On the Stability, Magnetic Moments, Nuclear Spins, and Electric Quadrupole Moments of Light Nuclei with Z < 9

Wladimir Guglinski , retired, author of the Quantum Ring Theory[1]

Key words: light nuclei stability, magnetic moments calculated with two different methods, nuclear spins, new Lagrangian for light nuclei, equilibrium between nucleons, magnetic moments induced by nucleons rotation, strong spin-interaction, magnetic force versus centripetal force on nucleons, electric quadrupole moments, halo neutron 4Be11, interpretation on its orbit radius 7fm in 2009 experiment.

Abstract
Dr. Wilfried Nörtershäuser of the Helmhotz Center for Heavy Ion Research at the University in Mainz says on the 2009 experiment which had detected a neutron halo in 4Be11 with distance 7fm from the cluster:
"*By studing neutron halos, scientists hope to gain further understanding of the forces within the atomic nucleus that bind atoms together, taking into account the fact that the degree of displacement of halo neutrons from the atomic nuclear core is incompatible with the concepts of classical nuclear physics*"[2]
In the case of 4Be11, the halo neutron and the nuclear core are separated by the distance of 7fm, and so such isotope represents the experimental proof that the cohesion of nucleons within the light isotopes cannot be promoted by the strong nuclear force.
Such experimental discovery published in 2009 had been predicted years ago, because according to the new nuclear model proposed in Quantum Ring Theory, published in 2006, the cohesion of the nucleons within the light nuclei is not caused by the strong nuclear force.

Here in this paper the new nuclear model is submitted to a scrutinity so that to verify whether from its structure it's possible to explain the stability of the light nuclei and to reproduce the nuclear properties as nuclear spins, electric quadrupole moments, and magnetic moments. Nuclear magnetic moments are calculated from two different and independent methods. In the second, named "*method of equilibrium between nucleons*", it's presented the Lagrangian for nuclei with Z < 8. The results obtained from them agree each other, and are corroborated by nuclear spins and electric quadrupole moments suplied by nuclear tables.

In this Part One are presented calculations on magnetic moments for the isotopes of lithium, beryllium, and boron. In the next paper Part Two will be exhibited calculations for carbon, nitrogen, and oxygen. In the paper Part Three the author will exhibit calculations for electric quadrupole moments.

1- Introduction

Since 1993 the author has worked in the development of a new nuclear model, and between 1999 and 2001 he had submitted some papers for publication in reputable journals of nuclear physics.
All the journals declined to publish the papers, because of two reasons:

- Firstly because his new nuclear model works through some new fundamental principles no considered in the Standard Nuclear Theory
- And secondly because the referees had used to suppose that the new nuclear model violates the results of some experiments

For instance, one of the referees had declined the paper *Anomalous Mass of the Neutron* with the following report:
"It is hard for me to believe those difficulties raised in this manuscript will have escaped the scrutinity of all those prominent particle theorists. For instance, the author proposes a new Planck constant for the uncertainty principle in the femtometer scale. Had this been true, the string theorists should have encountered the difficulty long time ago and even have proposed their own third different Planck constant"

But in July 2011 a new astronomical observation[3] suggested that author's hypothesis have to be considered seriously, because the observation showed that any underlying quantum 'graininess' of space must be at much smaller scales than previously predicted.
But the new nuclear model could not be accepted for publication before 2009 because the model seemingly violates some principles of Standard Nuclear Physics, as for instance the proposal according to which the aggregation of nucleons within the nuclei is not promoted by the strong force. Obviously no referee could accept such a nuclear model for publication. However a paper[2] published in 2009 describes an intriguing behavior of the neutron halo in the isotope 4Be11: it is 7fm far away of the cluster, and it has 13,81 seconds of half-life. As the strong force actuates in the distances of 2fm or the maximum of 3fm, the 4Be11 is a strong evidence suggesting that nucleons aggregation within light nuclei is not promoted by the strong nuclear force. Someone could argue that the halo neutron is weakly linked to the cluster, and it leaves out the nucleus after the 13,81 seconds just because of the weak link. However this is no true, because in 97% of decays the 4Be11 transmutes to 5B11, and therefore the neutron does not leave out the nucleus. In 4Be11 the neutron decays in a proton and electron, and the proton goes back to the cluster. If the strong nuclear force should be responsible for the cohesion of nuclei as the nuclear theorists suppose, the proton could never go back to the cluster, because in a distance of 7fm it cannot interact with the cluster via strong force, and the classical Coulomb repulsion between the cluster and the proton would be so strong that the proton would be expelled from the 4Be11, and 5B11 could not be formed in 97% of the 4Be11 decays.

Other unacceptable (earlier 2012) proposal of the theory is concerning the shape of the light isotopes with Z=N=pair. The experiments detect that they have null electric quadrupole moment, and so from the current nuclear models should be expected that light nuclei with Z=N=pair should have to have a spherical shape. But according to the new nuclear model proposed in Quantum Ring Theory those nuclei have non spherical shape, and so a referee of a reputable journal could not accept the publication of a paper with that model. Nevertheless a paper[4] published in 2012 in the journal Nature (which proposals are based on the results of recent experiments) proposes that those nuclei do not have a spherical shape. As a null electric quadrupole moment requires a spherical

shape from the principles of the standard nuclear theory, there was need to explain how can light nuclei with Z=N=pair do not have spherical shape.
The argument proposed by the authors of the Nature`s paper was the following:

- "*The nucleus is intrinsically deformed as shown, but has spin 0. Consequently, there is no preferred orientation in the laboratory frame and thus the experimental quadrupole is an average over all orientations and hence is zero. Experimentally is possible to show that the deformation of the ground state is non zero by breaking the symmetry and rotating the nucleus.*"

The argument proposed in the page 137 of the book Quantum Ring Theory is the same:

- "*Note that as the 8O16 has a null nuclear magnetic moment $\mu=0$, then its nuclear spin cannot be aligned toward a direction by applying an external magnetic field, and so its nuclear spin can indeed be chaotic. So the x-y plane has a chaotic rotation, and the six nucleons 1H2 perform the surface of a sphere, and the z-axis has a chaotic rotation around the center of the nucleus 8O16. By consequence the 8O16 behaves like if it should be a spherical distribution of positives loads, and not a flat distribution. That's why the 8O16 has Q(b) = 0.*"

However, there is a difference between the two proposals. The authors of the Nature`s paper had proposed the argument because in 2012 the experiments have shown that light nuclei with Z=N=pair have non spherical shape. While the argument published in 2006 in the book Quantum Ring Theory was a theoretical proposal, inferred from the nuclear properties of the new nuclear model proposed in the theory.

Earlier 2012 this paper could not be accepted for publication in any reputable journal of Physics, because among other restriction any referee of any journal would decline the paper with the following arguments:

1- Your new nuclear model is unacceptable, because it proposes a model which aggregation of nucleons within the nuclei is not promoted by the strong force.
2- According to the present nuclear model the light nuclei with Z=N=pair have non spherical shape. Such hypothesis is in contrast with the experiments, because nuclear data show that those nuclei have null electric quadrupole moment, and from the well known principles of Standard Nuclear Physics it's impossible for a nucleus with non spherical form to have null electric quadrupole moment.

The experiment published in 2009 proved to be wrong the belief in the first argument. The experiments published in 2012 proved to be wrong the belief in the second argument. Therefore the recent experiments in the field of Nuclear Physics proved that the present new nuclear model is being corroborated by new experimental findings, and therefore it is suitable for publication in a reputable journal of Physics.
Two different and independent methods are presented for the calculation of magnetic moments of light nuclei with Z< 8. The first one, named "*method of induced magnetic moments by nucleons*", is also applicable for nuclei with Z > 7. In the second, named "*method of equilibrium between nucleons*", it's presented the Lagrangian for nuclei with Z<8.
Probably new upcoming experiments will bring additional corroborations for this new nuclear model, published in 2006 in a book form.

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3- How the new nuclear model works

In order to understand the calculations on the stability of light nuclei with Z < 9 and on their nuclear spins and magnetic moments by using the new nuclear model, there is need to know how the model works, and we will see ahead its structure and the principles which rule its working.

3.1- Particles

According to Quantum Ring Theory, the space is filled by massless particles: electric particles e(+) and e(-), magnetic particles m(+) and m(-), permeability particles p(+) and p(-), attractive gravity particles g(+) and g(-), repulsive gravity particles G(+) and G(-). The laws of interaction between the particles are proposed in the book.
Within the nuclei there is interaction between the electric and the gravity particles (gravitons)

3.2- Central 2He4

The new nuclear model is formed with a central helium-4

3.3- Flux n(o)

There is a flux of gravitons, induced by the central 2He4. It was named flux n(o), and it is formed in a similar way of the Dirac's strings[5]. Protons, neutrons, and deuterons can be captured by the flux n(o), so that to form new different isotopes.

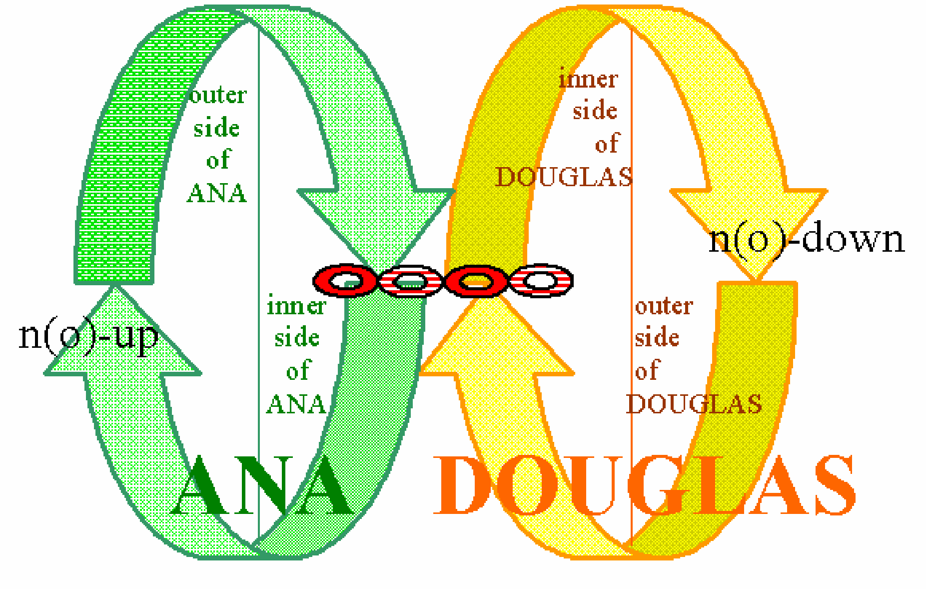
3.4- Sides Ana & Douglas

The nucleus has two sides, named Ana and Douglas (Fig. 1). The flux in the side Ana is named flux n(o)-up, and in the side Douglas it is named flux n(o)-down.
The sides Ana and Douglas are divided each one in two sides: inner and outer.

3.5- Hexagonal floors

When six deuterons are captured by the flux n(o), they form a hexagonal floor about the central 2He4 (Fig, 2). The oxygen 8O16 is the first nucleus with a complete hexagonal floor. The silicon 14Si28 has two complete hexagonal floors, 20Ca40 has three complete hexagonal floors, and so on.

Fig. 1



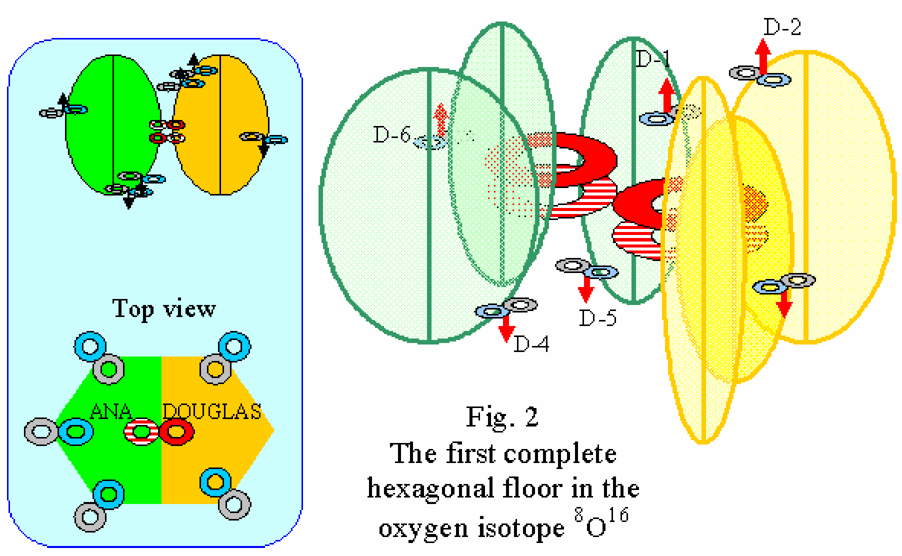


Fig. 2
The first complete hexagonal floor in the oxygen isotope $^8O^{16}$

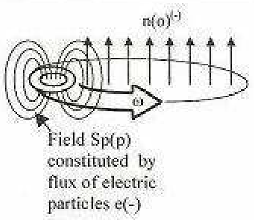


Fig. 1.1- Flux within the proton

This figure shows only one of the three quarks:

1. The principal field Sp(p) of proton is constituted by negative particles e(-).
2. The particles e(-) of the principal field Sp(p), submitted to the circular motion with angular speed ω, induce a gravitational flux $n(o)^{(-)}$ constituted by gravitons g(-).
3. The flux of gravitons g(-) induces the secondary field Sn(p) constituted by electric particles e(+).
4. Therefore, the principal field Sp(p) has negative electric load, while the secondary field Sn(p) has positive electric load.

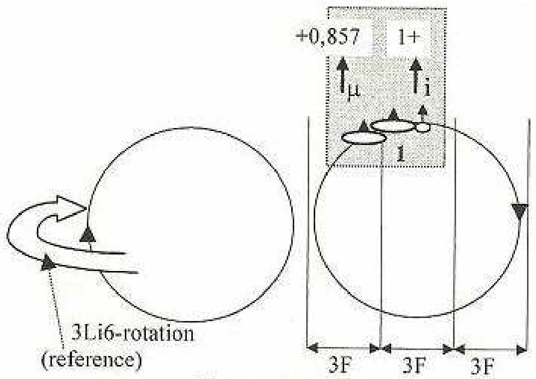


Fig. 6.2: The 3Li6

spin of 3Li6 = i(3Li6) = i(+) ⇒ reference

3.6- Influence of the nuclei rotation on the nuclear magnetic moment

For understanding on how the rotation of nuclei influences the nuclear magnetic moment, we choose the rotation of the isotope 3Li6 as a reference.

The pages 228 and 232 of the book Quantum Ring Theory show:

Fig. 1.1: how the flux n(o) crosses the structure of the proton

Fig. 6.2: the rotation of the isotope 3Li6 (used as reference for all the other nuclei).

Fig. 3
The flux n(o) and the Least Action Principle

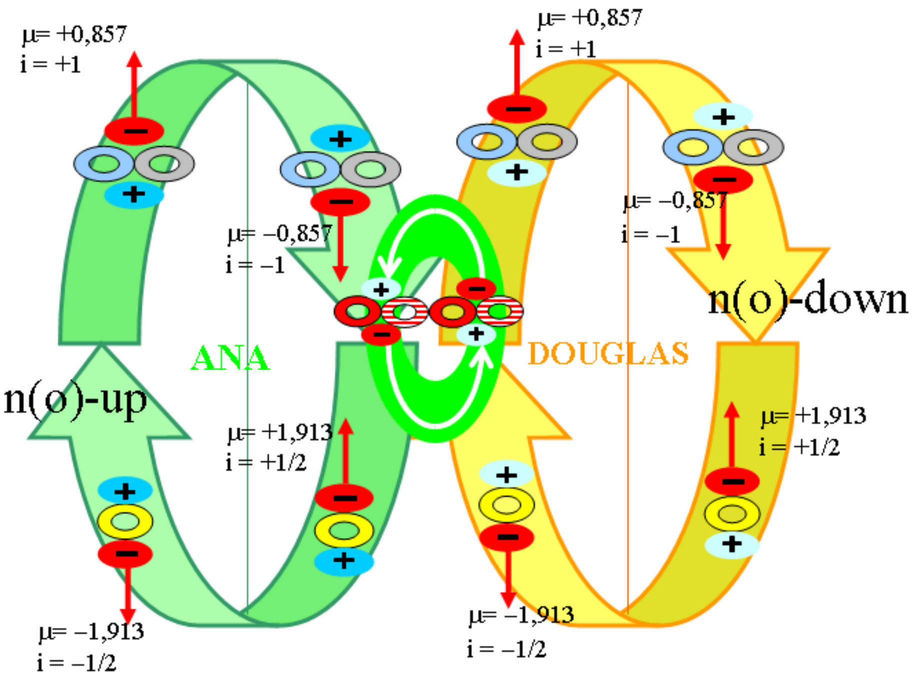
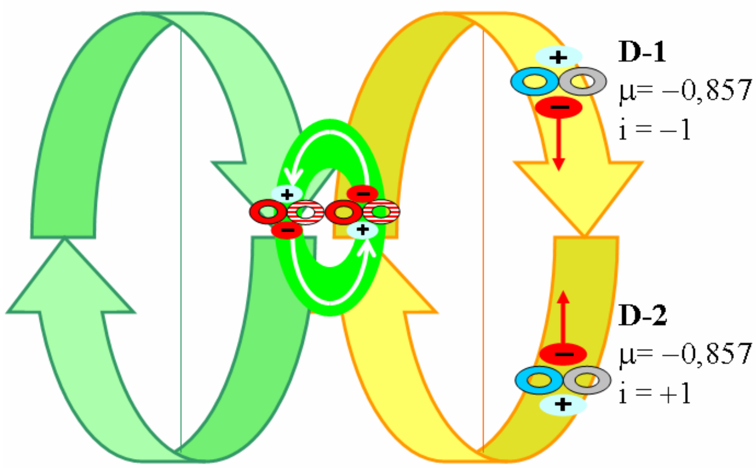


Fig. 4
The flux n(o) and the Least Action Principle



3.7- The flux n(o) within the nucleons according to the Least Action Principle

Fig. 3 shows the spins that deuterons and neutrons ought to have according to the Least Action Principle when they are captured by the flux n(o).

In Fig. 4 there are two deuterons D-1 and D-2 captured by the flux n(o)-down in the side Douglas.

The difference between the two deuterons is the following:

a) D-1 follows the Least Action Principle, and D-2 does not
b) From the viewpoint of the interaction with a neutron, both D-1 and D-2 have spin-down i= –1
c) From the viewpoint of the measurement of the spin by experiments, D-1 has spin-down i= -1, but D-2 is detected in the experiments with spin-up i=+1. The reason why D-2 has spin-up detected by experiments (but it behaves as it should have spin-down) is explained in the Fig. 5.

Such phenomenon sometimes occurs in some excited nuclei.

3.8- Equilibrium via strong spin-interaction and via magnetic force

The nucleons (protons, neutrons, and deuterons) are captured by the flux n(o) by following the principles of Pauli's Exclusion and Least Action, and their aggregation may occur by the following way:

- Magnetic interaction
- Strong spin-interaction
- Combination of the both them

A deuteron alone can be captured by the flux n(o) and a stable isotope can be formed, as for instance in the case of the isotope 3Li6. As there is not another nucleon to have spin-interaction with that deuteron, then it is kept in 3Li6 via magnetic interaction, as follows: the magnetic force on the deuteron is equilibrated by the centripetal force on it, as we will see in the calculations.

Unlike, an alone neutron or proton captured by the flux n(o) cannot form a stable isotope because of the following reasons:

a) neutron: it is no able to yield a magnetic force within the magnetic field of a nucleus, because it has no charge.
b) proton: the magnetic field on the proton is stronger than the centripetal force on it, because its mass is half of the deuteron's mass. So the proton is captured by the central 2He4, and the nucleus decays.
c) That' why 2He5 and 3Li5 cannot be stable.

3.9- Capture of a neutron of the side Douglas by the flux of the side Ana

Often occurs that a deuteron in the side Douglas has its spin aligned with the spins of two neutrons n-1 and n-2 in the side Ana, as shown in the Fig.6-(A). Then the two neutrons move to the side Douglas, but they keep the flux n(o)-up of the side Ana, as shown in (B). As we will see, in their original place at the inner side of Ana the two neutrons n-1 and n-2 induce each one (due to the rotation of the nucleus) a <u>positive</u> magnetic moment $\mu=+0,09\mu n$ (note that both have spin-up). But in their new position in the inner side of Douglas in (B), the two neutrons induce each one a <u>negative</u> $\mu=-0,09\mu n$ (note that they keep their spin-up).

