Question: How can a nucleus be held together by electromagnetics?
If we assume that protons are positively charged with a evenly distributed radial charge, and if we further assume that neutrons have no charge at all, then the electric force of the protons would repel each other, and the protons would fly apart. Given the two above assumptions, then there must be some sort of nuclear force, a force different from the electric force, that binds the nucleons together. This nuclear force must be an attractive force that opposes the repulsive electric force of the protons.

After the discovery of the neutron by Chadwick in 1932, it was clear that the atomic nucleus is made up from protons and neutrons. In such a system, electromagnetic forces cannot be the reason why the constituents of the nucleus are sticking together. Indeed, the repulsive electrical Coulomb force between the protons should blow the nucleus apart.

The very idea of an electromagnetic model of the nuclear force is, therefore, incongruent with this reasoning. Please explain how a nucleus can be held together by electromagnetics.

Answer:
These two mistaken concepts, of a homogeneously charged proton and an uncharged neutron, are what was believed prior to 1964. In 1964, quarks were discovered. They are proven experimentally to exist. We have known about quarks for over 50 years, and yet the misconceptions of a homogeneously charged proton and an unchanged neutron still, mistakenly, persist. These outdated erroneous concepts of the proton and neutron are, quite simply, wrong. After 50 years, it is time to obliviate those misconceptions.

The electric charge within the proton and neutron are completely contained within the quarks. It is the quarks and only the quarks where the electric charges reside. There is no electric charge outside of the quarks. Similarly, there are magnetic dipole moments associated with the quarks. (However, there is also a magnetic moment associated outside of the quarks, due to the spin of the neutron and proton.)

The proton has two positively charged quarks and one negatively charged quark. The neutron has one positively charged quark and two negatively charged quarks. The positive quarks have a charge of +2/3 the charge of a proton, and the negative quarks have a charge of -1/3 the charge of a proton. Thus, inside both the proton and neutron there are quarks that are both positively and negatively charged. The net charge of the neutron is zero, and the net charge of the proton is one. This is shown in Figure 1.

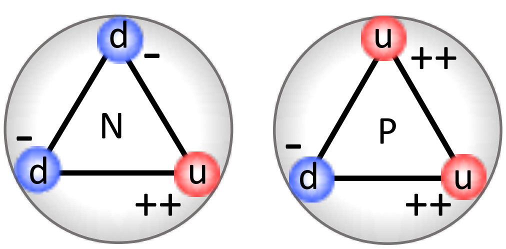

Figure 1: A symbolic illustration of the neutron and the proton, showing the positively charged up quarks (in red) and the negatively down quarks (in blue). In this figure, these colors are not related to the chromodynamic force.

With the understanding of the existence of quarks, it can now easily be understood that a negative quark inside of one nucleon and a positive quark inside another nucleon can be electromagnetically attracted to each other, with a strong enough attraction to overcome any net repulsive Coulomb energy. This is shown in Figure 2.

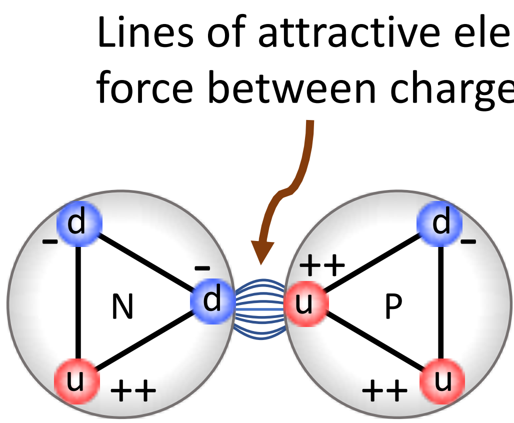

Figure 2: A deuteron, showing the electromagnetic bond between two quarks.

The electromagnetic forces between the two internucleon quarks form an attractive force, holding the two quarks together in a bond, and thus holding the two nucleons together in a bond. The strength of this electromagnetic bond depends only on the distance between the positive and negative quarks that form the bond. Since this parameter is not known experimentally, we can only estimate it. We do know that the smaller the distance between the two quarks, the stronger the force of the bond, and in the limit that this distance is infinitesimally small, the strength of this force goes to infinity. Thus, a very strong electromagnetic bond can be made between the two quarks. And as a result, a very strong electromagnetic bond can be made between the two nucleons.

The force that bonds the nucleons together in a nucleus is electromagnetic.