−3. This negatively charged baryon, which he dubbed the *omega-minus* (Ω^-) after the last letter in the Greek alphabet, would have a lifetime sufficiently long enough to leave a visible track in a bubble chamber photo. Here was the ideal quarry for experimental physicists.

At the time Brookhaven was building a new bubble chamber every bit the equal, if not the superior, of the big Berkeley device. Eighty inches long, it contained 900 liters of liquid hydrogen. To produce the omega-minus, Brookhaven physicists led by Nicholas Samios (the director of this laboratory today) fired a high-energy beam of negative kaons into the chamber. Then they searched through thousands of pictures for a characteristic short track emerging from a kaon-proton collision.

Early in 1964 Samios found just such a track. Detailed studies proved it was indeed the omega-minus, with strangeness −3 and almost exactly the mass Gell-Mann had predicted. After this convincing discovery, SU(3) symmetry was here to stay.

Just as these Brookhaven physicists were finding the omega-minus, a new idea was being published by Gell-Mann. The same idea had occurred simultaneously to George Zweig of the California Institute of Technology, then working at CERN, the European Center for Particle Physics in Geneva, but he had encountered difficulty getting it published. Both of them realized the octets and decimet of SU(3) symmetry followed logically if the mesons and baryons were built up from a set of just three fundamental building blocks, which Gell-Mann dubbed *quarks*. There was an "up" quark u, a "down" quark d, and a "strange" quark s—plus their respective antiparticles. According to Gell-Mann and Zweig, baryons were a combination of three quarks, while mesons had to be made from a quark plus an antiquark. Strange particles contained at least one strange quark that was not balanced by its antiquark, or vice versa.

For this scheme to work, however, the quarks had to have a peculiar property: *fractional* electric charge. The up quark had a charge of $+(2/3)e$, where $-e$ is the charge on an electron, while the down and strange quarks had $-(1/3)e$. Thus the proton charge, $+e$, came out okay if it were composed of two up quarks plus a down quark (2/3 + 2/3 − 1/3 = 1). All the allowed combinations of quarks and antiquarks, i.e., the hadrons, in fact, had whole-number charges.

The problem with fractional charge, however, was that it had never been observed. Within experimental errors, every previous measurement of the charge on a subatomic particle had come in as an integral multiple of e. So it was extremely difficult for physicists of the mid-1960's to accept the existence of quarks as real particles. Another severe problem was that putting two or three identical quarks—like two up quarks in a proton or three strange quarks in an omega-minus—together violated a basic tenet of quantum mechanics, the Pauli "exclusion principle" first enunciated by the Austrian theorist Wolfgang Pauli in the 1920's.

Despite these objections, a number of experimenters were game to try searching for quarks. They looked for evidence of fractionally charged particles in all kinds of places—at high-energy accelerators, in cosmic rays, in air, in dust, in sea water, and even in oyster shells! Over 20 such experiments occurred between 1964 and 1966, all without finding a single convincing example of a quark.

So the interest in quarks began to wane. Most physicists of the late 1960's, if they gave quarks any credence at all, considered them to be "mathematical" artifacts. They appeared in the equations describing the behavior of subatomic particles—but there was no experimental evidence for them. The origins of SU(3) symmetry were widely thought to lie elsewhere.