Fig. 5
What happens when the deuteron captured by the flux n(o)–up changes its spin

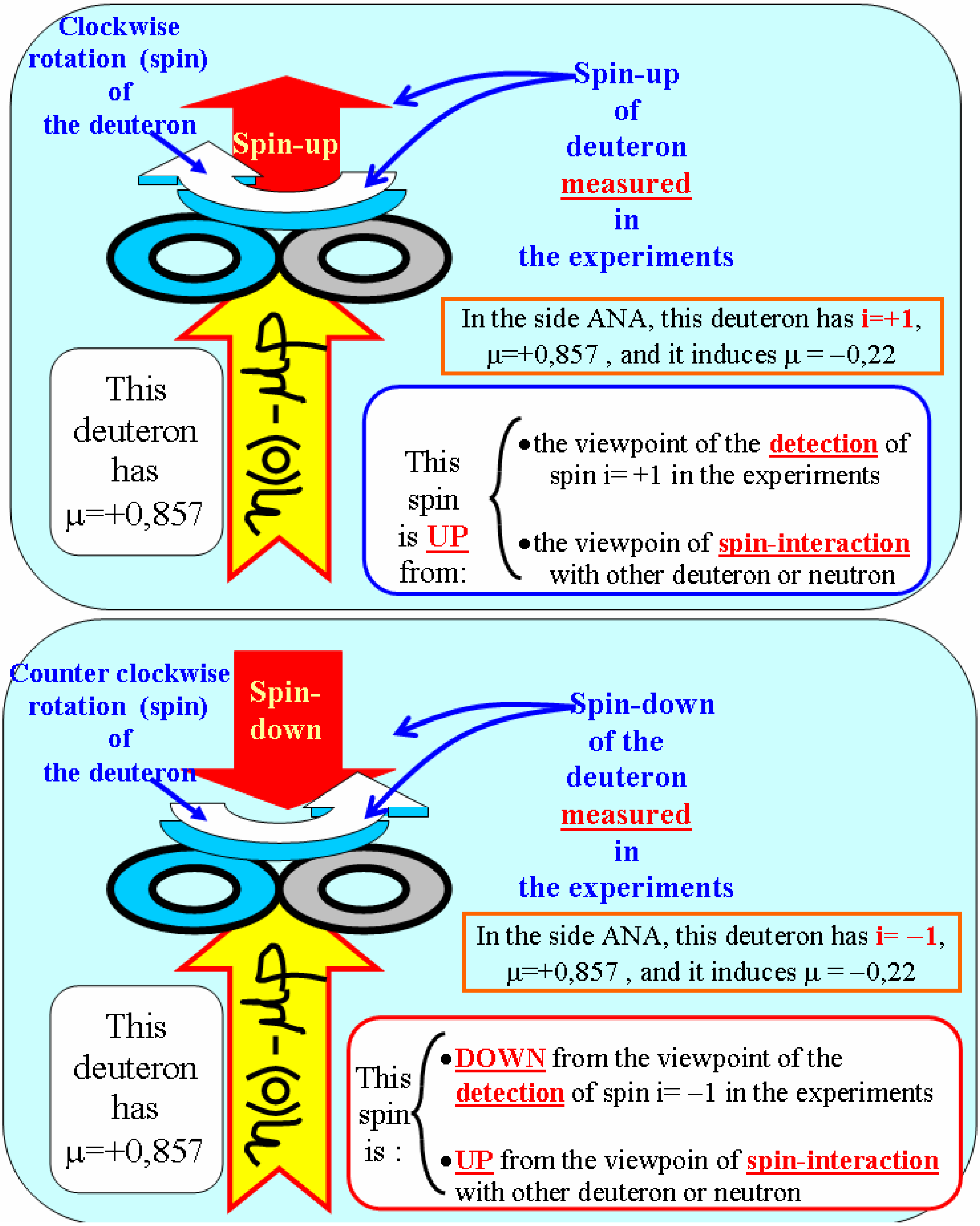
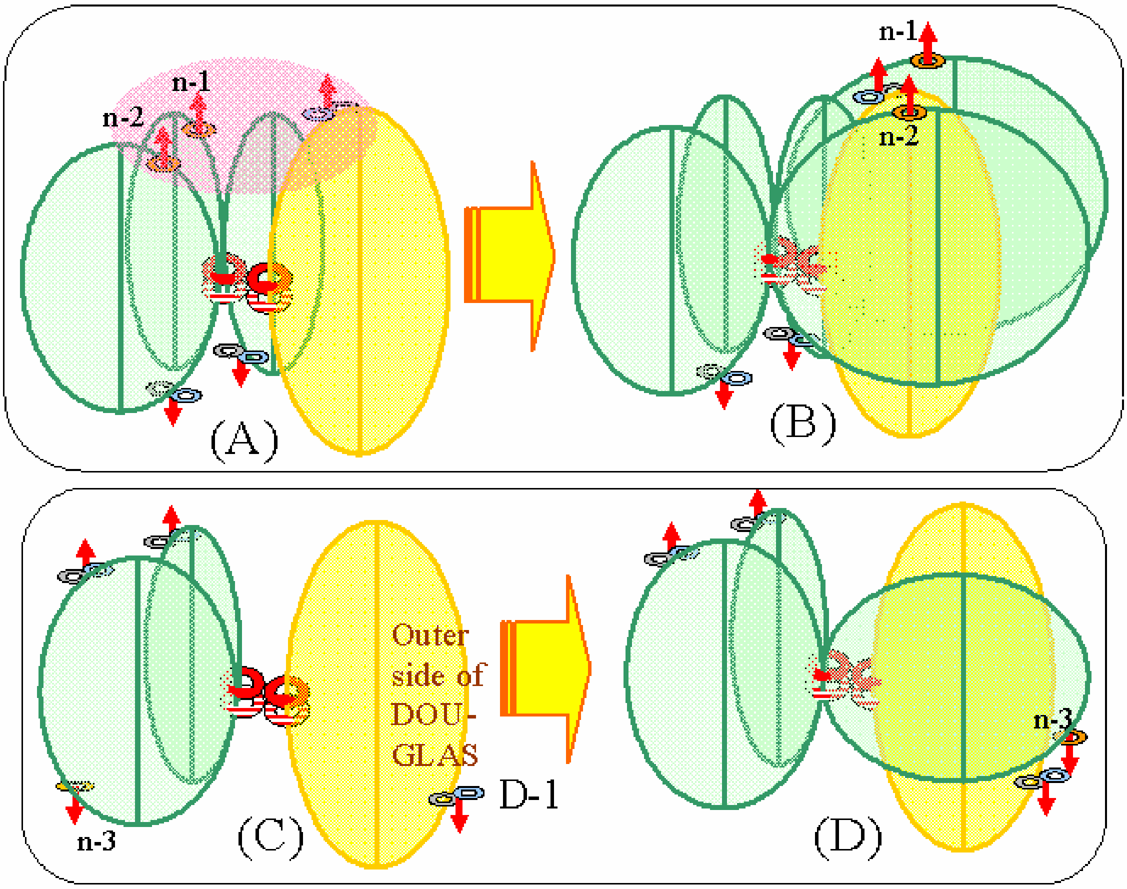


Fig. 6
Capture of neutrons of the side Ana by a deuteron of the side Douglas



Sometimes a deuteron with spin-down in the outer side of Douglas is going to capture a neutron, as the case of the deuteron D-1 in the Fig. 6-(C). As a neutron cannot be captured with spin-down in the outer side of Douglas, then D-1 captures the neutron n-3 from the outer side of Ana (keeping its flux n(o)-up), as shown in the Fig. 6-(D). As we will see later, if n-3 should be captured by D-1 with n-3 getting the flux n(o)-down of Douglas, n-3 would induce a negative magnetic moment μ =–0,526 in that place which it takes shown in Fig. 6-(D). However, as n-3 is captured from the flux n(o)-up of Ana, and it keeps that flux n(o), then it induces a **positive** magnetic moment μ =+0,526 (note that n-3 has spin-down in both two places shown in Fig. 6-C and Fig. 6-D)

The mechanism which explains such phenomenon is given in the Fig. 7.

3.10- Sign of deuterons and neutron within the flux n(o)

In the book Quantum Ring Theory it is proposed a quark model n=(u,d,u-e) of the neutron, where the orbiting electron is tied to the quark up of the proton (Fig. 8)

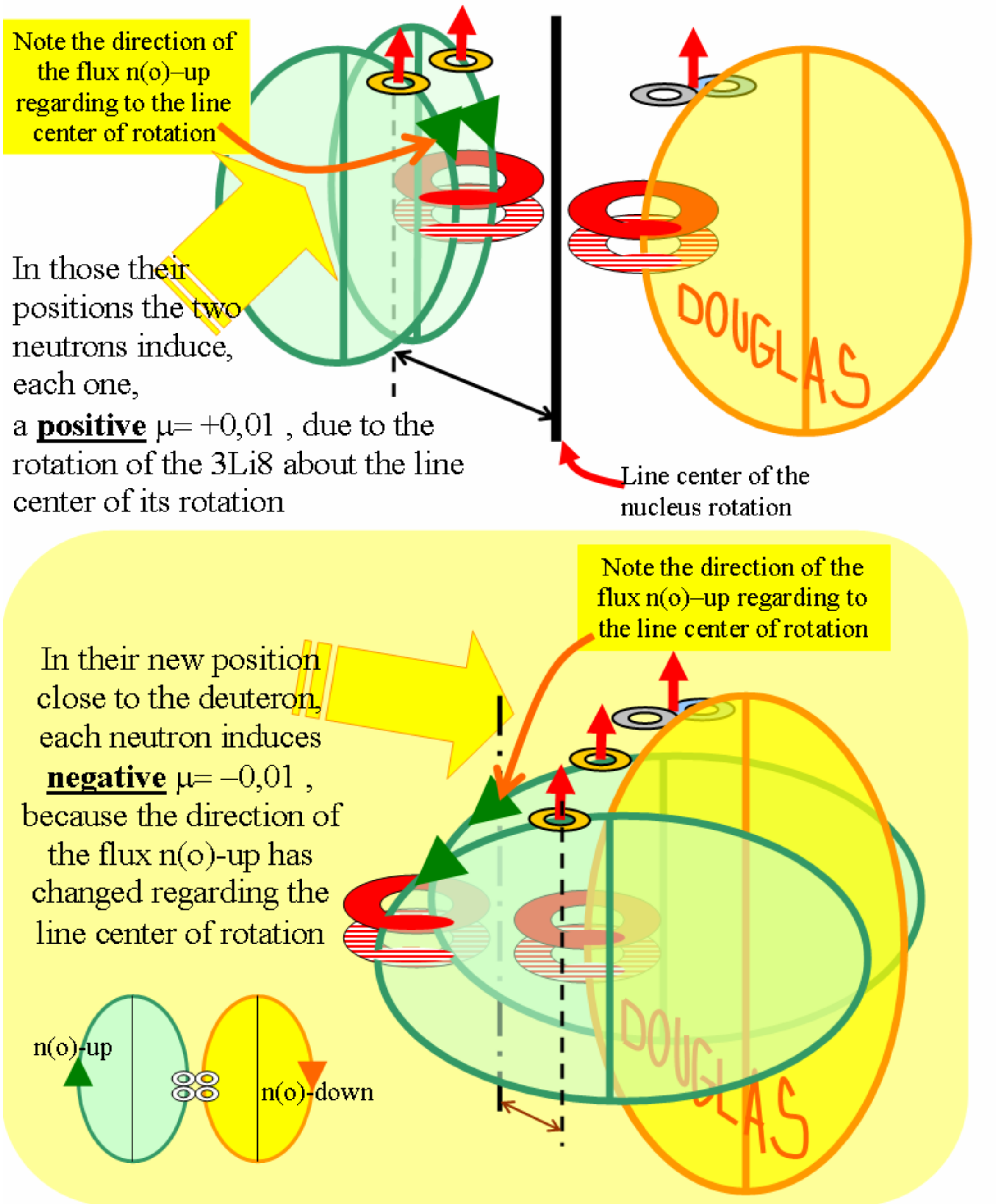
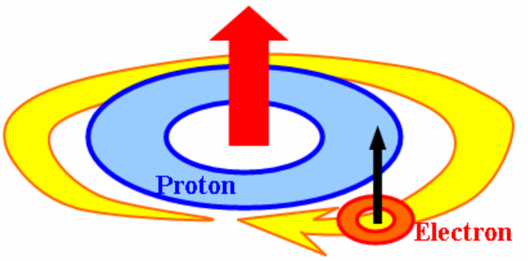


Fig. 7

Fig. 8

The neutron n=p+e



The theoretical restrictions against the neutron model n=p+e are eliminated in the book.

The spin 1/2 of the electron is the combination of two phenomena:

- intrinsic spin: it's the electron's rotation about the central axis which crosses its body

- helical trajectory: it's the electron's trembling motion, discovered by Schrödinger in the Dirac's theory of the electron. A theory on the helical trajectory, also known as zitterbewegung, was developed by David Hestenes[6].

When the electron is captured by the proton and they form the neutron, the electron loses its helical trajectory, and its spin becomes i=0. That's why the neutron has spin 1/2.

The neutron formed by proton+electron was confirmed by Don Borghi experiment[7]

The Borghi`s experiment was corroborated later by two experiments: one made by Elio Conte and Maria Pieralice[8] , with a different version of the experiment, and other made by Rughero Maria Santilli[9] , who used the same version of the experiment made by Borghi.

The sign of nucleons within the nuclei is explained in the Fig. 9.

3.11- Point of capture of the nucleons

All the nucleons, protons, deuterons, neutrons, are captured in the inner region of the nucleus (the inner sides of Ana and Douglas), where they have their original sign of magnetic moments. In that central region the deuteron has magnetic moment μ= +0,857μn , the proton has μ= +2,793μn , and the neutron has μ= −1,913μn. In any point outside of that central region they change the sign of their magnetic moment, and from the Least Action Principle there is no advantage for their capture.

3.12- Magnitude of forces responsible for nucleus aggregation

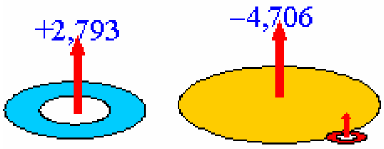
In Quantum Ring Theory the structure proposed for the proton is the following:

1- A body ring
2- The rotation of the body ring induces a negative electric field named principal field Sp(p)
3- The rotation of the field Sn(p) induces a positive electric field named secondary field Sn(p)

The structure of the electron is similar, but its principal electric field Sp(e) is positive, and its secondary electric field Sn(e) is negative.

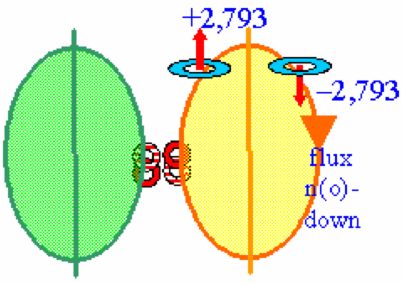
Fig. 9

Sign of magnetic moments of deuteron, neutron, and proton within the nuclei



The magnetic moment of the neutron is the overlap of the μ= +2,793 of the proton and μ=−4,706 induced by the orbit of the electron about the proton:

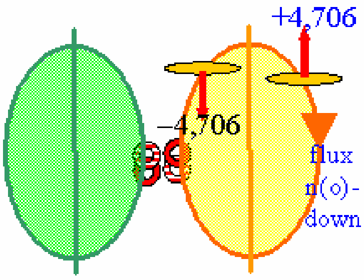
$$\mu_{NEUTRON} = +2{,}793 - 4{,}706 = -1{,}913$$



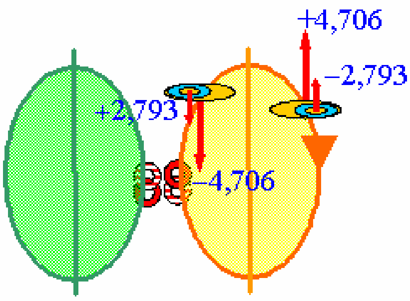
- **<u>Side Douglas</u>:**

Within the flux n(o)-down the natural spin of the **<u>proton</u>** is spin-up in the inner side and spin-down in the outer side.

- **<u>Side Ana</u>:** the contrary of Douglas



Within the flux n(o)-down the natural spin of the **<u>electron's</u> <u>orbit</u>** about the proton is the contrary of that of the proton.



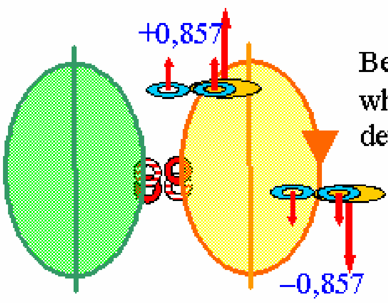
- **<u>Side Douglas</u>:**

Because the electron`s orbit has $\mu$=4,706 and the proton has $\mu$=2,793, the direction of the neutron`s spin is defined by the electron`s orbit.

So, within the flux n(o)-down the natural nuclear properties of the **<u>neutron</u>** are:

1. Spin-up and μ = +1,913 in the outer side
2. Spin-down and μ = −1,913 in the inner side

- **<u>Side Ana</u>:** the contrary



- **<u>Side Douglas</u>:**

Because the two protons in the deuteron have μ=5,586, while the electron`s orbit has $\mu$=4,706, the direction of the deuteron`s spin is defined by the two protons.

So, within the flux n(o)-down the natural nuclear properties of the **<u>deuteron</u>** are:

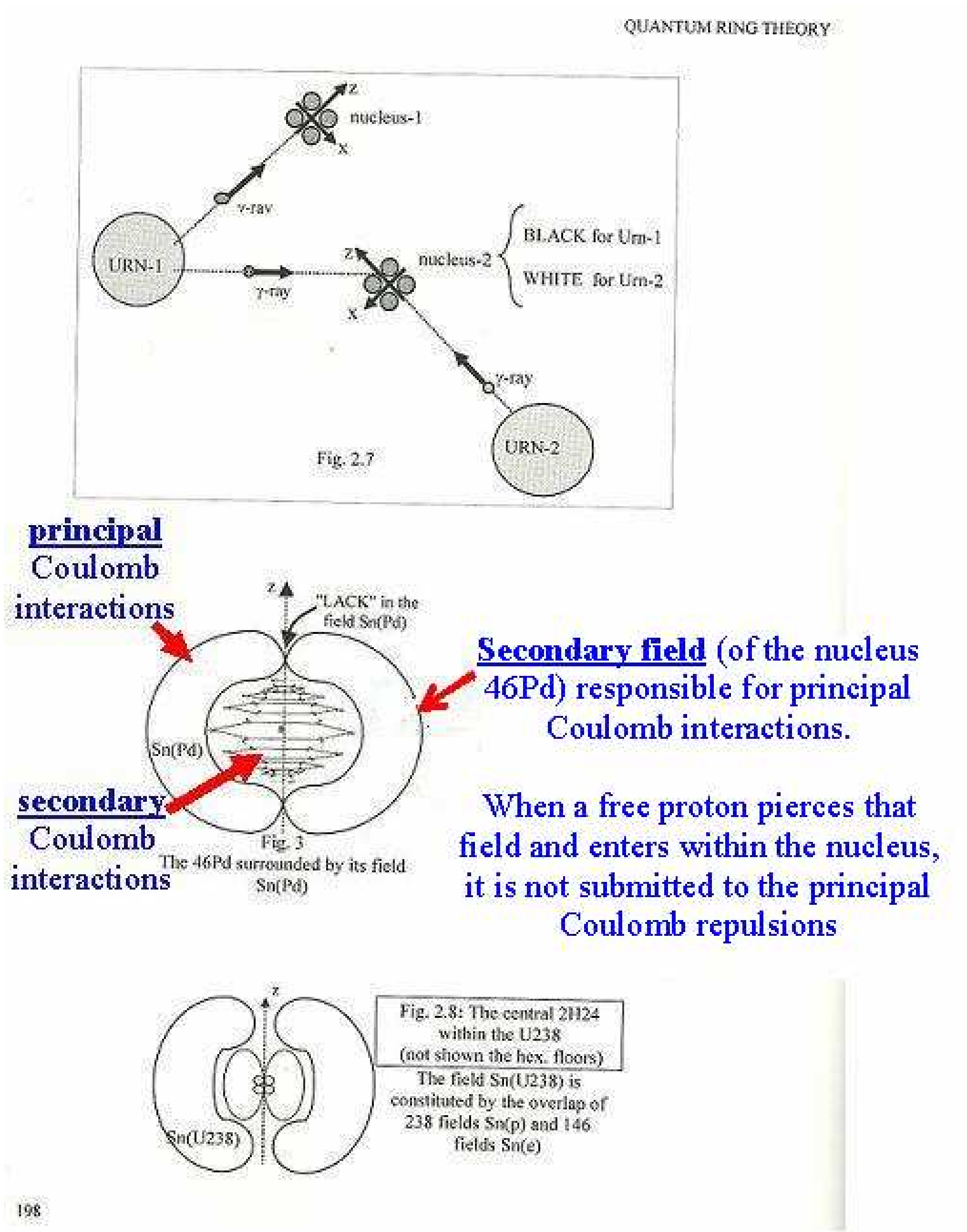
1. Spin-down and μ = −0,857 in the outer side
2. Spin-up and μ = +0,857 in the inner side

- **<u>Side Ana</u>:** the contrary

The secondary fields are responsible for the principal Coulomb interactions. Therefore the classic well known strong Coulomb repulsion between two protons is due to the interaction of their secondary fields, and a proton and an electron interact also though their secondary fields.

