Physical Origin, Basic Attribute and Action Feature of Nuclear Forces

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Abstract: giving physical origin, basic attributes and action features of nuclear forces derives from first principles and expressed in an explicit form

Main viewpoints and conclusions:

Those issues, the physical origin, basic attributes and action features of the nuclear force, now, could be derived from first principles and expressed in an explicit form based on the basic theory of particle physics and nuclear physics, and the latest related experimental data and research results.

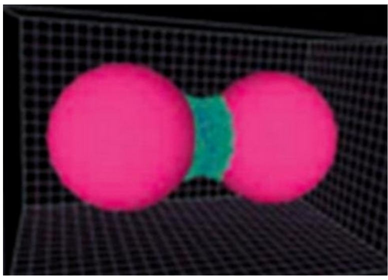

Image 1. shows a light nucleus

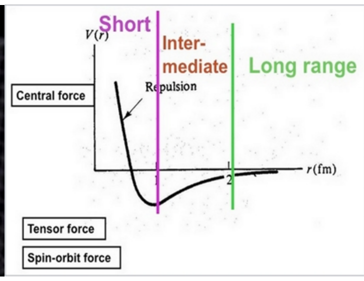

Image 2. features of nuclear forces

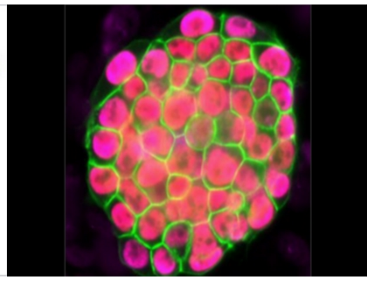

Image 3. shows a heavy nucleus

1. Nuclear Forces' Physical Origin

One atomic nucleus consists of protons and neutrons that are binding together by the nuclear force and then forming into the atomic nucleus. [1][2]

By a series number of the latest related experimental data and research results, obtained: a neutron consists of a proton and a π-meson, then, an atomic nucleus with Z protons and N neutrons is also consists of $A(\geq 2)$ protons and N π-mesons that in the form of soft matter with negative charges; or in another perspective, the atomic nucleus consists of the $A(\geq 2)$ protons and a body which consists of the N π-mesons that in the form of soft matter with negative charges. [3][4][5]

For instance, a deuteron consists of a neutron and a proton; and it is also consists of the two protons (red) and one π-meson (green) which as showed in the image 1; and the two protons and the π-meson are binding together by the mutual attraction — the nuclear force which produced of the positive-negative charges that belongs to each of their own and then forming into the deuteron. [3][4][5][6][7]

Therefore, the nuclear force originated in the electrostatic attraction of nucleons' charges; the most fundamental nature of the nuclear force is the polymerization by electrostatic attraction – electrostatic forces; and the basic structure of an atomic nucleus is a bound state of protons and a π-mesons body in a similar frog-eggs structure. [4][5][7][8]

Moreover, the bound state of a single proton and a π-meson— a neutron is unstable; but, the bound state of two protons and one π-meson –a deuteron is stable, this means there are must at least two protons to bind a π-meson could able reaches to stable bound state; further, more protons are required if want to form a stable bound state with multiple π-mesons.

2. Nuclear Forces' Basic Attributes

There exist the phenomenons observed, experimental data and measurement results by the related experiments with regards the basic attributes of the nuclear force as follows:

It is a short-range force: a few fm; it is an attractive and strong enough to overcome and discourage the long-range Coulomb repulsion between protons; it is a "saturated", each proton only occurs interaction with the π-mesons or protons which it neighboring; it is a non-central force; it is "charge no-difference" of each and every individual among all protons and all π-mesons (not is "charge independent" of type of nucleons).[2][5][9][10][11][12]

3. Nuclear Forces' Action Features

By combined with the related experimental data and results of nuclear forces' action features; and r_p = 0.5 fm, r_n = 2.0 fm, the thickness of neutrons' outer π-meson layer is 1.5 fm; obtained the action features and mechanisms of nuclear forces as follows:[2][4][5][9]

It is a "hard core" repulsive force at the least distance between their centers of the two neighboring protons less than 1.5 fm (the least distance between the two protons' edges less than 0.5 fm); it becomes a net attractive force at the distance between their centers of the two protons larger than 1.5 fm (the least distance between the two protons' edges larger than 0.5 fm); becoming maximal at the center–center distance about 2.0 fm; (the least distance between the two protons' edges at about 1.0 fm. The nearly proton's 1/2 volume and 1/2 surface area embedded in the neutron's π-meson outer layer when the proton's center point is on the outer contour plane or the contour line of the neutron, and the center-center distance of the proton and neutron also happening to be the neutron's radius—2.0 fm); beyond this distance it drops essentially exponentially, until the distance between their centers of the two protons beyond about 2.0 fm separation (until the least distance between the protons' edges beyond about 1.0 fm), it drops to negligibly small values; it would gradually weaken and disappear at their centers distance separation from 2.0 reaches and exceeds 2.5 fm (the proton and neutron is external cutting when the centers distance of the proton and neutron is equals to 2.5 fm; the proton and neutron at separation state when their centers distance larger than 2.5 fm). [2][4][5][9][10][11][12][13]

References

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