaller than electrons, to devise rules about them (rules that seem true, based on current knowledge), and to predict how they will behave in linear accelerators. Paeans and even poems have been written to the esoteric nature of the smallest building blocks of matter: how they manifest as everywhere and nowhere, seem to come out of emptiness, and at the ultimate level seem to be distilled from pure nihility.

But is the universe really composed of nothing, or are there merely limits on our ability to conceptualize incredible smallness? And even if the universe is made of nothing, how does that help us comprehend our lives? Bricks in your home may be fashioned from probability packets that came from a "dense vacuum," in the delightful Big Bang phrase, and that are composed primarily of spinning nothing. But if one of those bricks hits you, it still knocks you out; the universe acts plenty tangible, solid, and certain. Based on what has been found to date, quantum physics is about as useful as medieval hermeneutics. Maybe it's time to demythologize particle physics, dropping it out of the category of mind-bending and into a lesser standing of "interesting, but. . . ."

Johnson alludes to this, noting that particle physicists of Gell-Mann's generation sought "truths so wispy and subtle that it was never entirely clear whether there was any substance to them at all." He notes as well that Gell-Mann himself scorns many abstract claims about physics as "quantum flapdoddle." One such idea is the postulation, based on a literal reading of Heisenberg's Uncertainty Principle and seriously entertained by some researchers, that the universe would stop existing if we weren't here to look. The Uncertainty Principle holds that particles only snap into a fixed location when observed: if unobserved, the components of the firmament would seem obligated to cease having fixed locations, and then the universe couldn't exist. Maybe this means God keeps the universe in existence by observing it, but maybe it means there's a lot of flapdoddle in physics.

In the 1980s, Gell-Mann shifted his attention from particles to "complexity theory," an attempt to understand how elaborate phenomena (biological cells, the mind) can arise out of interactions of relatively simple rules. Gell-Mann was a founder of the Santa Fe Institute, which studies this emerging discipline. One of the goals of complexity theory is to figure out why there is life instead of inanimacy. It's not clear that complexity thinkers will attain any breakthroughs, and they are often derided by "hard" scientists as dreamers who have drunk too much wine while watching New Mexico sunsets. (When chaos theory and complexity theory became fashionable at around the same time, orthodox scientists scoffed at them collectively as "chaoplexity.") But the potential of complexity theory is great.

For some reason, Johnson, who lives in Santa Fe and knows the work of the institute well, devotes nearly all his attention to Gell-Mann's first career in physics, saying little about his second. Nascent though it is, complexity theory has the potential to be much more relevant to human lives than quantum theoretics. Complexity might help us learn how biology began and why sociological structures develop. It might even tell us not just what the universe is made out of, but whether it has a purpose and a destiny. Still only 70, Gell-Mann has turned his dazzling mind to this subject, and we can hope that he will find something of sufficient value to merit a *Strange Beauty* sequel.

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Conscripts to Adulthood

THE RISE AND FALL OF THE AMERICAN TEENAGER.
By Thomas Hine. Bard/Avon. 322 pp. $24

READY OR NOT:
Why Treating Children as Small Adults Endangers Their Future—and Ours.
By Kay S. Hymowitz. Free Press. 292 pp. $25

by A. J. Hewat

There is a moment at the beginning of each of these books when you wonder whether to keep reading. Thomas Hine, arguing that parents should give teenagers more rein, mentions that he doesn't have any children. Kay Hymowitz, arguing that parents should exert more control, lets fall that her young daughter