A nucleus "A" is also involved by a secondary field, responsible for the principal Coulomb interactions with nucleons outside the nucleus "A" and with other nuclei B, C, D... . But in order to be captured by a nucleus X, a nucleon (as for instance a proton) has to pierce the secondary field Sn(X). Within that nucleus X the nucleons are submitted to secondary Coulomb repulsions due to the principal field Sp(X) only, which magnitude is despicable (compared with the magnitude of the magnetic force) in distances larger than 1fm.

In the Fig. 3 of the page 198 of the book Quantum Ring Theory, reproduced here, it is shown the 46Pd nucleus surrounded by its secondary field Sn(Pd), responsible for the principal Coulomb repulsions.



In order to enter within that 46Pd nucleus a free proton needs to pierce that secondary field Sn(Pd), while the field repels the proton with the classic Coulomb repulsion. But at once the proton crosses the field Sn(Pd) it is free of the classic Coulomb repulsion due to the secondary field. Then within the nucleus it experiences with other protons only a secondary Coulomb repulsion due to the principal field of each one of them, but the repulsion due to the principal field is despicable face the magnetic and strong spin-interaction between the nucleons. In short, the secondary field Sn(x) of a nucleus X is responsible for the principal classic Coulomb interactions outside the nucleus X, while its principal field Sp(x) is responsible for secondary non-classic Coulomb interactions within the nucleus X, which are despicable in distances larger then 1fm.

Therefore, the interactions responsible for the nucleons aggregation within the nuclei is due to the following sort of interactions:

a) Spin-interaction only (between deuterons, protons, and neutrons)
b) Equilibrium only, between magnetic forces on deuterons&protons and centripetal forces on deuterons& protons&neutrons linked to deuterons
c) They acting together

The forces of equilibrium are calculated in this paper.

3.13- Equilibrium and forces on the nucleons captured by the flux n(o)

3.13.1- Deuteron:

We will use the isotope 3Li6 for the illustration on how the forces actuate on the deuteron within the nuclei. Obviously the mechanism is the same for all the nuclei which do not depend on the strong spin-interaction for their aggregation.

3Li6 has a nuclear magnetic moment μ= +0,822. The deuteron has an electric charge equal to the proton. As the deuteron gyrates within the magnetic field due to μ= +0,822 of the 3Li6, it is submitted to a force F_M in the contrary direction of the centripetal force Fc on it, as shown in Fig. 10. The isotope 3Li6 is stable thanks to the equilibrium between the two forces F_M and Fc.

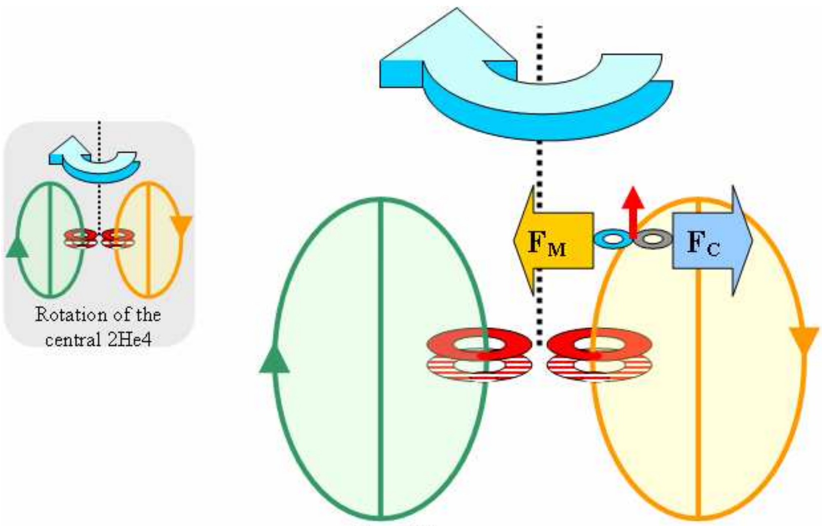


Fig. 10
Equilibrium of forces on the deuteron in the 3Li6

3.13-2- Neutron

The neutron has no electric charge, and so there is no force F_M on it. When a neutron is captured by the central region of a 2He4, two things may occur:

a) the neutron is not captured by the flux n(o) of the 2He4, as shown in the Fig. 11-(A). Then the neutron interacts directly with the 2He4, breaking up its structure, as shown in the Fig. 11-(B).

b) The neutron is captured by the flux n(o) as shown in the Fig. 11-(C), and so it gyrates arrested by the rotation of the 2He4. As there is only the centripetal force Fc on the neutron, it is expelled from the flux n(o), leaving away the 2He4, as shown in the Fig. 11-(D). That's why does not exist 2He5.

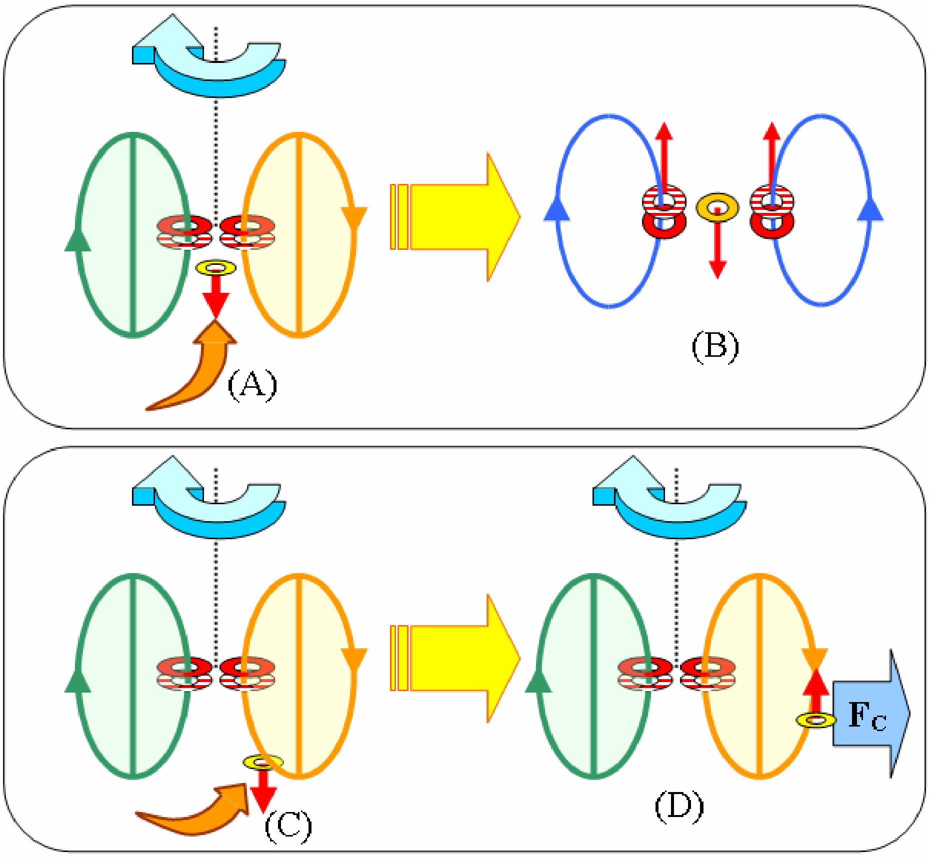


Fig. 11
Capture of a neutron by a 2He4

3.13-3- Proton

The proton has the same electric charge of the deuteron. So, if the proton is captured by the flux of a nucleus 2He4, and they form the 3Li5, its nuclear magnetic moment is approximately $\mu = +2{,}7\mu n$. In 3Li6 the nuclear magnetic moment is $\mu = +0{,}822\mu n$. So, the magnetic force Fm= q.v.B on the proton in 3Li5 is very stronger than the magnetic force on the deuteron in 3Li6. But the deuteron's mass is twice of the proton. Therefore, while the centripetal force on the deuteron succeeds to keep it in equilibrium in 3Li6, however it is no able to keep the proton in equilibrium in 3Li5, and the proton is pulled toward the central 2He4 direction by a strong magnetic force, and so it enters within the structure of the central 2He4, as shown in the inferior side of the Fig. 12, it breaks up the helium structure, they form a 3Li5 with spin 3/2, and it emits a proton:

3Li5 –> 2He4 + p.

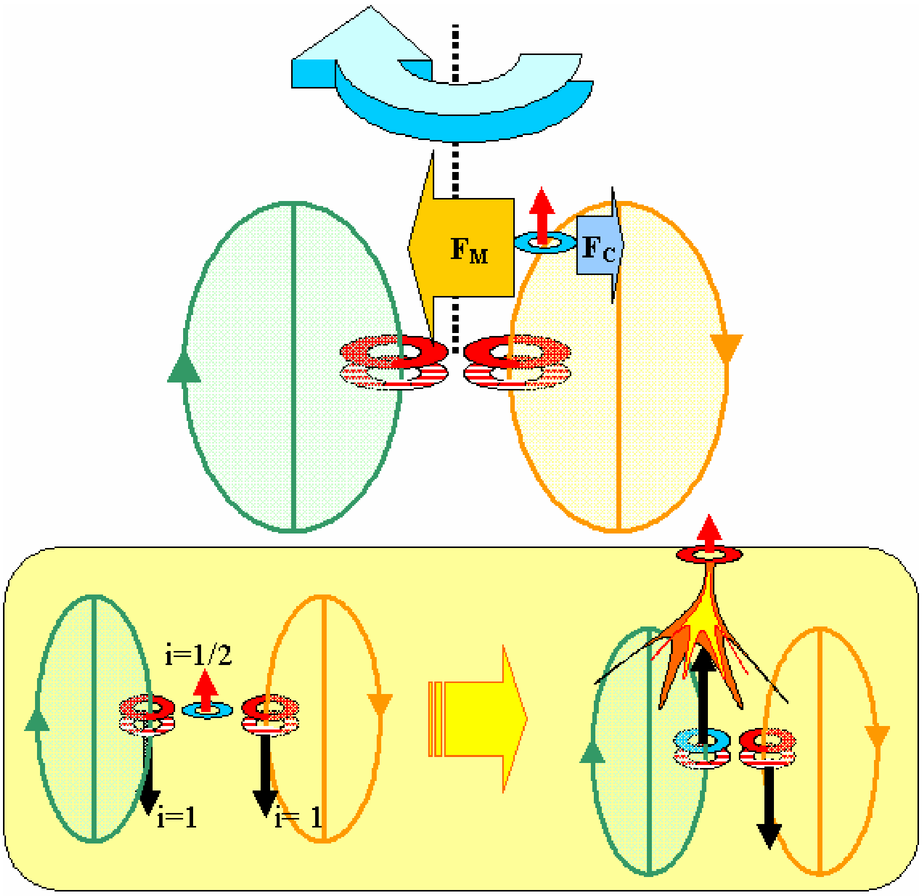


Fig. 12
Unbalance of forces on the proton in the 3Li5

3.13-4- Deuteron and neutron in 3Li7

The neutron is captured in the inner side of Douglas of 3Li6. Due to the centripetal force it is pushed to the outer side of Douglas, it has spin-interaction with the deuteron, and the force of attraction between them avoids the neutron to be expelled.

3Li7 has magnetic moment is μ = +3,256μn, very stronger than μ = +0,822μn of 3Li6, and therefore the magnetic force F_M on the deuteron is stronger, and it is able getting equilibrium with the centripetal force on the deuteron and neutron.

The equilibrium of the forces shown in the Fig. 13 occurs as follows:

a) The centripetal force on the neutron is $Fc = m.\omega^2.R$, and on the deuteron is $fc = 2m.\omega^2.r$. As the radius R of the neutron's orbit is very longer than the radius r of the deuteron`s orbit, then Fc > fc , in spite of the mass of the neutron is half of the deuteron`s one.

b) The magnetic force F_M keeps the deuteron and the neutron in the 3Li7, because it equilibrates the sum of the forces Fc and fc. But the aggregation of the 3Li7 obviously depends on the spin-interaction force Fsi between the two nucleons, otherwise the neutron would be expelled by the centripetal force on it.

The scattering experiments proton-neutron have shown that the interaction between them is 60% stronger when the proton and the neutron have parallel spins, and this explains why the deuteron has spin i=1, and why there are no deuterons with spin zero.
Stable 3Li7 has spin 3/2 because of the spins are parallel. An isotope 3Li7 with spin 1/2 does not exist because the antiparallel spin-interaction force Fsi between the deuteron and the neutron should be 40% weaker, and so the neutron could not be kept in such 3Li7 with spin 1/2.

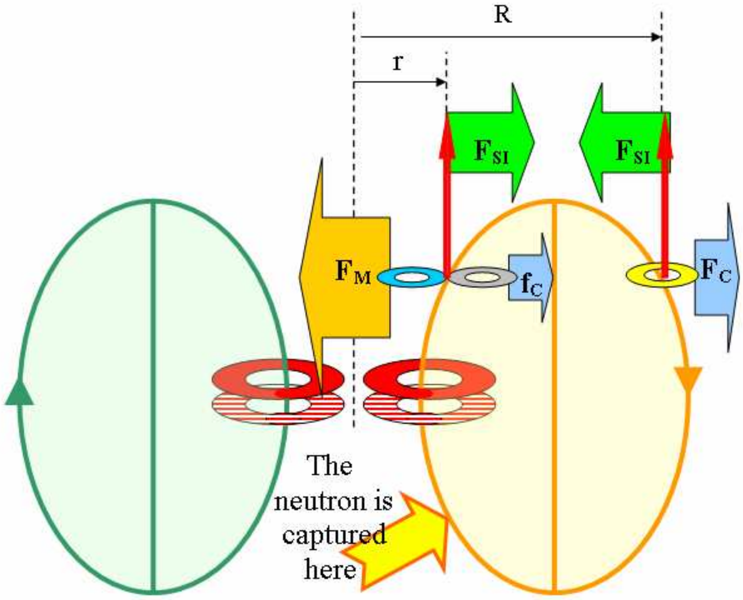


Fig. 13
Equilibrium of forces on the spin-interaction deuteron-neutron in the 3Li7

3.13-5- Two deuterons in the 4Be8

Fig. 14: the two deuterons D-1 and D-2 are captured with antiparallel spins by the flux n(o) , and D-1 aligns its spin with the deuteron D-3 of the central 2He4, while D-2 aligns its spin with D-4. As 4Be8 has null nuclear magnetic moment, there is no magnetic force F_M on D-1 and D-2. There is secondary Coulomb repulsion force F_R between the two protons of D-1 and D-2, and there is spin-interaction attraction force Fsi between D-1 and D-2 (although 40% weaker than if they had parallel spins). As D-1 is aligned with D-3 its radius orbit is approximately zero, and so the centripetal force on D-1 is approximately null. The same happens with D-2.
Because Fsi > F_R , D-1 is captured by D-3 and they have fusion, while D-2 is captured by D-4 and they fuse too, and so 4Be8 decays.

3.13-6- Four deuterons in the 6C12

6C12 has null nuclear magnetic moment, and therefore there is no magnetic force F_M actuating on any of the four deuterons.
The forces on the deuteron D-1, shown in Fig. 16, are the following:

a) F_{SI} – spin-interaction force with D-2 (spin parallel to D-1)
b) f_{SI} – spin-interaction force with D-3 (spin antiparallel with D-1), $f_{SI} < F_{SI}$
c) F_R – secondary Coulomb repulsion force with D-2
d) f_R – secondary Coulomb repulsion force with D-3
e) Fc – Centripetal force

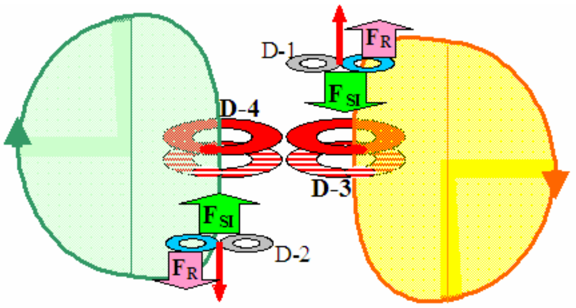


Fig. 14
4Be8 rupture because of the
spin-interaction deuteron-deuteron

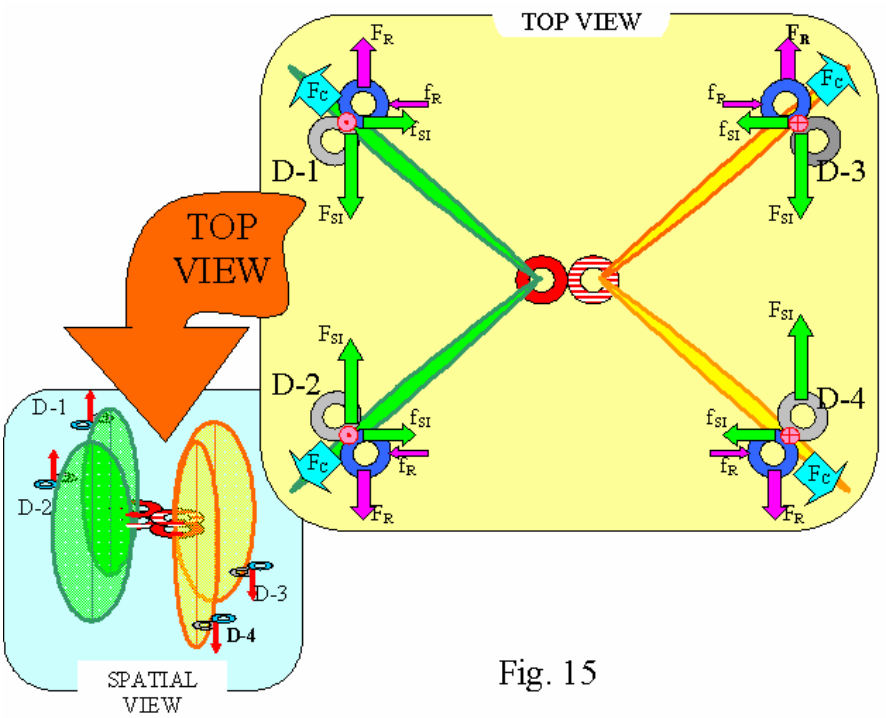


Fig. 15

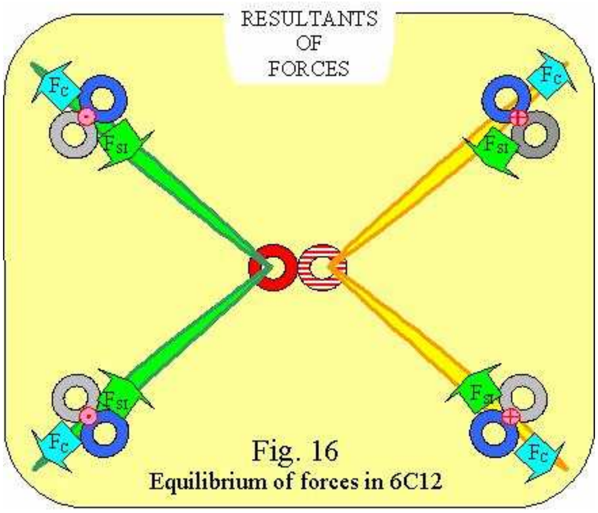


Fig. 16
Equilibrium of forces in 6C12

We did not consider the interaction with D-4 because it is despicable.

The nucleus gets stability with the resultant of the forces on each deuteron, shown in the Fig. 16.

3.14- Multiplication Factor

When two or more nucleons have parallel spins in the same side (either Ana or Douglas), there is a growth on the magnetic moments, induced by each of them.
For instance, consider the Fig. 17-(A), with three deuterons with parallel spins in the side Ana. Each deuteron alone has charge q and in normal conditions it induces (due to the rotation of the nucleus) a magnetic moment μ=–0,236μn. But when the multiplication factor phenomenon occurs, it happens the following:

- When two or more deuterons get strong spin-interaction (with parallel spins), the induced magnetic moment by each deuteron in such partnership can be μ_{MF} = –0,8μn , and such growth depends on several variables (if Douglas is empty or nucleons or not, if the nucleons are in the inner or outer side, etc).
- If other nucleon is captured by Ana with antiparallel spin, as shown in the Fig. 17-(B), the phenomenon does not occur.

In the calculation of the induced magnetic moment by nucleons satisfying the condition shown in the Fig. 17-(A), we will use two sorts of Multiplication Factors:

- Internal Multiplication Factor - Mfi
- External Multiplication Factor- Mfe.

