

The proton and the neutron (1960s)

Atom nuclei consist of protons and neutrons. Only the nucleus of the hydrogen atom can exclude neutrons.

Protons and neutrons consist of quarks tied together by gluons. Gluons are like glue! One proton has two up-quarks and one down-quark. The up-quark has the electrical charge $+\frac{2}{3}$. The down-quark has the electrical charge $-\frac{1}{3}$. Therefore, the proton has the total electrical charge $+1$. The neutron has two down-quarks and one up-quark so the total electrical charge is neutral.

The existence of quarks was proposed by *Murray Gell-Mann* and *Georg Zweig* in 1964. Since particles consisting of quarks decompose in different ways with different life times the theory requires yet another particle. This is why the gluons were included in the Standard model. Gluons were first seen experimentally in Germany in 1979.