

Quarks, Fundamental Constituents of Nature

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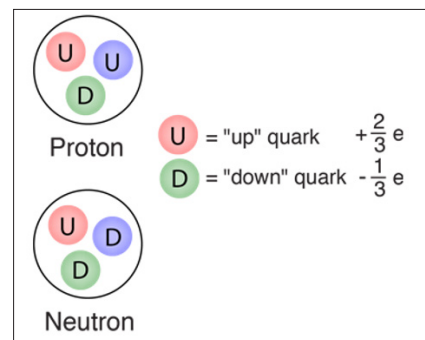
In elementary particle physics, quarks are a class of subatomic particles that is in the category of fermions and their strong interactions give rise to the matter that makes up atomic nuclei. That is why quarks are the particles from which protons and neutrons are made. Its existence was proposed in 1964 by Murray Gell-Mann of the California Institute of Technology and George Zweig of Geneva, who sought a simple physical explanation for the strong interaction between particles in the atomic nucleus [1].

To generate the known elementary particles, quarks must have unusual properties. Among other things, they must have electrical charges which are a fraction of the electric charge of the electron, making these particles the exception to the rule, since any other known electric charge is equivalent to that of the electron or an integer multiple thereof. Quarks are the basic building blocks of matter and just as there is matter and antimatter, there are quarks and antiquarks. In the following table we present the names of the three best known quarks, where each of them corresponds to its antiparticle [2].

Name of the Quark	Symbol of the Quark	Symbol of Antiquark
Up	u	\bar{u}
Down	d	\bar{d}
Strange	s	\bar{s}

The u and d quarks form a family of isotopic spin 1/2 and -1/2, respectively, above and below refer (up and down in English) to the projections of this spin. Strange refers to the fact that this quark has spin S=1 while the others have S=0.

Now, how is it built from these structural blocks? Let's start with the baryons. These are composed of three quarks and their most representative examples are the proton and neutron. The neutron, with its net charge of 0, must include two quarks, each charged and one charged. The proton has spin 1/2 charge +1 so it must be made of two charged u quarks and one charged d quark so a possible arrangement of proton and neutron is shown in the following figure [2,3]



It is then concluded that when the sum of the charges is an integer, they form hadrons. Quarks can also have "color" which is the name with which scientists call the property responsible for strong nuclear attraction. These colours can be blue, green or red, and it is what distinguishes protons and neutrons from electrons which are elementary particles or lepton-like particles. According to the quark model, the fundamental particles of matter are quarks and leptons [2].

The quark model represents the most solid model within the complexity inherent to the standard model of matter. One of the main arguments in favor of quarks is their great success in explaining hadrons. The hundreds of known particles have been replaced by the three quarks and their antiparticles, regarded as the basic structural blocks of matter [1].

References

1. Trefil J (1985) From Atoms to Quarks. Salvat Editores 1985
2. Murray GM (1995) The Quarks and the Jaguar. Barcelona: Tusquet.
3. Gribbin J (1977) Richard Feynman: A Life in Science. Dutton.

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