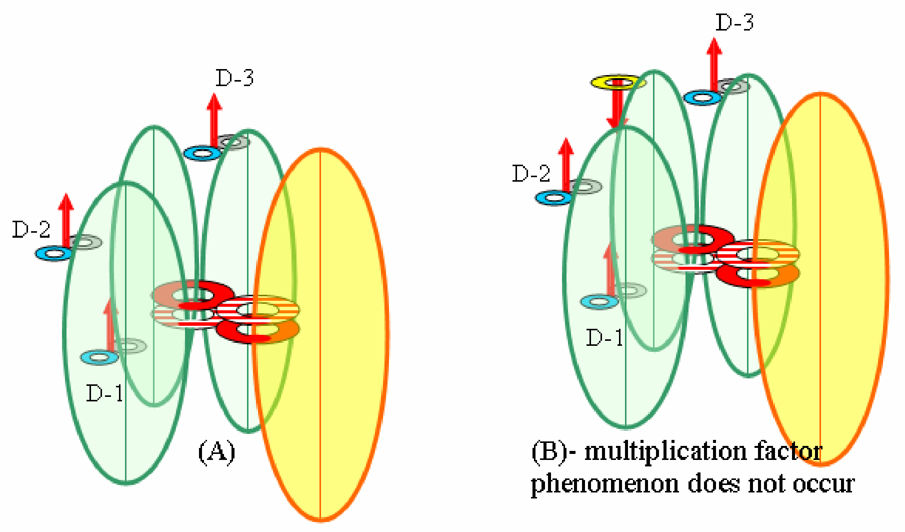


Fig. 17

3.15- Physical causes of the multiplication factor phenomenon

In Bohr model of the hydrogen atom the radius is quantized: R= n^2 , n=1,2,3... We will consider that all the orbit radii within the light nuclei are also quantized. And therefore the angular momentum is also quantized, and also the angular velocity ω is quantized.
As said, the multiplication factor is the phenomenon of an anomalous growth in the intensity of the induced magnetic moments by the orbiting nucleons, and the phenomenon also depends if the opposite side is either empty or not, because the induced moment in the side Ana are opposite to those induced in the side Douglas. That's why 4Be8 has μ = 0. When there are only parallel spins in one side, there is a growth in the intensity of the induced magnetic fields, because of two causes:
1- the quantized growth of the angular velocity

2- the quantized growth in the intensity Φ of the flux n(o)

When the strong spin-interaction occurs with three deuterons with parallel spins, there is shrinkage of the orbit radii, and it tends to diminish the growth in the intensity of the induced magnetic moments. For instance, in the case of 5B10 the shrinkage is so big that it cancels 95% the occurrence of the multiplication factor phenomenon.

As we don't know what is the contribution of each of the two causes (ω and Φ) because the contribution of each of them can be different in different isotopes, then we will consider them together, by defining a factor K.

We take the factor K of the 3Li6 as reference, as follows:

Factor K=1 , $\omega(1) = 0{,}653\text{x}10^{-19}\text{x}(822/653)^{(k-1)/2}$, k= 1, 2, 3... [1]

The multiplication factor phenomenon occurs thanks to the following interactions:

- One deuteron and one neutron forming spin i=3/2 in isotopes with Factor K > 1
- One deuteron and two neutrons forming spin i=2
- Two protons forming spin i=1
- One proton and one deuteron forming spin i=3/2
- Two deuterons forming spin i=2
- Two protons and one deuteron forming spin i=2
- Three deuterons forming spin i=3

There are two sort of light nuclei with Z < 8:

1- **Isotopes which <u>do not depend</u> on the spin-interaction**

These isotopes have K=1 , $\omega(1) = 0{,}653\text{x}10^{-19}$, and we will use the isotope 3Li7 so that to explain the mechanism of equilibrium within the light nuclei for the isotopes which do not depend on the spin-orbit interaction for their stability.

3Li7 – Consider the nucleus 3Li6 where the deuteron moves within a magnetic moment μ=0,822 μn , with orbit radius R=0,355 (we will calculate it). When a neutron is captured by the flux n(o) of the 3Li6, it is formed the 3Li7 with the deuteron and the neutron linked by the strong spin-interaction, and their contribution for the new magnetic moment of the 3Li7 is μ = +0,857 +1,913= +2,770.

- They had started moving together with that radius R= 0,355. In that orbit the deuteron induces μ= -0,035μn , and the neutron induces μ= +0,090μn. But now the centripetal force has increased because of the mass of the neutron, and the magnetic moment μ = +2,770 is not enough to keep them with that original orbit radius R=0,355. Then the orbit starts to increase by quantized jumping ΔR, because the two nucleons are pushed by the centripetal force.
- As the deuteron is submitted to the magnetic force, its orbit grows slowly while the neutron's orbit grows quickly, and when the neutron arrives to the orbit with radius R=2,391 it is inducing μ= +0,529μn, while the deuteron arrives to the orbit with radius R=0,405 inducing μ= –0,040μn. So, with the growth of the orbit radii the induced magnetic moments by the neutron increased from +0,090 up to +0,526, while of the deuteron the growth was from -0,035 up to -0,04.. Due to the growth of the radii of their orbits, the magnetic moment of 3Li7 experienced a growth from +2,770 up to +3,256 because of that difference between the higher growth of the neutron's power to induce magnetic moments, and now this new magnetic moment of the 3Li7 is able to keep the stability of the deuteron and the neutron, and they keep moving orbiting, because the magnetic force on the proton has

increased thanks to the growth of the 3Li7 magnetic moment from 0,822μn when it was newborn up to 3,256μn when it became adult.

Notes:

- As the neutron is in the inner side of Douglas when it is captured by the 3Li6 and the 3Li7 is formed, it is violating the flux n(o). Then from the viewpoint of the spin detection in experiments its spin is down, and that newborn 3Li7 has spin ½. But from the viewpoint of interactions, its spin is up, and it induces positive magnetic moments, and its interaction with the deuteron forms a spin 3/2, and so they are interacting via strong spin-interaction.
- As the orbit radii grow, in order do not violate the conservation of the angular momentum the angular velocity would have to decrease. Nevertheless, as the induced magnetic moments are increasing, then the proton's charge q= $1,6x10^{-19}$C within the stronger magnetic field restores the angular velocity, and 3Li7 keeps the original angular velocity of 3Li6.
- As the deuteron and the neutron have a strong spin-interaction in 3Li7, we had to expect they be moving very close one each other. However while the deuteron induces a negative μ , the neutron induces a positive μ , and from the Least Action Principle it's disadvantageous for the nucleus to have them together inducing magnetic moments with contrary signs. So, while they have attraction by the strong spin-interaction, they also are repelled by their contrary tendencies of inducing magnetic moments and by the centripetal force, and so the neutron stays moving with orbit radius R=2,391fm and the deuteron with R=0,405fm.

In lithium isotopes there is a direct relation between their magnetic moments and the distribution of masses, just because the equilibrium of their nucleons does not depend on the spin-interaction. For instance look such relation in 3Li6, 3Li7, and 3Li8, 3Li9, exhibited ahead. Consider "m" the mass of the neutron, and "2m" the mass of the deuteron

1- 3Li6 (Fig. 18):
It has one deuteron with R= 0,355:
2m.0,355 = **0,710**.m --------------→ μ = **0,822**

2- 3Li7 (Fig. 19):
It has one deuteron with R= 0,405 and one neutron with R= 2,4:
2m.0,405 + 1m.2,4 = **3,210**.m --------------→ μ = **3,256**

3- 3Li8 (Fig. 21):
It has one deuteron and two neutrons with R=0,355:
4m.0,355 = 1 **1,420**.m ---------------→ μ = **1,653**

4- 3Li9 (Fig. 22):
It has one deuteron with R=0,441, one neutron with R=2,606, and two neutrons cancel each other:
1m.2,606 + 2m.0,441 = **3,488**.m ----------------→ μ = **3,439**

2- **Isotopes dependent on the spin-interaction**

In these isotopes the magnetic force works together with the strong spin-interaction. They have angular velocity faster than those lithium nuclei with K=1. As the centripetal force Fc increases with the square of the angular velocity, its growth is very greater than the growth of the magnetic force Fm, and so in these nuclei the

force Fc alone cannot keep the nucleons. In these nuclei the additional force is given by the strong spin-interaction.
The growth in the intensity of the induced magnetic moments also depends on how the nucleons with parallel spins move. Compare the following isotopes:

- 5B8- It has K= 3, ω= 0,822x 10^{-19}. Look at the Fig. 32. The proton p-2 moves in the same orbit of the proton p-1. So, p-2 moves in the "shadow" of p-1, and then the power of p-2 of inducing magnetic moments has a reduction.
- 4Be7- It also has K=3, but the proton and the deuteron move in different orbits, and so no one of them move in the "shadow" of the other.

Therefore, in spite of both 5B8 and 4Be7 have the same K=3, however there is a difference, as follows:

  - Regarding to the equilibrium of nucleons between the centripetal force and the magnetic force, 5B8 and 4Be7 are in the same level K=3
  - But regarding to intensity of the induced magnetic moments by them, 4Be7 induces them in a higher level than 5B8.

4. Calculus on the magnetic moments

We will calculate the magnetic moments of several isotopes. In all the calculations it is used the unity μn for the magnetic moment, all distances are given in 1fm = 10^{-15}m, and electric quadrupole moments Q(b) are given in barns , 1b= 10^{-28} m^2 .

4.1- Isotopes 3Li6 and 3Li7

<u>3Li6</u>

μ induced by the deuteron :

μ= 0,822 - 0,857 = –0,035 [2]

The magnetic moment μ= 0,857 with area S=π.Ro^2 induces 0,035:

0,857.π.Ro^2 => 0,035 [3]

<u>3Li7</u>

μ induced by deuteron and neutron:

μ= 3,256 –(1,913+0,857) = +0,486 [4]

The sum of magnetic moments μ= 0,857 with area S=π.R_d^2 and μ= 1,913 with area S=π.R_n^2 induce μ= +0,486:

(–0,857.π.R_d^2 + 1,913.π.R_n^2) => +0,486 [5]

Let's use the well known formula R= 1,25.$A^{1/3}$ so that to calculate the radius orbit of the neutron:

Rn= 1,25.$7^{1/3}$ = **2,391** [6] **Rn = <u>neutron's orbit radius in 3Li7</u>**

Note that we have no assurance on the accuracy of the value 2,391. In the case of having even a little difference between 2,391 and the actual radius existing in 3Li7 isotope, such difference introduces errors in the calculations.

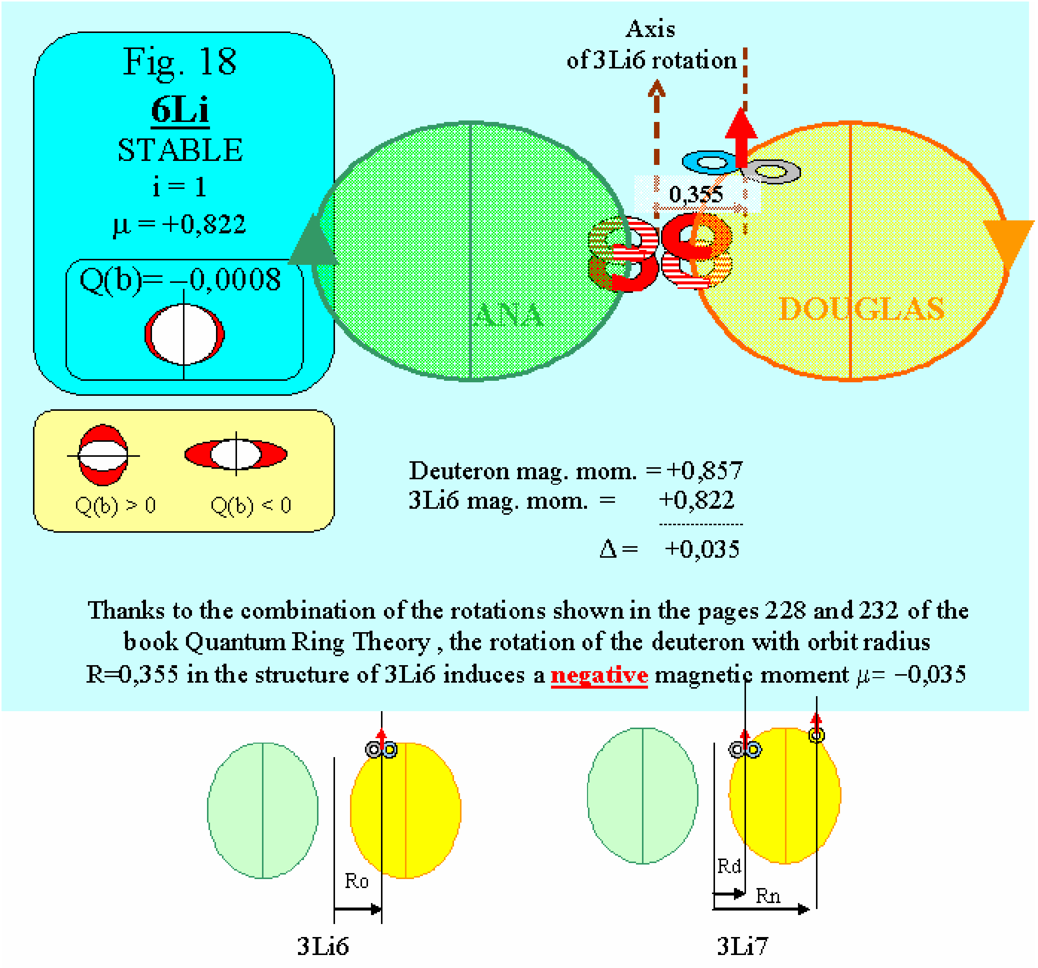


Fig. 18
6Li
STABLE
i = 1
μ = +0,822
Q(b)= –0,0008
Q(b) > 0
Q(b) < 0
Axis
of 3Li6 rotation
0,355
ANA
DOUGLAS
Deuteron mag. mom. = +0,857
3Li6 mag. mom. = +0,822
Δ = +0,035
Thanks to the combination of the rotations shown in the pages 228 and 232 of the book Quantum Ring Theory , the rotation of the deuteron with orbit radius R=0,355 in the structure of 3Li6 induces a negative magnetic moment μ= −0,035
Ro
Rd
Rn
3Li6
3Li7

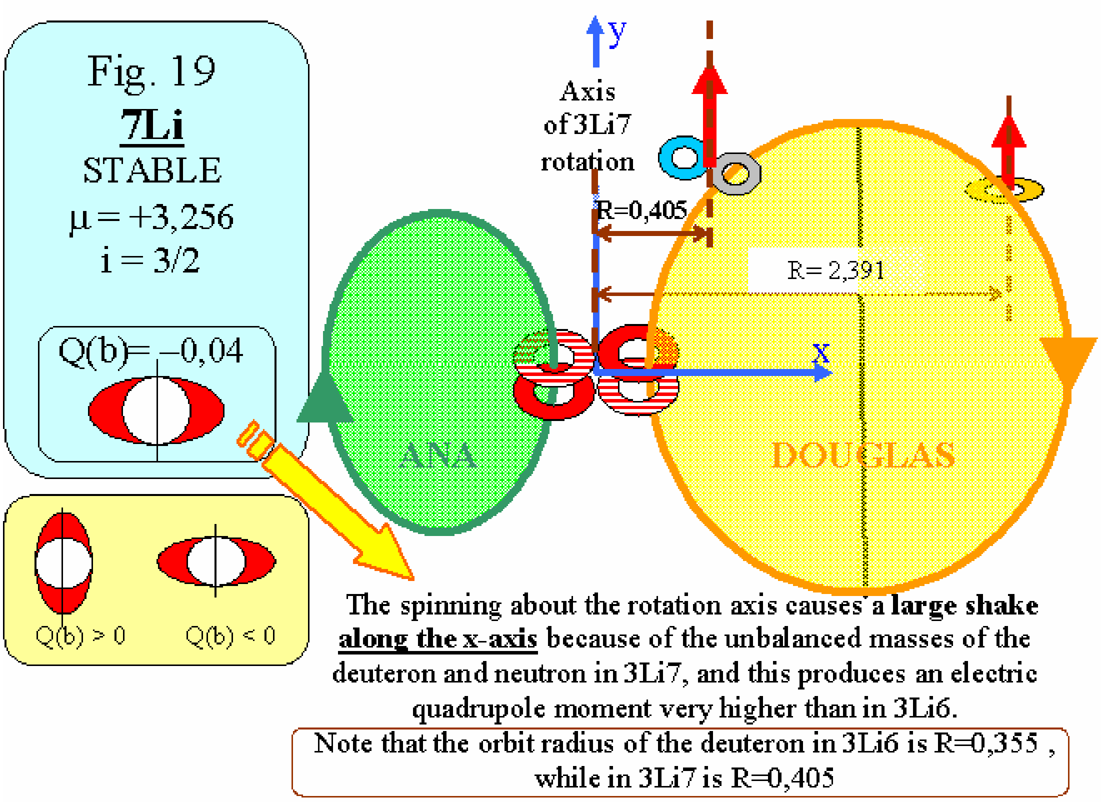


Fig. 19
7Li
STABLE
μ = +3,256
i = 3/2
Q(b)= –0,04
Q(b) > 0
Q(b) < 0
y
Axis
of 3Li7
rotation
R=0,405
R= 2,391
x
ANA
DOUGLAS
The spinning about the rotation axis causes a large shake along the x-axis because of the unbalanced masses of the deuteron and neutron in 3Li7, and this produces an electric quadrupole moment very higher than in 3Li6.
Note that the orbit radius of the deuteron in 3Li6 is R=0,355 , while in 3Li7 is R=0,405

3Li6

$Fm = q.\omega.r.B$ [7] , where B is the magnetic field where the deuteron moves

$Fc = m.\omega^2.r$ [8]

Deuteron:
$q= 1,6x10^{-19}$
$m= 2,014u$
$r= Ro$
B= 0,822 (as the field induced by the rotation of the deuteron' charge is proportional to the magnetic moment of the 3Li6 nucleus, then we may consider B= μ=0,822).

From the equilibrium Fm = Fc in eq. 7 and 8 we have:

$$1,6x10^{-19}.\omega.Ro.0,822 = 2.014.\omega^2.Ro \qquad [9]$$

And so the factor K for the 3Li6 is:

K = 1 , $\omega(1) = 0,653x10^{-19}$ [10] **Factor K=1 of 3Li6**

If we had used the mass of proton in kg we should get $\omega(1)$ with the order of 10^8.

3Li7

For the 3Li7 we use the same $\omega(1) = 0,653x10^{-19}$, because 3Li7 has one unique deuteron, and so it does not have spin-interaction with other deuterons.

Neutron : m= 1,0087u , q=0
$r= R_n$

Deuteron
$q= 1,6x10^{-19}$
$m= 2,014u$
$r= R_d$
B= 3,256

Centripetal force on the neutron:
$$F1= m.\omega^2.R_n = 1,0087.\omega^2.R_n \qquad [11]$$

Centripetal force on the deuteron:
$$F2= = m.\omega^2.R_d = 2,014.\omega^2.R_d \qquad [12]$$

Magnetic force on the deuteron:
$$Fm = 1,6x10^{-19}.\omega.R_d.3,256 = 1,6x10^{-19}.\omega.R_d.3,256 \qquad [13]$$

Putting F1 + F2 = Fm we have:

$$1,0087.\omega^2.R_n + 2,014.\omega^2.R_d = 1,6x10^{-19}.\omega.R_d.3,256 \qquad [14]$$

$$1,0087.\omega.R_n + 2,014.\omega.R_d = 1,6x10^{-19}.R_d.3,256 \qquad [15]$$

$1{,}0087\mathrm{x}0{,}653\mathrm{x}10^{-19}.R_n + 2{,}014\mathrm{x}0{,}653\mathrm{x}10^{-19}.R_d = 1{,}6\mathrm{x}10^{-19}.R_d.3{,}256$ [16]

$0{,}659.R_n + 1{,}316.R_d = 5{,}21.R_d$ [17]

As we had adopted Rn= **2,391** , we get Rd: [18]

Rd = 0,659 x 2,391 / (5,21-1,316) [18.1]

Rd= 0,40464 (~ 0,405) [19] **Rd= <u>deuteron orbit radius in 3Li7</u>**

From eq. 5 we can get the magnetic moments induced by the deuteron with radius orbit Rd= 0,405 and by the neutron with radius orbit Rn=2,391:

Deuteron contribution: 0,857 x 0,405 = 0,3471 [23]
Neutron contribution: 1,913 x 2,391 = 4,574 [24]
Then the neutron contribution is 4,574/0,3471 = 13,176 times higher [25]
As deuteron's contribution is (μ_N / 13,176) , then in 3Li7 we get:

- Neutron contribution:
  μ_N –(μ_N / 13,176) = 0,486 => $\mu_{NEUTRON}$ = +0,526 [26]
- Deuteron contribution:
  μ_D = 0,486 –0,526 => $\mu_{DEUTERON}$ = –0,039907 (~0,04) [27]

As the deuteron in 3Li6 induces μ= 0,035 , then its radius orbit we get from eq. 27:
0,039907.Ro / 0,405 = 0,035
and we get:

Ro = 0,3552 (~ 0,355) [28] **Ro= <u>deuteron orbit radius in 3Li6</u>**

4.2.1- Electric quadrupole moment Q(b) of the 3Li6

Often the predictions of the classic nuclear models for the Q(b) are five times upper or lower than the true value measured in the experiments. This is because those models do not consider the contribution of the shake due to the unbalance of masses in the eccentricity of electric charges. An analysis is made in the page 149 of the book Quantum Ring Theory in the Paper No. 12 entitled Incompatibility Between Nuclear Theory and Electric Quadrupole Moment. Basically the electric quadrupole moment is the combination of two tendencies:

1. The distribution of the positive charges of protons and deuterons along the vertical y-axis direction and the spread of those charges along the horizontal x-axis. A large distribution along the vertical contributes for positive Q(b), which is the case of nuclei with thin spread along the x-axis, as the case of 5B10, while the spread along the horizontal contributes for negative Q(b), as it is the case of nuclei with flat distribution of charges along the x-axis
2. The shake of the nucleus about the y-axis (due to the unbalance of masses) causes an eccentricity on the shape of charges distribution along the x-axis, and it contributes for negative Q(b).

The combination of the two tendencies is illustrated for the 3Li6 in the Fig. 20.

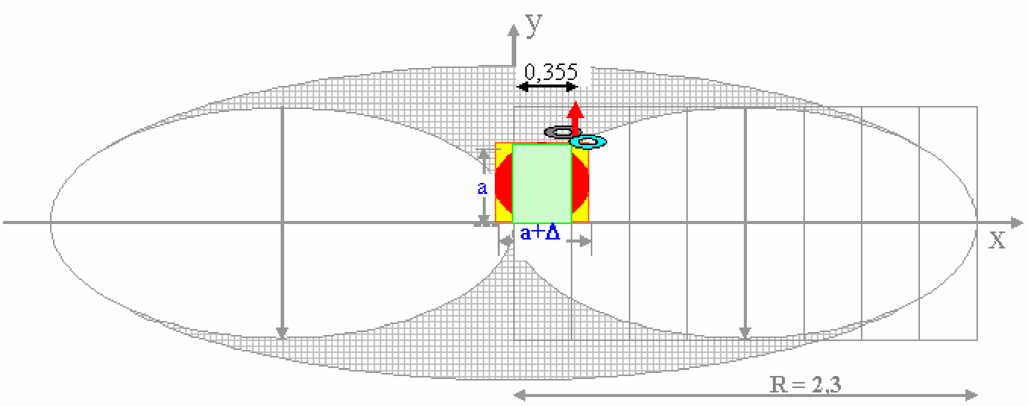


Fig. 20
Contributions for electric quadrupole moment in 3Li6

1. Distribution of the charge along the y-axis
- If z > k , positive contribution
- If z < k, negative contribution

2. Distribution of the charge due to shake along the x-axis – negative contribution

3. Resultant of the two contributions – the yellow area with sides "a" and "b" is the combination of the two distributions
- If a=b , Q(b) = 0
- If a > b , Q(b) > 0
- If a < b , Q(b) < 0

In the case of 3Li6, b = a + Δ , where Δ > 0 and very small

4.2.2- **Q(b) of the 3Li6 and 3Li7**

The structures of 3Li6 and 3Li7 shown in the figures 18 and 19 are corroborated by their electric quadrupole moments. Indeed, the deuteron in 3Li6 has orbit radius Ro=0,355 and it has a very little Q(b)= –0,0008, because the unbalance of mass is weaker and its contribution is a little upper than the contribution of the position of the deuteron's charge along the vertical (see Fig. 20). While in 3Li7 there is a big unbalance of masses, because the deuteron and the neutron have orbits radii respectively Rd= 0,405 and Rn= 2,391, and so the greater Q(b)= –0,04 is consequence of the strong shake along the horizontal, since the shake contributes for a negative Q(b)

4.3- Isotope 3Li8 and internal multiplication factor Mfi

A) **Method of equilibrium between nucleons**

As the three centripetal forces on the deuteron and the two neutrons actuate in the same direction, it is reasonable to suppose that the three nucleons are orbiting approximately with the same radius R , because the spin-interaction has the tendency to put the three nucleons along a straight line and because the three nucleons are in the same inner side of Douglas.

As 3Li8 has only one deuteron it has the same factor K=1 , $\omega(1) = 0{,}653\text{x}10^{-19}$ obtained for 3Li6 (eq. 10), because there is only one magnetic force Fm contributing for the equilibrium, since there is no other deuteron so that to have spin-interaction between them and to contribute for the equilibrium with a second magnetic force.

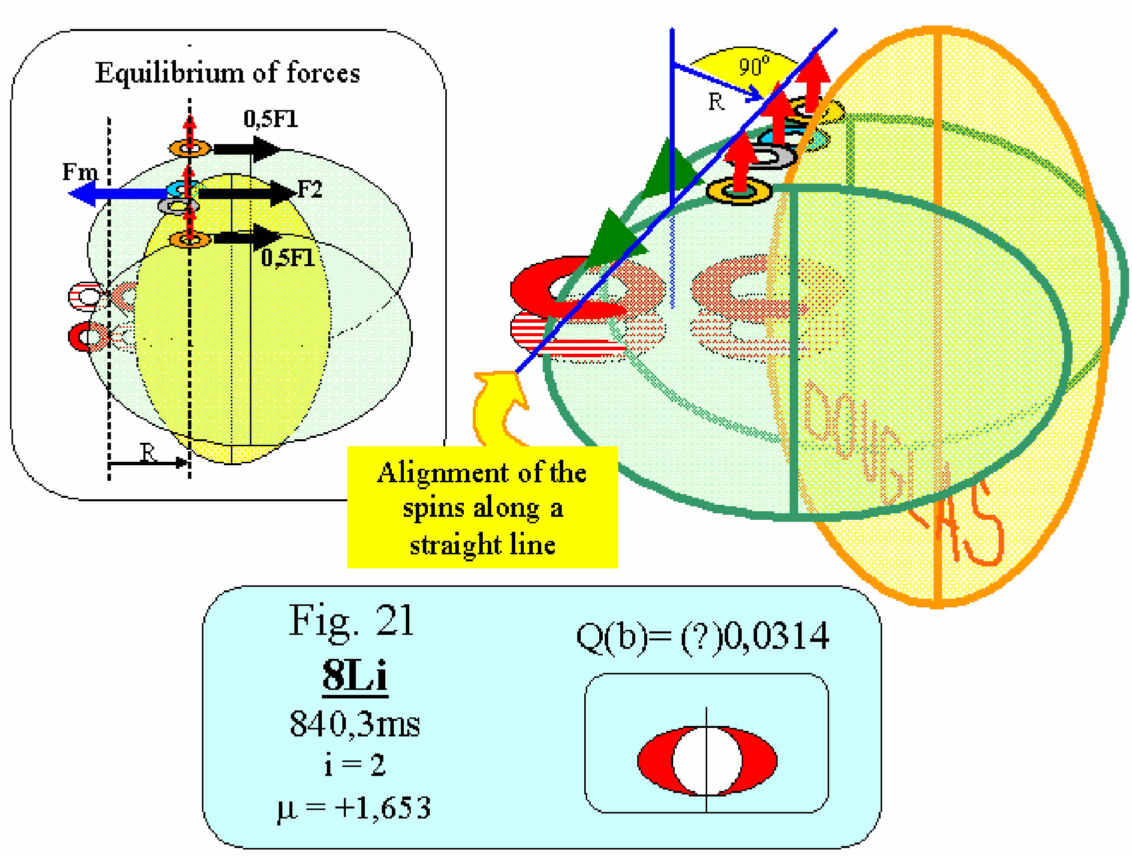


Fig. 21
8Li
840,3ms
i = 2
μ = +1,653
Q(b)= (?)0,0314

As the deuteron and the two neutrons are in the inner side of Douglas, the three nucleons are very close, and therefore their spin-interaction is very strong. So, in spite of the deuteron's mass is twice of the neutron, the stronger centripetal force on the deuteron does no cause a considerable deviation in the alignment of the spins along the straight line (see Fig. 21).

Centripetal force on the two neutrons:
$F1= 2.m.\omega^2.R = 2\text{x}1{,}0087.\omega^2.R = \quad 2{,}0174.\omega^2.R$ [26]

Centripetal force on the deuteron:
$F2= = m.\omega^2.R = \quad 2{,}014.\omega^2.R$ [27]

Magnetic force on the deuteron:
$Fm = \quad 1{,}6\text{x}10^{-19}.\omega.R.\mu$ [28]

The **Lagrangian** for the equilibrium is:
$F1 + F2 = Fm$ [29]
So we have:
$2{,}0174.\omega^2.R + 2{,}014.\omega^2.R = 1{,}6\text{x}10^{-19}.\omega.R.\mu$ [30]

As $\omega(1)= 0{,}653x10^{-19}$
then:
$\mu = (2{,}0174 + 2{,}014)x0{,}653x10^{-19}/1{,}6x10^{-19}$ [31]

Magnetic moment of 3Li8 **$\mu =$ 1,6453** [32]
Compare with its experimental value μ= +1,653 in the Fig. 21.

Note: the sign of the magnetic moment of the isotopes cannot be predicted in this method, because the sign does not influence in the equilibrium. For instance, if all the nucleons in one isotope change their spin, then the sign of all magnetic moments also change, however the equilibrium does not change. It's possible to improve the method so that to get the sign of the predicted magnetic moment by introducing the parity in the calculation, but the method would become so complex that it runs away of the scope of this paper.

B) **Improvement on the calculation of μ**
The difference Δ= 1,653 -16453 = 0,0077 between the values experimental and theoretical is because we have considered that the deuteron and the two neutrons are perfectly aligned with the same radius R (Fig. 21).
However the deuteron is tied by the magnetic force to the center of the nucleus, while the two neutrons are tied only through the spin-interaction with the deuteron. So, due to the centripetal force, the two neutrons are pulled by the centripetal force, and their orbit radius has a little increase ΔR.
In 3Li6 the mass of the deuteron is submitted to the centripetal force and to the magnetic force due to μ = 0,822 . In 3Li8 one deuteron plus two neutrons experiences a similar situation with μ = 1,653. As the mass in 3Li8 is twice and μ is also twice, then 3Li8 and 3Li6 have to have approximately the same radius. As the radii are quantized, then 3Li8 have to have the same radius R= 0,3552 of 3Li6.
The radius of nuclei grows by quantized degrees $\Delta R = 1{,}25.A^3$, then let's consider that the next degrees ΔR after the 3Li6 orbit radius R are given by the following equation::
$\Delta R = 0{,}3552 \text{ x } (1 +0{,}3552^3)^{1/3}$
Then the radius orbit of the two neutrons is the next degree is R= 0,3604, and ΔR=0,0054

Let's calculate the magnetic moment of 3Li8 again.
Centripetal force on the two neutrons:
$F1= 2.m.\omega^2.(R+\Delta R) = 2x1{,}0087.\omega^2.(0{,}3552+ 0{,}0054) = \quad 0{,}72747.\omega^2.$ [32.1]

Centripetal force on the deuteron:
$F2= = m.\omega^2.R = 2{,}014.\omega^2.0{,}3552 =$ 0,71537 [32.2]

Magnetic force on the deuteron:
$Fm = 1{,}6x10^{-19}.\omega.0{,}3552.\mu$ 0,56832 [32.3]

The Lagrangian for the equilibrium is:
F1 + F2 = Fm [32.4]
So we have:
$0{,}72747.\omega^2 + 0{,}71537.\omega^2= \quad 0{,}56832x10^{-19}.\omega.\mu$ [32.5]

As $\omega(1)= 0,653x10^{-19}$
$\mu = (2,0174 + 2,014)x0,653x10^{-19}/1,6x10^{-19}$ [32.6]

Magnetic moment of 3Li8 μ = **1,6578** [32.7]

The difference is now Δ= 0,0048. Remember that the orbit radius R= 0,3552 of the deuteron in 3Li6 used in the calculation here was obtained from Rn= 2,391, which is the starting point for all the calculations. However we are not sure on the accuracy of the formula $R= 1,25.A^{1/3}$ used to calculate Rn, and so little errors can be spread along all the calculations in the paper. It is of interest an accurate value of the 3Li7 radius be measured by experiments, in order to get more accurate results.

C) **Internal multiplication factor Mfi in 3Li8**
Let's verify if the anomalous value μ =1,653 of 3Li8 can be credited to a growth of orbit radius.
2x1,913 + 0,857 = 4,683 [32.9]
4,683- 1,653 = 3,03 [32.10]
R.(2x0,525/2,39 + 0,04/0,405) = 3,03 [32.11]
R= 5,62 [32.12]

So, if the anomalous growth of the induced magnetic moments should be due to the growth of the orbit radius of the deuteron and the neutrons, their radius orbit would have to be 5,62.
3Li7 has Q(b)= 0,04, and 3Li8 has Q(b)= 0,0314. Therefore the three nucleons in 3Li8 cannot have radius orbit 5,62, because its Q(b) should be very upper than that of 3Li7 (in absolute values). In 3Li8 there are two neutrons with short orbit radius, and in 3Li7 there is one neutron with big orbit radius, and so it is explained why they have Q(b) with almost the same value. Therefore we have to conclude that the anomaly is caused by a multiplication factor indeed, since it cannot be credited to the growth of the orbit nucleus.

The internal Mfi occurs in the case when the nucleons with parallel spins are in the inner side of Ana or Douglas.
As already explained in the Fig. 7, the two neutrons belong to the flux n(o)-up of the side Ana, but they are captured by the deuteron in the flux n(o)-down of the side Douglas. For this reason the two neutrons, instead of to induce a positive magnetic moment (as it would occur if they should belong to the flux n(o)-down in the side Douglas) they actually induce a negative magnetic moment.

Looking at the Fig. 21 we realize that as the deuteron and the two neutrons have spin-up, then their total magnetic moment is::
μ= +0,857 + 2x1,913 = +4,683 [33]

If the multiplication factor phenomenon should not exist, the induced magnetic moment due to each nucleon would be:

- Deuteron: μ= –0,0399 (see eq. 27)
- Neutrons: as the two neutrons are inner as the deuteron, each one induces the following magnetic moment:

μ= –0,0399x1,913/0,857 = –0,089 [34]

So, with no multiplication factor the 3Li8 would have the following magnetic moment:
μ= +4,683 –0,0399 – 2x0,089 = +4,651 [35]

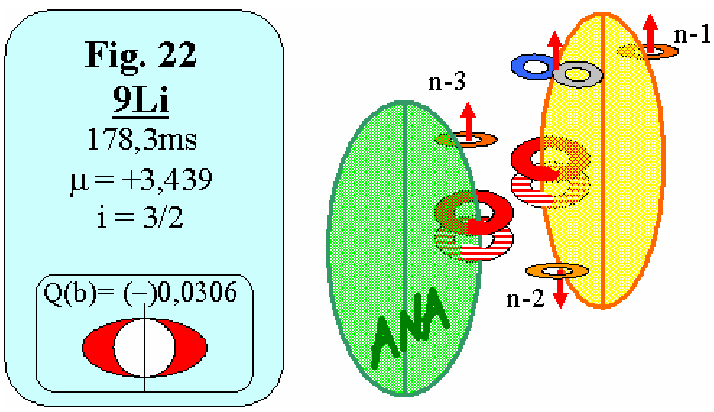
As 3Li8 has μ= +1,653, we get the internal multiplication factor from the difference:
Δμ= 4,651 – 1,653 = 2,8121 [36]

Mfi.(0,0399 + 2x0,089) = 2,8121 [37]

Mfi = 12,905 [38] (**Internal Multiplication Factor Mfi**)

4.4- Isotope 3Li9

The structure shown in the Fig. 22 is corroborated by the electric quadrupole moment measured in the experiments, Q(b)= (-)0,036, a little lower than Q(b)= –0,04 of the 3Li7 isotope, because: A) n-3 and n-2 cancel each other their contribution for the shake along the x-axis. B) So, the shake of 3Li9 is similar to that in 3Li7. C) The deuteron is pulled by its spin-interaction with n-3 toward the inner side of Douglas, decreasing the orbit radius of the deuteron, and so the shake along the x-axis in 3Li9 is weaker than in 3Li7 D) As the shake contribute for negative Q(b), then Q(9Li)<Q(7Li). E) On another hand, 3Li9 has Q(b) a little upper than Q(b)=0,0314 of 3LI8, which unbalance of masses is due to two neutrons and one deuteron, but they have a short orbit radius, since they are in the inner side.



A) **Method of equilibrium of forces**

Radius of 3Li9 = $1,25x9^{1/3}$ = 2,606 [39]
Radius of 3Li7 = $1,25x7^{1/3}$ = 2,391 [40]
2,606 / 2,391 = 1,09 [41]

As 3Li9 has one deuteron it has the same factor K=1 of 3Li6 and 3Li7.
We will consider that in 3Li9 the deuteron and neutron n-1 in the side Douglas have respectively the orbit radii they have in 3Li7 (eq. 18 and 19) , multiplied by 1,09 (see eq. 41):
Rn= 2,391x1,09 = 2,606 [42]
Rd = 0,405x1,09 = 0,441 [43]

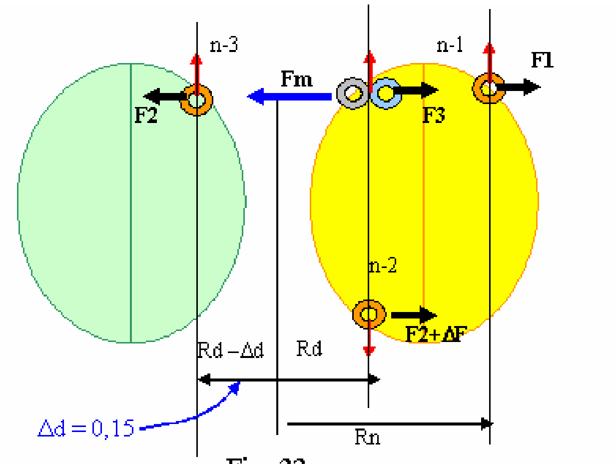


Fig. 23

Neutron : m= 1,0087u , q=0
n-1: R= 2,606 [44]
n-2: R= 0,441 [45]
n-3: R = 0,441 –Δd = 0,441 –0,15= 0,291 [46]

Deuteron: q= $1{,}6\text{x}10^{-19}$, m= 2,014u
r = 0,441 [47]
B= μ = ? (to be calculated)

Centripetal force on neutron n-1:
$F1= m.\omega^2.R = 1{,}0087.\omega^2.2{,}606 =$ $2{,}629.\omega^2$ [48]

Centripetal force on the neutrons n-2 and n-3:
If they should have the same radius, one would cancel each other. But let's consider that n-2 has a radius a little larger than n-3, because n-2 has spin-interaction with (D,n-1) , and so n-2 is pulled toward the right direction, due to the centripetal force on the three nucleons in the side Douglas.
Let's consider ΔR= 0,15

$F2= m.\omega^2.\Delta R = 1{,}0087.\omega^2.0{,}15 =$ $0{,}1513.\omega^2$ [49]

Centripetal force on the deuteron:
$F3= = m.\omega^2.R = 2{,}014.\omega^2.0{,}441 =$ $0{,}888.\omega^2$ [50]

Magnetic force on the deuteron:
$Fm = 1{,}6\text{x}10^{-19}.\omega.R.\mu = 1{,}6\text{x}10^{-19}.\omega.0{,}441.\mu =$ $0{,}706.10^{-19}.\omega.\mu$ [51]

Writing the equation of equilibrium:
F1 + F2 +F3 = Fm [52]
we have:
$2{,}629.\omega^2 +0{,}1513.\omega^2 + 0{,}888.\omega^2 = 0{,}706.10^{-19}.\omega.\mu$ [53]

With K=1, $.\omega(1) = 0{,}653.10^{-19}$ we have: [53.1]
$\mu = (2{,}629 +0{,}1513 +0{,}888)\text{x}0{,}653\text{x}10^{-19} / 0{,}706\text{x}10^{-19}$ [54]

Magnetic moment of 3Li9 μ = **3,393** [55]

B) **Method of induced magnetic moments by nucleons**

- Magnetic moment due to nucleons: (see Fig. 22):

μ = +0,857 +1,913 = +2,77 [56]

Magnetic moments induced by nucleons:

- Deuteron:

With orbit radius 0,405 in 3Li7 it induces μ =–0,04 (eq. 27)
With orbit radius 0,441 (eq. 43) it induces:
μ = –0,04x(0,441/0,405) = –0,0435 [57]

- Neutron n-1:

With orbit radius 2,391 in 3Li7 a neutron with spin-up induces μ = 0,526 (eq. 26)
Then n-1 with spin-up and orbit radius 2,606 (eq. 42) induces:
μ = +0,526x(2,606/2,391) = +0,573 [58]

- Neutron n-2:

As the deuteron with radius Rd induces –0,0435 (eq. 57), then n-2 with the same radius Rd, and because it has spin-down, induces:
μ = –0,0435x1,913/0,857 = –0,097 [59]

- Neutron n-3:

As its radius is 0,15 shorter than that of n-2, its radius is 0,441 –0,15 = 0,291. So, from eq. 59, because it has spin-up, it induces the magnetic moment:
μ = +0,097x(0,291/0,441) = +0,064 [60]

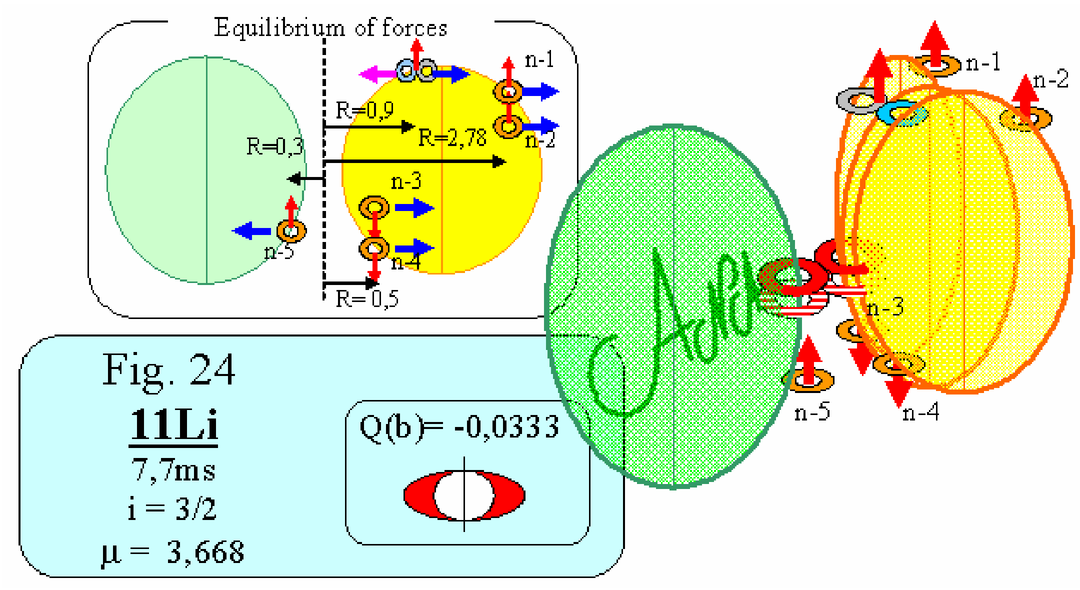
So the total theoretical magnetic moment is:
μ = +2,77 –0,0435 +0,573 –0,097 –0,097 [61]

Magnetic moment of 3Li9: μ = **+3,266** [62]

The difference between the experimental value μ = +3,439 and the theoretical value calculated by the two methods, μ = +3,393 and μ = +3,266 , is because the values of the radii orbits are not exactly. For instance the calculation has started from the orbit radius R= 2,606 obtained from the equation R= $1{,}25x9^{1/3}$, which value we are not sure is exactly correct. And we are no sure if ΔR= 0,15 is the most suitable.

4.5- Isotope 3Li11

The structure shown in Fig. 24 is corroborated by the electric quadrupole moment measured in experiments, Q(b)= (-)0,0333, a little lower than Q(b)= -0,04 of 3Li7, and a little upper than Q(b)= (-)0,0306 of 3Li9. The neutrons n-3, n-4, and n-5 contribute for diminishing the shake along the x-axis.. Note: when we mention “lower” and “upper” obviously we are referring to absolute values.



A) **Method of induced magnetic moments by nucleons**

Radius of 3Li11 = $1{,}25x11^{1/3}$ = 2,78 [63]

Radius of 3Li7 = $1{,}25x7^{1/3}$ = 2,391 [64]

2,78 / 2,391 = 1,16 [65]

Rn= = 2,78 [66]

Rd = 0,405x1,16 = 0,47 (if the deuteron should be having spin-interaction with one neutron. Having spin-interaction with two neutrons, they pull it strongly because of their centripetal force. Then we consider R= 0,9) [67]

Deuteron, R= 0,9 (spin-interaction with two neutrons, Fig. 24) [68]

n-1, n-2, R = 2,78 [69]

n-3,n-4, R=0,47 => 0,5 [70]

we consider that due to centripetal force the radius of n-3 and n-4 grows from 0,47 to 0,5 , because Rd=0,47 would be the orbit for one neutron.

n-5, R = 0,3 [71]

due to the interaction with n-3 and n-4, the orbit of n-5 decreases from 0,47 to 0,3 , because their mass is twice of the n-5

- Magnetic moment due to nucleons:

μ= +0,857 + 1,913 = +2,77 [72]

- Magnetic moments induced by nucleons:

From Table 1, where μ = 0,040 for inner deuteron in 3Li7, μ = 0,526 for outer neutron, and μ =0,09 for inner neutron, we get:

Deuteron:

μ = –0,04x(0,9/0,405) = –0,089 [73]

Neutrons n-1 , n-2:

μ = +2x0,526x(2,78/2,391) = +1,223 [74]

Neutron n-3, n-4:

μ = –2x0,09x(0,5/0,405) = –0,222 [75]

Neutron n-5:
μ = +0,09x(0,3/0,405) = +0,067 [76]
Σ= +0,979 [77]

So the theoretical magnetic moment of 3Li9 is:
μ = +2,77 +0,979 [78]
Magnetic moment of 3Li9: μ = **+3,749** [79]

B) **Method of equilibrium between nucleons**

Centripetal force on the deuteron:
F1= $m.\omega^2.R = 2{,}014.\omega^2.0{,}9$ = $1{,}813.\omega^2$ [80]

Magnetic force on the deuteron:
Fm = $1{,}6x10^{-19}.\omega.R.\mu$ = $1{,}6x10^{-19}.\omega.0{,}9.\mu$ = $1{,}440.10^{-19}.\omega.\mu$ [81]

Centripetal force on n-1 and n-2:
F2= $2.m.\omega^2.R = 2x1{,}0087.\omega^2.2{,}78$ = $5{,}608.\omega^2$ [82]

Centripetal force on n-3 and n-4:
F3= $2.m.\omega^2.R = 2x1{,}0087.\omega^2.0{,}5$ = $1{,}009.\omega^2$ [83]

Centripetal force on n-5:
F4= $2.m.\omega^2.R = 1{,}0087.\omega^2.0{,}3$ = $0{,}303.\omega^2$ [84]

Writing the equation of equilibrium:
Fm + F4 = F1 + F2 +F3 [85]
we have:
$1{,}44.10^{-19}.\omega.\mu + 0{,}303.\omega^2 = 1{,}813.\omega^2 + 5{,}608.\omega^2 + 1{,}009.\omega^2$ [86]
With ω= $0{,}653x10^{-19}$ we have:
Magnetic moment of 3Li11: μ = **3,685** [87]

4.6- Excited 5B10 isotope

A) **Method of equilibrium of nucleons**:
Radius of excited 5B10: R= $1{,}25x10^{1/3}$ = 2,693 [88]
Radius of 3Li6: $1{,}25x6^{1/3}$ = 2,271 [87]

D-1 and D-2 cancel each other.

Centripetal force on D-3:
F3= $m.\omega^2.R = 2{,}014.\omega^2.R$ [89]

Magnetic force on D-3:
Fm3 = $1{,}6x10^{-19}.\omega.R.\mu$ [90]

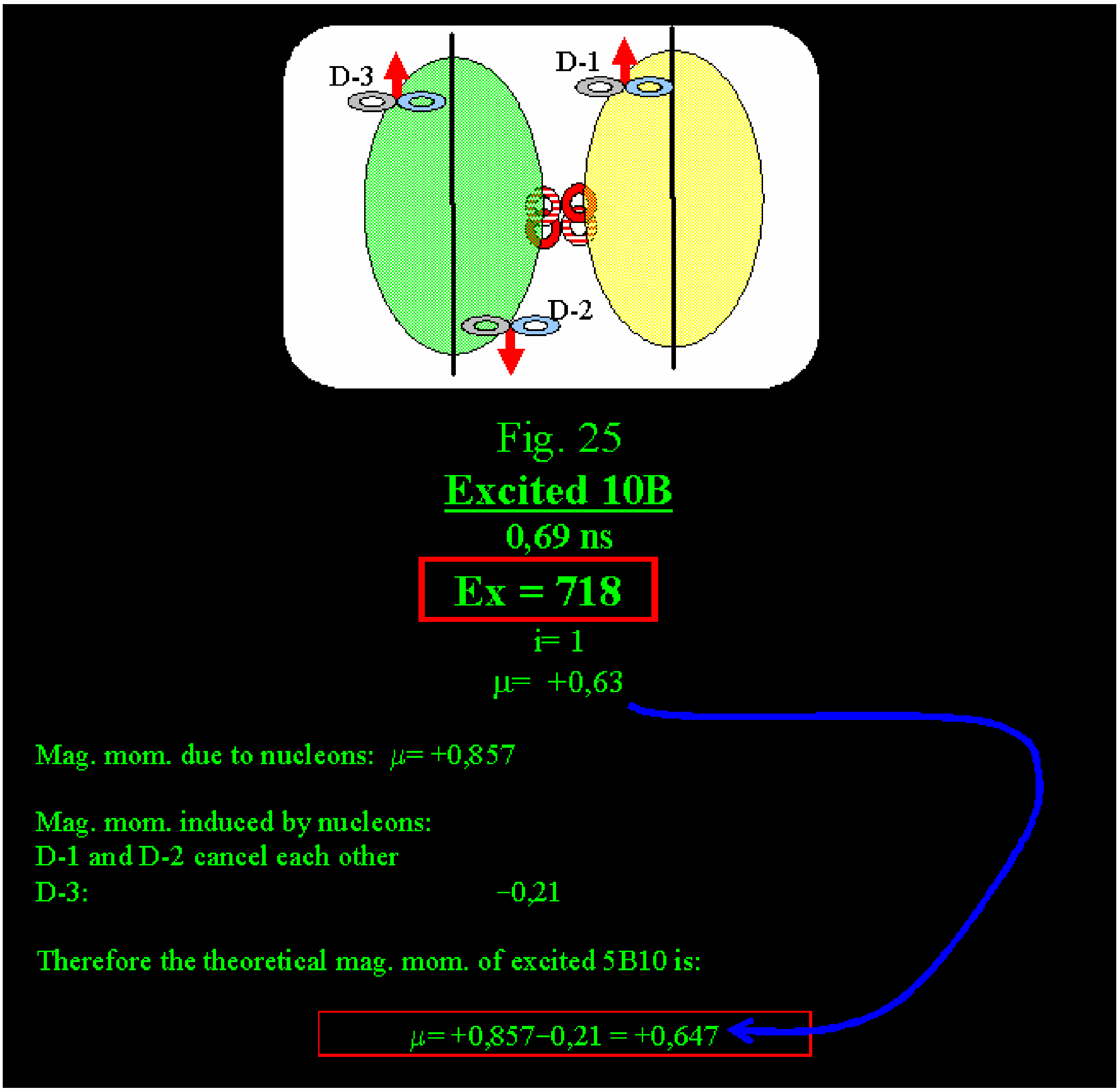
From the equation of equilibrium:

F1 = Fm1, [91]

we have:

$2{,}014.\omega^2 = 1{,}6\text{x}10^{-19}.\omega.\mu$ [92]

$\mu = 2{,}014.\omega / 1{,}6\text{x}10^{-19}$ [93]



Let's suppose that the excited 5B10 and 3Li6 have the same factor K=1, $\omega(1)=0{,}653\text{x}10^{-19}$. We get:

Magnetic moment of excited 5B10: $\mu = 0{,}822$ [94]

while the experimental value is $\mu = 0{,}63$

However the deuterons in 5B10 move with orbit radius R= 2,693, and the deuteron in 3Li6 move with radius R=0,355. So, we conclude that in the excited 5B10 the factor K is bellow to K=1, $\omega(1)=0{,}653\text{x}10^{-19}$. As excited 5B10 has no nucleons with parallel spins in the same side, and therefore there is no growth in the intensity of its flux n(o), we conclude that its lower factor K is due to its angular velocity only, and so it gyrates slowly than 3Li6.

If we consider a factor K with $\omega = 0{,}5187\text{x}10^{-19}$, [95]

we get:

Magnetic moment of excited 5B10: μ = **0,653** [96]

Note: the factor K defined in equation 1 cannot decrease, and so we should have to define another factor K for the isotopes with K bellow the value 1, like the excited 5B10, but we will not do it here.

B) **Method of induced magnetic moments by nucleons**:

Orbit radius of 5B10: $R= 1{,}25\text{x}10^{1/3} = 2{,}69$ [97]

Orbit radius of 3Li7: $R= 1{,}25\text{x}7^{1/3} = 2{,}39$ [98]

2,69 / 2,39 = 1,12 [99]

The neutron in 3Li7 with orbit radius R=2,39 induces a magnetic moment μ=+0,526 (eq. 26). Then the deuteron D-3 with radius 2,69 in the same position in 5B10 induces the following magnetic moment:

μ= –0,526x(2,69 / 2,39)x0,857 / 1,913 = –0,265 [100]

- Magnetic moment due to nucleons: μ = +0,857 [101]

- Magnetic moments induced by nucleons:

D-1 and D-2 cancel each other.

As excited 5B10 gyrates slowly than 3Li7, let's introduce a factor of correction. From the value $\omega = 0{,}653\text{x}10^{-19}$ for 3Li6 , from $\omega = 0{,}5187\text{x}10^{-19}$ (eq. 95) for 5B10, and from eq. 100, we have the correct magnetic moment induced by D-3:

D-3: –0,265x0,5187 / 0,653 = –0,21 [102]

Σ = –0,21 [103]

Magnetic moment of excited 5B10: μ = +0,857 -0,21= **+0,647** [104]

4.7- Excited 6C12

The excited isotope 6C12 has spin i=2 and magnetic moment zero. It's impossible to conciliate those two nuclear properties by considering the principles of the Standard Nuclear Physics. The explanation for those seemingly impossible nuclear properties of the excited 6C12, according to the present new nuclear model, is given in the sequence of the figures 26, 27, 28, and 29.

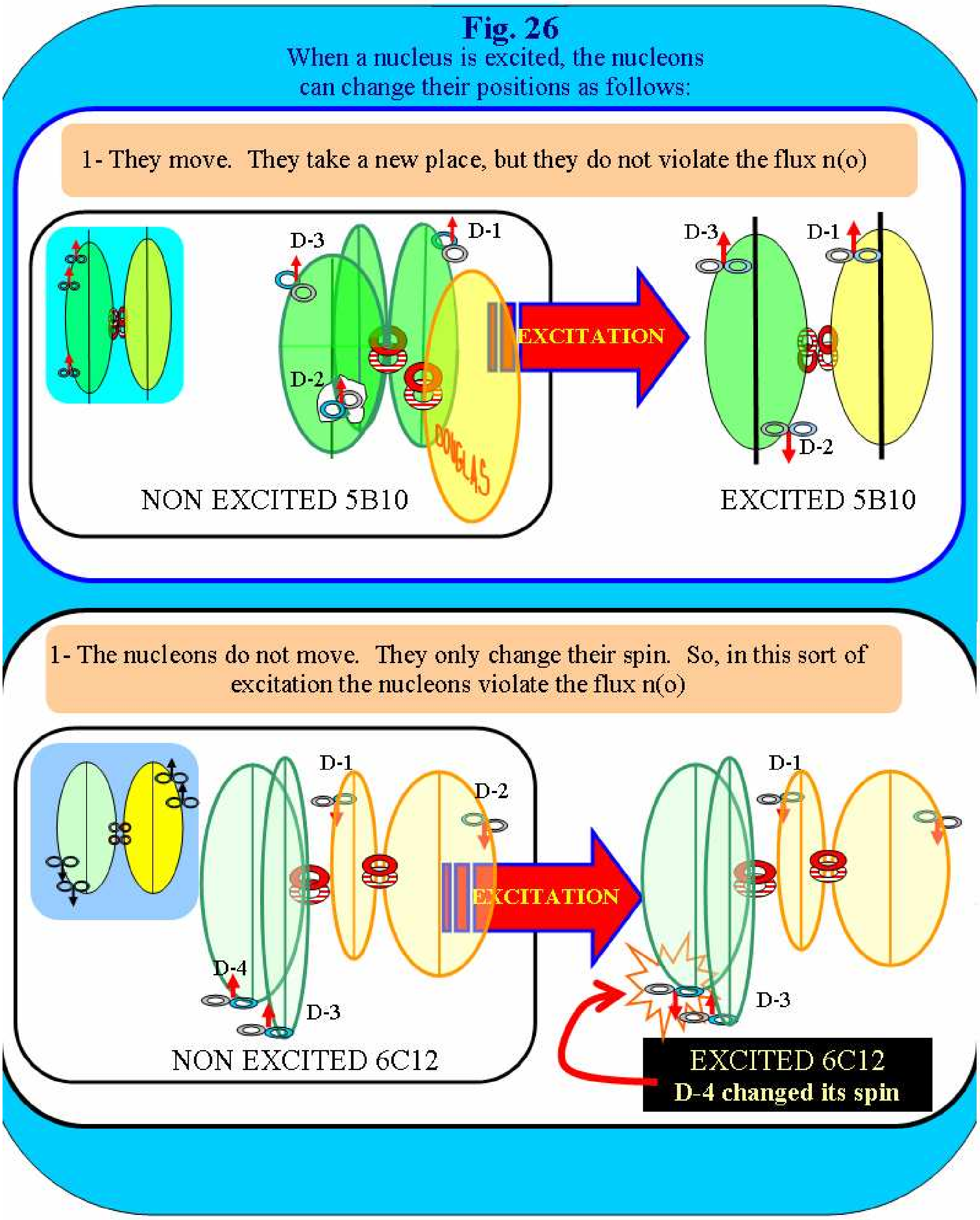
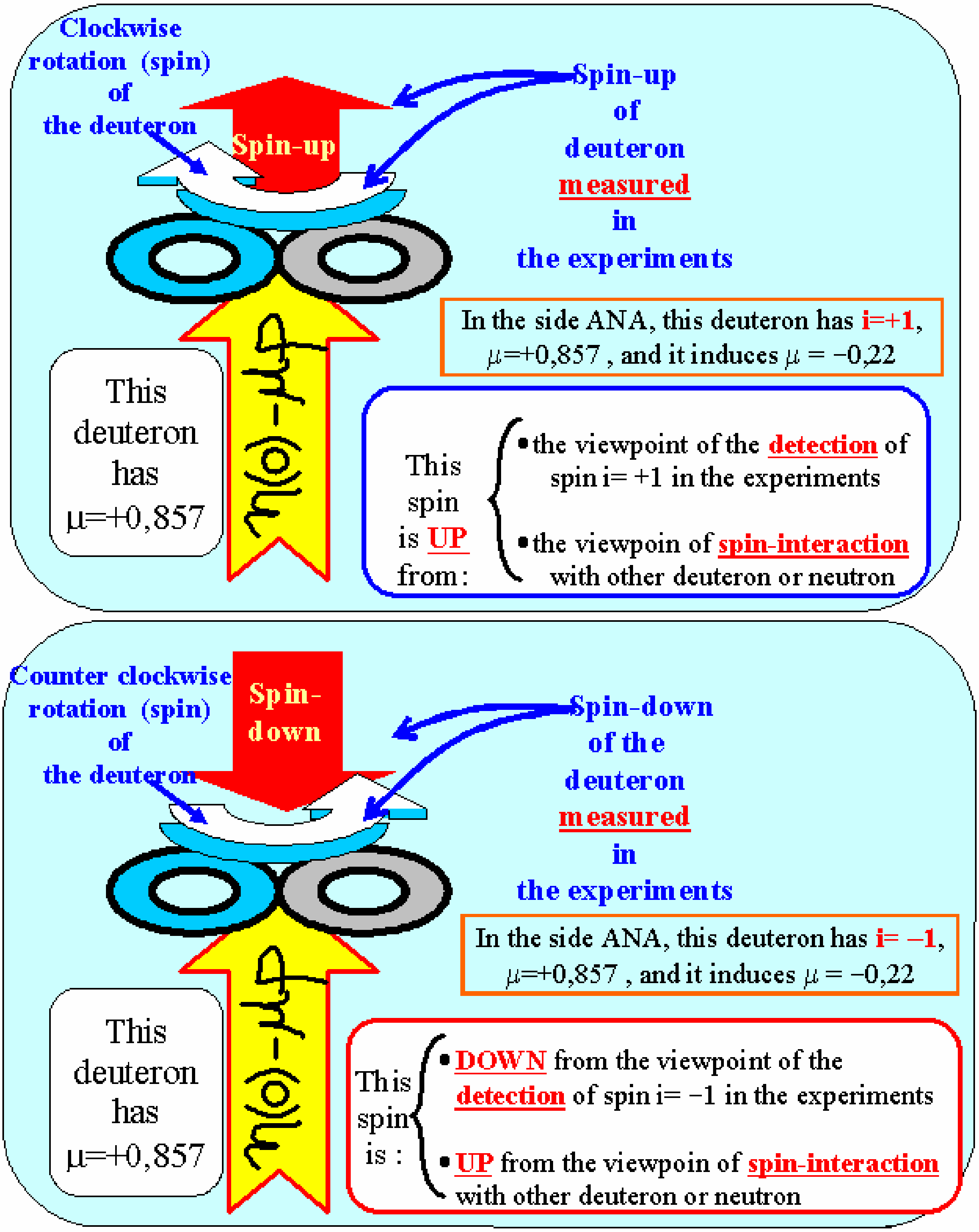


Fig. 26
When a nucleus is excited, the nucleons
can change their positions as follows:
1- They move. They take a new place, but they do not violate the flux n(o)
D-3
D-1
D-2
EXCITATION
D-3
D-1
D-2
NON EXCITED 5B10
EXCITED 5B10
1- The nucleons do not move. They only change their spin. So, in this sort of excitation the nucleons violate the flux n(o)
D-1
D-2
EXCITATION
D-4
D-3
D-1
D-3
NON EXCITED 6C12
EXCITED 6C12
D-4 changed its spin

Fig. 27
What happens when the deuteron captured by the flux n(o)–up changes its spin



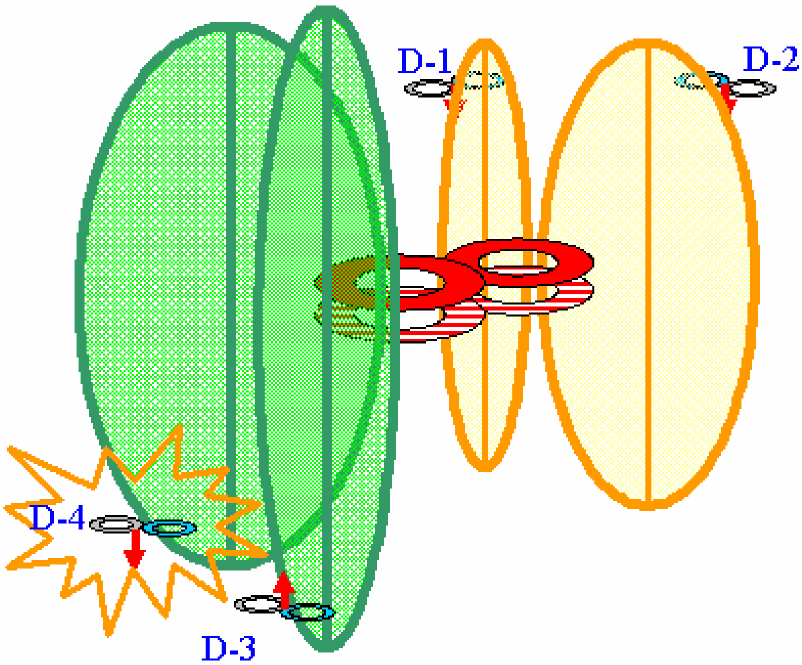


Fig. 28

Excited 12C

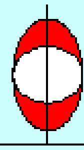
45 fs

Ex = 4438

i = 2

$\mu = 0$

Q(b)= +0,06



The deuteron D-4 of the STABLE 6C12 changes its spin from up to down. So, D-4 is violating the flux n(o)-up of ANA, and the consequences are the following (see Fig. 27):

1. In the stable 6C12 the deuteron D-4 was inducing a magnetic field $\mu = -0{,}22$.
2. In the excited 6C12 D-4 continues to induce $\mu = -0{,}22$, because the sign of the induced μ depends on the relation between the flux n(o)-up of Ana and the rotation (spin) of the deuteron D-4. The deuteron D-4 changed the rotation, however the flux n(o) is entering within D-4 from the wrong side (see Fig. 3).
3. From the viewpoint of detection of the spin in the **experiments** , D-4 in the excited 6C12 has spin **down**.
4. But from the viewpoint of the **interaction** with the deuteron D-3, the deuteron D−4 in the excited 6C12 has spin-**UP** , as consequence of the item 2 above.
5. Therefore the strong spin-interaction between D-4 and D-3 continues the same in the excited 6C12, in spite of D-4 changed its spin from up to down.
6. D-4 has $\mu = +0{,}857$ and it induces $\mu = -0{,}22$, as consequence of the item 2 above.

Therefore we have:

Mag. mom. of nucleons: $\mu = 0$

Mag mom induced by nucleons:

D-2 and D-4 cancel each other, and D-1 and D-3 cancel each other.

Mag mom of excited 6C12 (Ex= 4438): $\mu = 0$

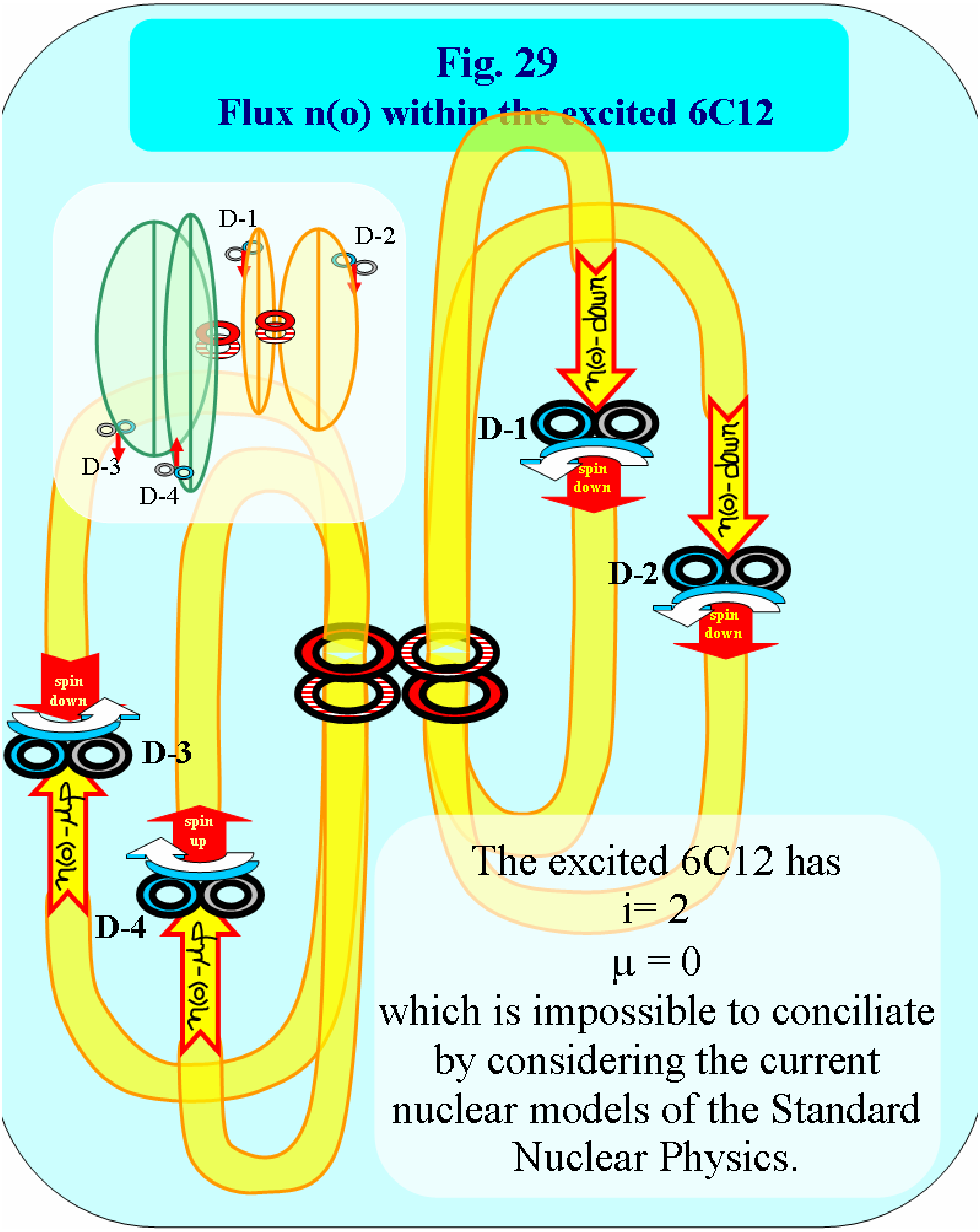
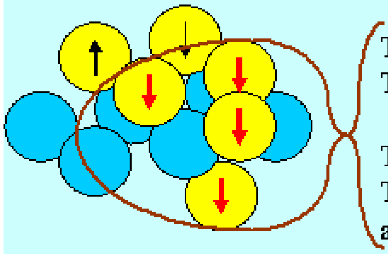


Fig. 29
Flux n(o) within the excited 6C12

Note: In the Chapter 11 of the book Models of the Atomic Nucleus[10] it's stated in the page 231:

"This chapter shows how the lattice model can explain most of the important, low-energy experimental data relevant to nuclear structure."

However, the lattice model (and any nuclear model based on the classical principles of the Standard Nuclear Physics) cannot explain even simple questions, as the nuclear properties of the excited 6C12, explained in the Part One of this series of papers. The structure of the excited 6C12 according to the lattice model is analysed in the Fig. 29-A



Total spin of protons: i= 0
Total spin of neutrons: i= 2

Total magnetic moment of protons: $\mu = 0$
Total magnetic moment of neutrons according to Lattice model: $\mu = -4x1{,}913 = -7{,}652$

$\boxed{\text{Experimental: } \mu = 0}$

Actually it's **impossible**, from **any nuclear** model working with the classical principles of current Standard Nuclear Physics, to explain the experimental μ= 0 of the excited 6C12, because it's **impossible** (from any combination of the values μ= +2,793 of a proton and μ=−1,913 of a neutron) to get μ= 0 and i= 2.

Therefore, from the principles of the Classical Nuclear Physics, it's **impossible** to explain the experimental μ= 0 of the excited 6C12.

Fig. 29-A

Structure of the excited 6C12 according to the Lattice Model

(Fig. 11-18 at the page 248 of the Cooks book[2])

4.8- Table 1 with induced magnetic moments by neutrons and deuterons

With the objective to simplify the calculations by the method of induced magnetic moments by nucleons, we will use the Table 1.

From eq. 26 and 27:	**μ**
External neutron in **3Li7** (R= 2,391):	**0,526**
Internal deuteron in **3Li7** (R= 0,405):	**0,040**
Internal deuteron in **3Li6** (R= 0,355):	**0,035**
3Li7:	
Internal neutron: 0,04x1,913/0,857 =	**0,090**
External deuteron: 0,492x0,857/1,913 =	**0,236**

Fig. 30

Values cannot be used in calculations using Mfe= 4,2

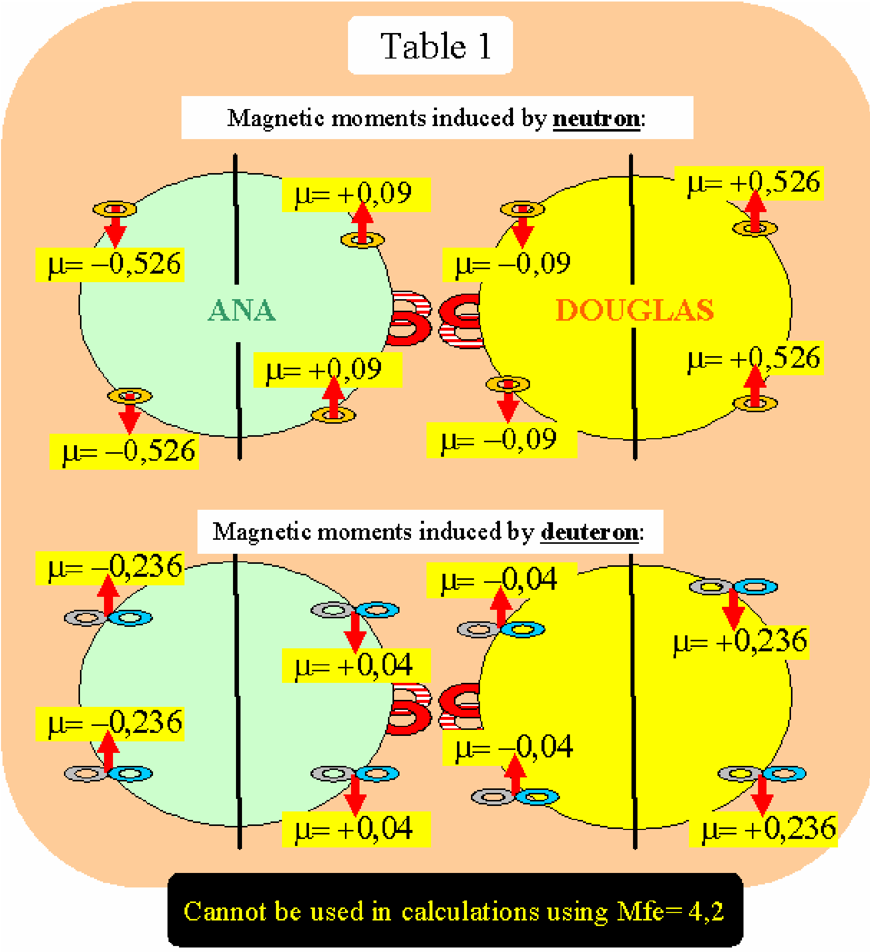


Fig. 31

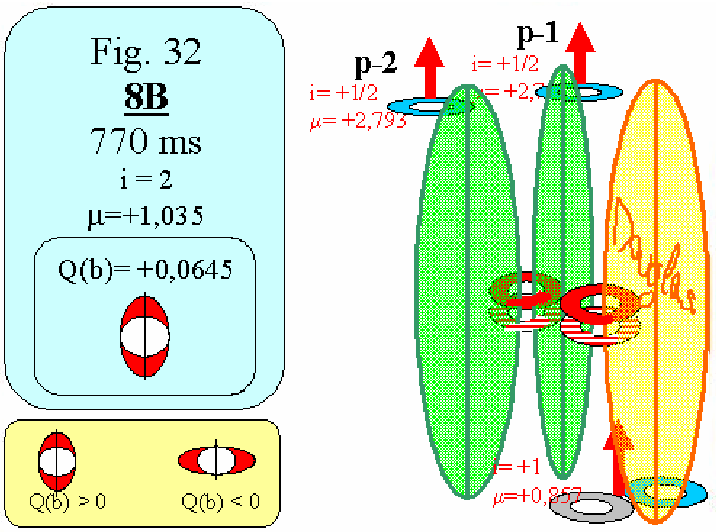
4.8- Isotope 5B8 and its External Multiplication Factor Mfe

The structure shown in the Fig. 32 is corroborated by the electric quadrupole moment Q(b)= +0,0645 measured by the experiments, because:

a) The three charges are distributed along the vertical.

b) There is a weak shake along the x-axis, because the mass 2m of the deuteron is inner, and the masses m+m = 2m in the side Ana are outer.

c) so, prevails the positive contribution of the masses distributed in the vertical



4.8.1- Method of equilibrium between nucleons

We don't know the distance between the two protons in the side Ana. But as they have the same charge and the same mass, it is reasonable to hope they form an equilateral triangle with sides R , as shown in the blue triangle of the Fig. 33.

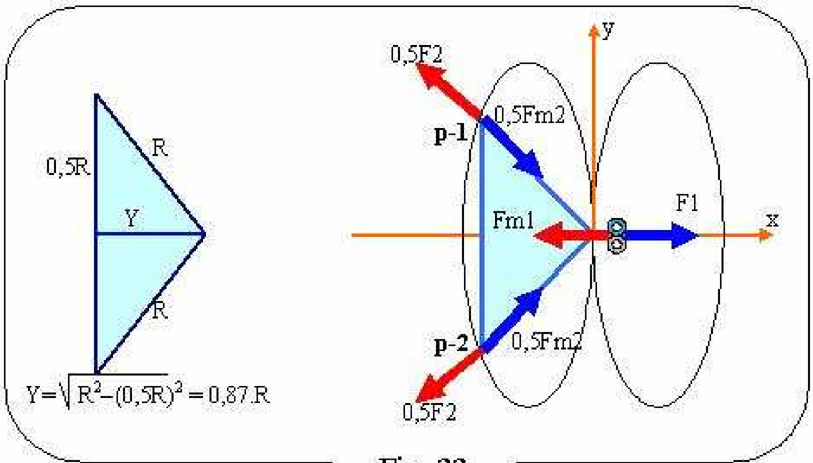


Fig. 33

The component of forces along the x-axis for the protons is the leg= Y= 0,87.R over the hypotenuse:

R: 0,87.R/R = 0,87 [105]

Protons : m= 1,007u , q= $1,6x10^{-19}$

r= 2,391 (neutron`s orbit in 3Li7)

Deuteron: q= $1,6x10^{-19}$, m= 2,014u

r= 0,355 (orbit radius of deuteron in 3Li6)

Centripetal force on deuteron:

$F1= m.\omega^2.R = 2,014.\omega^2 x0,355 = \quad 0,715.\omega^2$ [106]

Centripetal force on the two protons along x-axis:

$F2= 0,87x2.m.\omega^2.R = 0,87x2x2,014.\omega^2.2,391 = \quad 8,38.\omega^2$ [107]

Magnetic force on the deuteron:

$Fm1 = 1,6x10^{-19}.\omega.R.\mu = 1,6x10^{-19}.\omega.0,355.\mu = \quad 0,568.\omega.\mu$ [108]

Magnetic force on the two protons along x-axis:

$Fm2 =0,87x2x1,6x10^{-19}.\omega..R.\mu =0,87x2x1,6x10^{-19}.\omega.2,391.\mu = 6,657x10^{-19}.\omega.\mu$ [109]

The equation of equilibrium is:

F1 + Fm2 = F2 + Fm1 [110]

and we have:

$0,715.\omega^2 +6,657x10^{-19}.\omega.\mu = 8,38.\omega^2 +0,568.\omega.\mu$ [111]

$\mu = (0,715 -8,38).\omega/(0,568 -6,657)$ [112]

By using K= 3, $\omega= 0,653x(822/653)^{(3-1)/2}x10^{-19} = 0,822xx10^{-19}$ [113]

we have:

Magnetic moment of 5B8: μ **= +1,035** [114]

4.8.2- Calculation of the External Multiplication factor Mfe from the 5B8

As there is a growth of the induced magnetic moments when all nucleons have parallel spins, we need to calculate the External Multiplication Factor Mfe , and we will use the isotope 5B8.

But we cannot use the well-known formula $R= 1,25.A^{1/3}$, because the radius of the isotope 5B8 is actually shorter than the radius of the isotope 3Li7 (from which we have obtained the value μ= 0,526 for the induced magnetic moment of external neutron in 3Li7). The orbit radius in 5B8 is shorter because it has two protons interacting via strong spin-interaction, which causes shrinkage in the radius of the nucleus (we mean the shrinkage in 5B8 radius orbit regarding the radius of 3Li7).

However we do not know the radius of the isotope 5B8. So, some theoretical difficulties arise. For instance, we cannot get a good estimation for the value of the induced magnetic moment by the proton in 5B8 from the equation μ_P=0,526x2,793/1,913, since we don't know if we can apply for 5B8 the value 0,526 of the neutron's induced magnetic moment in 3Li7, because the orbit radius of 5B8 is different of that of 3Li7.

We had solved this problem by using the isotope 6C13 as a calipers, as follows:

We choose an arbitrary value for the μ of an hypothetical neutron in the 5B8 (such neutron does no exist in 5B8, but we use it as a starting point, from a comparison with the neutron of 3Li7, which is actually the initial starting point of the whole calculus. For instance, suppose we choose μ= 0,47 as the μ of the hypothetical neutron in 5B8 as the starting point. Then we follow the following steps:

Step 1- Based on the radius R= 2,391 from where we got the neutron's induced magnetic moment μ_N = 0,526 in the isotope 3Li7, we calculate the μ for the proton and deuteron in 5B8

Step 2- With the values obtained in step 1, we calculate the Mfe for 5B8 (we show how to do it in the Fig. 35).

Step 3-The value of Mfe obtained in step 2 for 5B8 we apply to the calculation of the μ of the isotope 6C13. Its experimental value is μ=0,7024.

Step 4- By starting from the chosen μ_N = 0,47 , we get for 6C13 the value μ=0,7095 , and therefore we need to try again with another initial value (for instance μ_N=0,475), in order that, after many attempts, we reach the experimental value μ=0,7024 of 6C13.

Fig. 34

It was used the Excel for finding the value of Multiplication Factor Mfe, starting from from the isotope 5B8,
in order that, by applying the results of Mfe on the isotope 6C13,
we finally reach its μ = 0,7024 measured in the experiments

The values obtained from such calculation in the Excel are:

- μ of external neutron in 5B8 (only as starting point) = 0,429
- radius of 5B8= 1,95
- External Multiplication Factor Mfe = 4,2

μ of hypothetical external neutron in 5B8 (to get μ external proton) =	0,42925	[1]	
μ of external proton in 5B8= [1] x 2,793 / 1,913 =	**0,626709**	[2]	
μ of external deuteron in 5B8 = [1] x 0,857 / 1,913 =	**0,192299**	[3]	
μ of internal deuteron in 5B8 = 0,04 x [7] / 2,391 =	**0,032643**	[4]	(0,04=> see Table 1)
radius of 5B8 = ((2,391 x [1]) / 0,526) =	**1,951211**	[7]	(2,391 is 3Li7radius)

see Fig. 35

induced μ of 2 outer protons +1 inner deuteron in 5B8 , μ=	1,286062	[5]	
Multiplication factor Mf in 5B8 = 5,408 / [5] =	**4,205086**	[6]	
μ of external neutron in 6C13 = [1] x 2,94 / [7] =	0,646775	[8]	(2,94= 6C13 radius)
μ of external deuteron in 6C13 = [3] x 2,94 / [7] =	0,289747	[9]	

see Fig. 36

Calculus of μ in 6C13:

D-3, D-4 : -([6] x 2 x [9]) =	-2,43682	[10]
D-1, D-2 : +2 x [9] =	0,579495	[11]
n : [8]	0,646775	[12]
μ of 6C13 = 1,913 + ([10] + [11] + [12]) =	0,702445	
μ of 6C13 measured in the experiments =	0,7024	

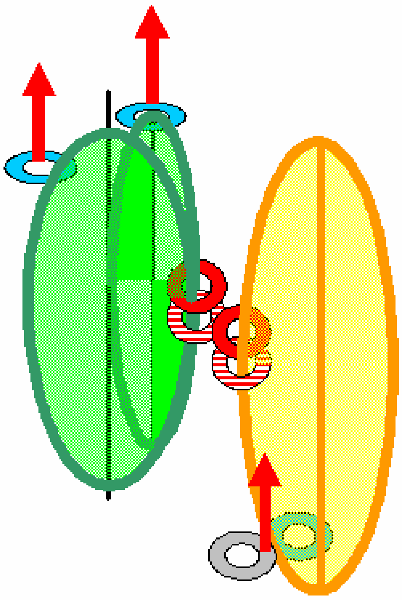


Fig. 35

8B

770 ms

i = 2

μ=+1,035

The two protons are in the side ANA and the deuteron in the side DOUGLAS

- 2 protons: 2x2,793= 5,586
- 1 deuteron: 0,857

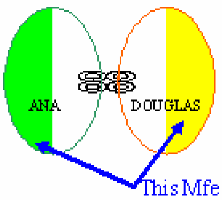
Total : **6,443**

$\Delta = 1{,}035 - 6{,}443 = -5{,}408$

- Radius of 5B8: 1,951 (obtained in Fig. 34, by using Excel)
- μ_N of hyphotetical neutron in 5B8: $\mu_N = 0{,}429$
- μ_D of internal deuteron in 5B8: $\mu_D = 0{,}0326$
- μ_P of external proton in 5B8: $\mu_P = 0{,}429\text{x}2{,}793/1{,}913 = 0{,}626$

Mag mom induced by 2 external protons and one internal deuteron:

$$\mu = -(2 \text{ x } 0{,}626 + 0{,}0326) = 1{,}2846$$



The **external multiplication factor** is:

Mf_E = 5,408 / 1,2846

Mfe = 4,2

This Mfe factor is applied for nucleons situated in **outer** sides of Ana and Douglas

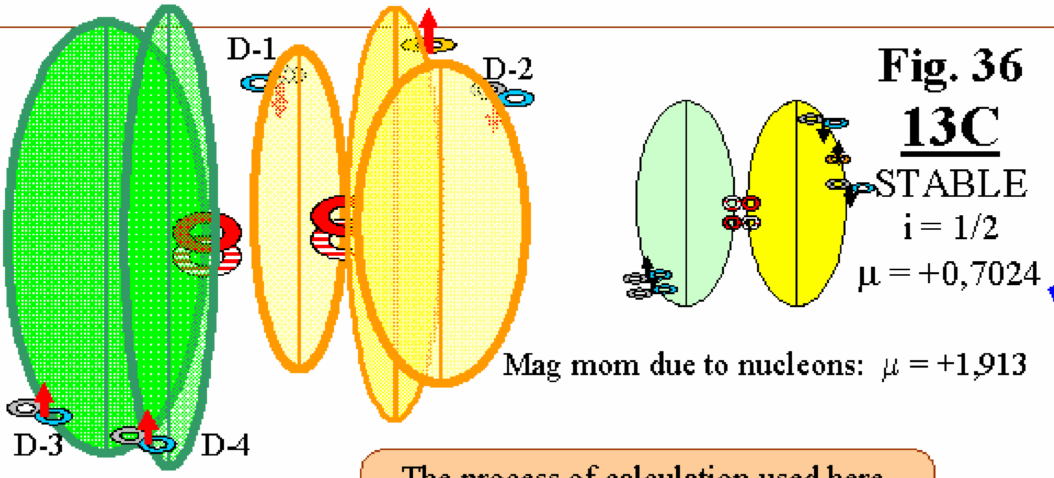
The calculus has been run in the Excel (see Fig. 34) and the initial value from which we get μ=0,7024 for 6C13 is μ_N=0,4688, which would be the induced magnetic moment of a hypothetical neutron in 5B8. From the value 0,4688 we finally can get the induced magnetic moment of a proton in the 5B8, with good accuracy.
Very important: Mfe= 4,2 has been obtained from the 5B8, and Mfi= 12,905 from 3Li8. Then when they are used together the values for Mfe ought to be those of the Fig. 34 (as μ=0,429 of external neutron, μ=0,192 of external deuteron, etc), while Mfi have to be calculated with the values of the Table 1 (respecivelly μ=0,526 and μ=0,236 for the inners neutron and deuteron).

In the Fig. 36 the Mfe = 4,2 is not applied to the deuterons D-1 and D-2 because the neutron with contrary spin breaks up the multiplication factor phenomenon, which occurs only in the side Ana, with D-3 and D-4.

6C13 was chosen as calipers because:

- Its side Douglas is non-empty
- The neutron in the side Douglas breaks up the multiplication factor phenomenon in that side

Therefore Mfe= 4,2 must be applied on D-3, D-4, and no any other sort of Mf must be applied on D-1 and D-2.



The process of calculation used here is the same used in the calculation via Excel, shown in Fig. 34

Correction due to the growth of the obits from 5B8 to 6C12:

- Radius of 5B8 (from where was obtained Mfe = 4,2): R = 1,95
- Radius of 6C13: $R = 1{,}25 x 13^{1/3} =$ 2,94
- 2,94/1,95 = 1,51

The hypothetical neutron in 5B8 has μ= 0,42925
μ of external deuteron in 5B8 μ= 0,192299

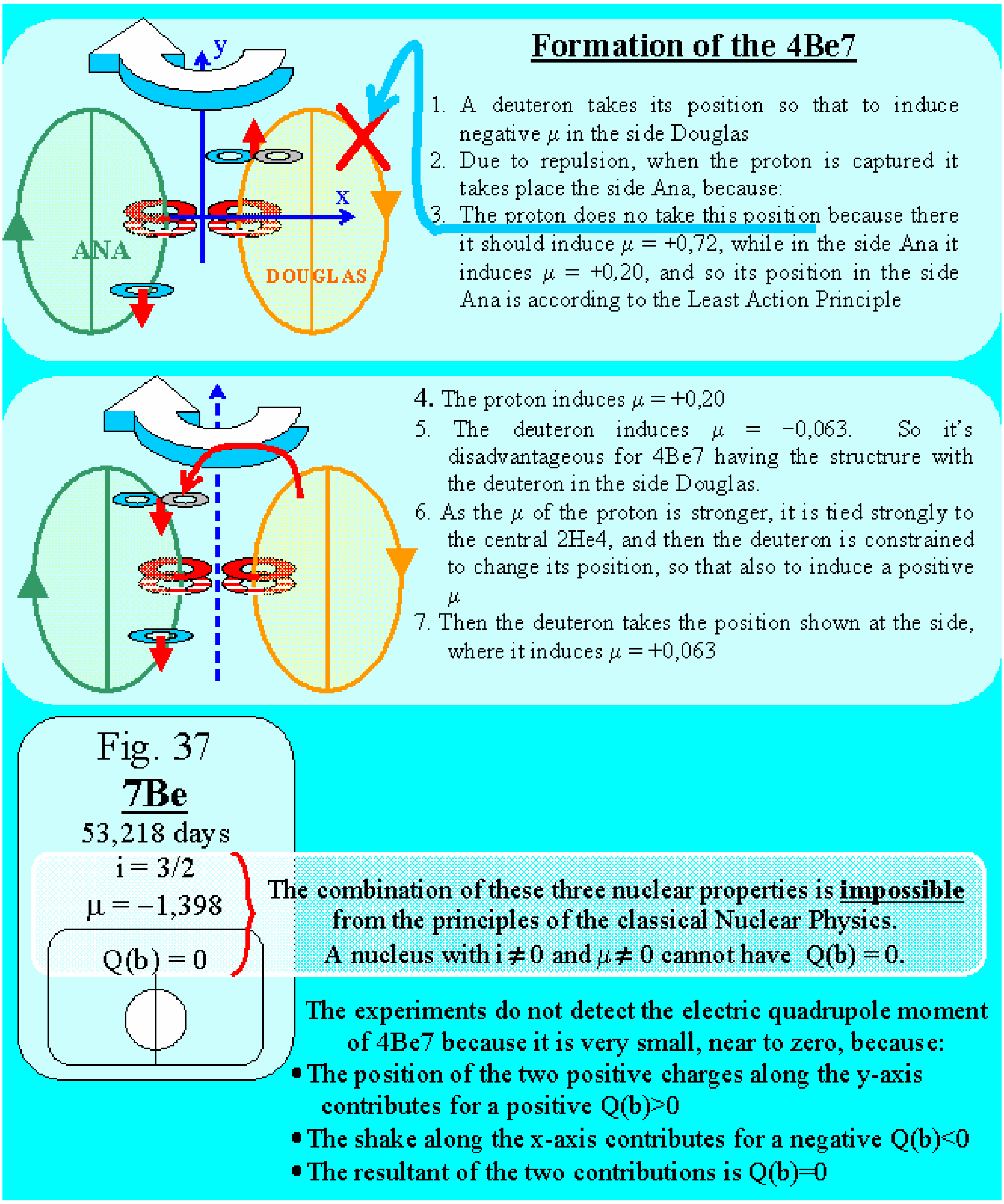
- μ of external neutron in 6C13: μ = 0,42925x1,51 = 0,646775
- μ of external deuteron in 6C13: μ = 0,192299x2,94/1,951= 0,289747

D-3, D-4:	−4,2x2x0,289747=	−2,43682
D-1, D-2:	+2x0,2893=	+0,579495
n:		+0,646775
	Σ=	−1,21055

μ of 6C13 = +1,913 −1,21055= +0,70245

4.9- Isotope 4Be7

The structure of 4Be7 shown in Fig. 30 is corroborated by the null electric quadrupole moment detected by experiments, Q(b)= 0. The distribution of the two charges $1{,}6x10^{-19}$C along a vertical straight line contributes for a positive Q(b). Unlike, the nucleus spin about its rotation axis yields a shake and cause an eccentricity on the charge distribution along the x-axis, due to the unbalance of masses, which contribution for Q(b) is negative. If the distance "h" between the deuteron and the proton in the vertical is equal to the length "d" of the displacement along the x-axis due to shake produced by the unbalance of masses, then the distribution of charges perform a vertical square cross section, resulting in a null electric quadrupole moment, Q(b)=0.
From the principles of the Standard Nuclear Theory it's impossible for a nucleus with non null magnetic moment and non null spin to have Q(b)= 0.



A) **Method of equilibrium between nucleons**

Centripetal force on the proton:

$F1 = m.\omega^2.R = 1{,}007.\omega^2.R$ [115]

Centripetal force on the deuteron:

$F2 = = m.\omega^2.R = \quad 2{,}014.\omega^2.R$ [116]

Magnetic force on the deuteron:

$Fm1 = 1,6x10^{-19}.\omega.\ R.\mu$ [117]

Magnetic force on the proton:
$Fm2 = 1,6x10^{-19}.\omega.R.\mu$ [118]

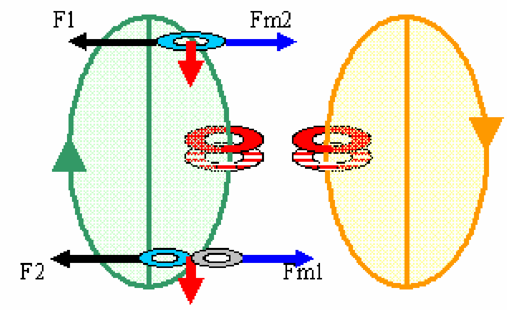


Fig. 38

The Lagrangian of equilibrium is:
$F1 + F2 = Fm1 + Fm2$ [119]
we have:
$1,007.\omega^2.R + 2,014.\omega^2.R = 1,6x10^{-19}.\omega.\ R.\mu + 1,6x10^{-19}.\omega.R.\mu$ [120]

$3,021.\omega = 3,2x10^{-19}.\mu$ [121]

$\mu = 3,021.\omega / 3,2x10^{-19}$ [122]

Using K=8, $\omega(8) = 0,653x(822/653)^{(8-1)/2}\ x10^{-19} = 1,461\ x10^{-19}$ [123]
we get:
Magnetic moment of 4Be7: μ= **1,38** [124]

It's of interest to note that 4Be7 has half-life of 53 days, although it has an excess proton in its structure. While the 4Be8 has no excess proton in its structure, but its half-life is a fraction of seconds. The reason, as we already have seen, is because 4Be8 has null nuclear magnetic moment. The proton and the deuteron in 4Be7 get spin-interaction with parallel spins, because Pauli's Principle allow it since they are different particles, but the two deuterons in 4Be8 cannot interact with parallel spins because his principle does not allow, and so they cannot interact via strong spin-interaction. As the two deuterons in 4Be8 also cannot get equilibrium via magnetic force, because 4Be8 has μ =0 , then it decays.

B) **Calculation of magnetic moment by the method of induced magnetic moments**

- Magnetic moments due to nucleons:

$\mu = -0,857 - 2,793 = -3,65$ [125]

- Magnetic moments induced by nucleons:

A neutron with μ = +1,913 in that position of the proton induces μ= +0,090 (Table 1)..
Then a proton with μ= –2,793 would induce the following magnetic moment:
μ= +0,090x2,793/1,913 = +0,131 [126]

Induced magnetic moment by inner deuteron in 3Li6: μ= +0,035 [127] (Table 1)

As the proton and the deuteron move in different orbits (and therefore no one of them move in the "shadow" of the other), the power of 4Be7 to induce magnetic moments has to be stronger than that of 5B8.

5B8:

Consider that in 5B8 the protons p-1 and p-2 have the following contribution (because p-2 moves in the "shadow" of the p-1 orbit):

p-1 : $\Delta\mu = (822/653)^{2/3} = 1{,}1658$ [128]

p-2 : $\Delta\mu = (822/653)^{1/3} = 1{,}0797$ [129]

4Be7:

Then in 4Be7 the contribution will be the same for deuteron and proton, since no one of them moves in the shadow of the other. The we have:

D: $\Delta\mu = (822/653)^{2/3} = 1{,}1658$ [130]

p: $\Delta\mu = (822/653)^{2/3} = 1{,}1658$ [131]

The power to induce magnetic moments in 4Be7 is:

$(1{,}1658)^2 / 1{,}1658 \times 1{,}0797) = 1{,}0797$ times stronger than in 5B8 [132]

Therefore we have to use for 4Be7:

Mfi= 12,905x1,0797= 13,93 [133]

From eq. 126, 127, and 133, we get the magnetic moment induced by the deuteron and the proton:

$\mu = +13{,}93\times(0{,}131 + 0{,}035) = +2{,}312$ [134]

From eq. 125 and 134, we get:

$\mu = -3{,}65 + 2{,}312$ [135]

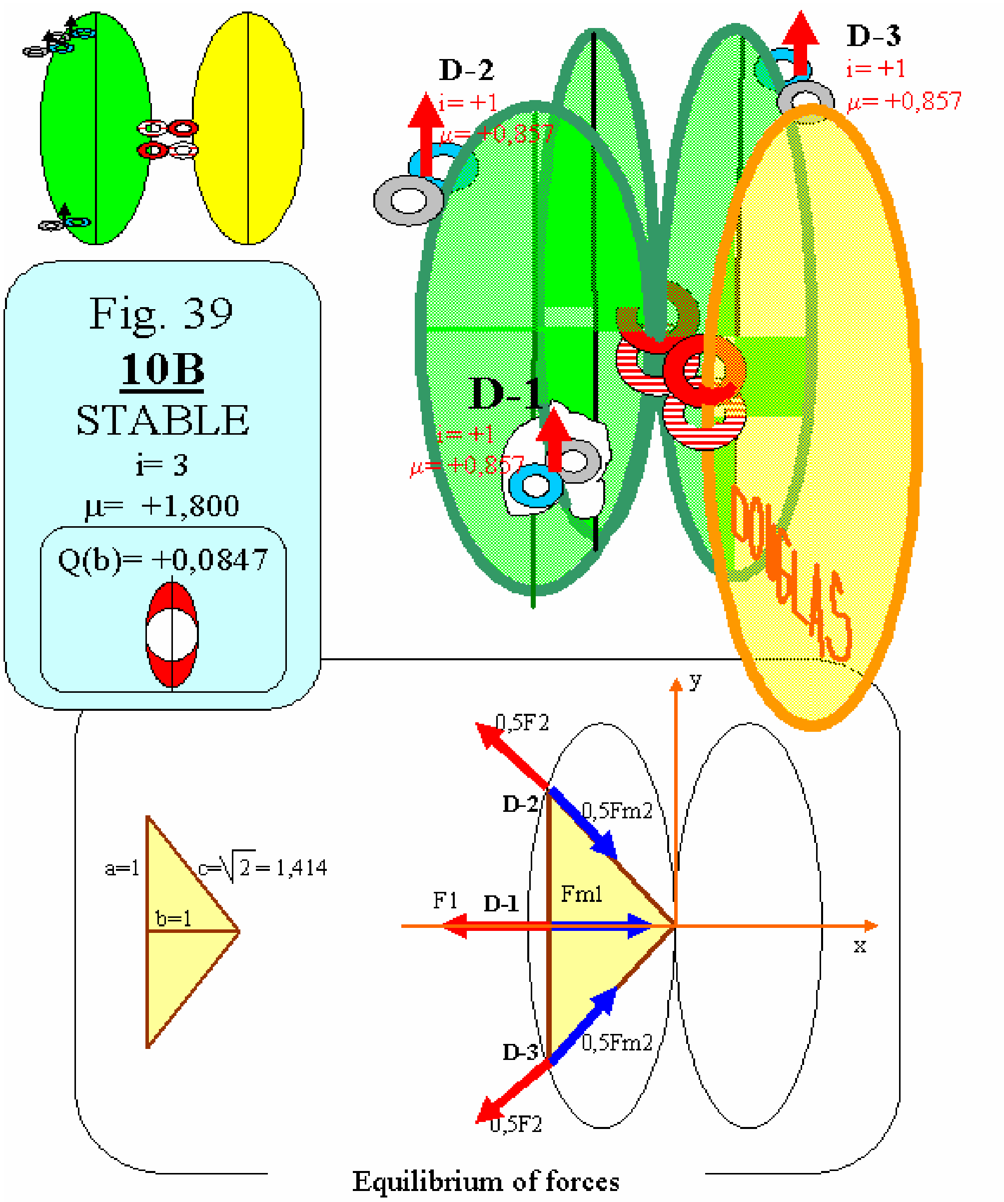
Magnetic moment of 4Be7: $\mu =$ **−1,338** [136]

4.10- Isotopes 5B10 and 7N14

4.10.1- Isotope 5B10

The structure shown in the Fig. 39 is corroborated by the electric quadrupole moment Q(b)= +0,0847 measured by the experiments, because the three deuterons occupy only the side Ana, and it has a high Q(b) because the three charges are distributed in the vertices of a pyramidal volume with height "h", which cross-section (the yellow triangle in Fig. 39) has shorter sides a = b << h.

But the unbalance of masses is also high, because the side Douglas is empty, and the nucleus has a strong shake along the x-axis. If it should not have the shake its Q(b) would be very greater than +0,0847.



A) **Method of equilibrium between nucleons**

We don't know the distance between the three deuterons. But as they have the same charge and the same mass, it is reasonable to hope they form an isosceles triangle with two sides c=1,414, composed by two triangle rectangle each one with legs a=1 and b=1, as shown in the Fig. 39.

Deuteron: q= $1{,}6\times10^{-19}$, m= 2,014u
D-1, D-2, D-3, all they have orbit radius r= R
B= μ = ?

The component of forces along the x-axis for the deuterons D-2 and D-3 is the leg=1 over the hypotenuse=1,414:
1 / 1,414 = 0,707 [137]

Centripetal force on D-1:

$F1 = m.\omega^2.R = 2{,}014.\omega^2.R$ [138]

Centripetal force on D-2 and D-3 along x-axis:
$F2 = 0{,}707x2.m.\omega^2.R = 0{,}707x2x2{,}014.\omega^2.R = 2{,}848.\omega^2.R$ [139]

Magnetic force on D-1:
$Fm1 = 1{,}6x10^{-19}.\omega.R.\mu$ [140]

Magnetic force on D-2, D-3 along x-axis:
$Fm2 = 0{,}707x2x1{,}6x10^{-19}.\omega.R.\mu = 2{,}262x10^{-19}.\omega.R.\mu$ [141]

The equation of equilibrium is:
$F1 + F2 = Fm2 + Fm1$ [142]
and we have:

$2{,}014.\omega^2.R + 2{,}848.\omega^2.R = 2{,}262x10^{-19}.\omega.R.\mu + 1{,}6x10^{-19}.\omega.R.\mu$ [143]

$\mu = (2{,}014 + 2{,}848).\omega / (2{,}262 + 1{,}6)$ [144]

The isotope 4Be7 has one proton and one deuteron with parallel spins in the inner side of Ana, and the side Douglas is empty, and we had used the factor K= 8 (eq. 123) in the calculation of its magnetic moment. We may hope to use the same factor K=8 for 5B10 because:
a) In both 4Be7 and 5B10 the side Douglas is empty
b) In 4Be7 nor the proton neither the deuteron moves in the "shadow" of the other. In 5B10 neither the deuterons (D-2,D-3) D-1 nor D-1 move in the "shadow" of the other.

So, using K=8 , $\omega(8) = 1{,}461x10^{-19}$ we get:
Magnetic moment of 5B10: μ = **+1,84** [145]

B) **Method of induced magnetic moments by nucleons:**

- Total magnetic moment due to 3 deuterons:

$\mu = +0{,}857x3 = +2{,}571$ [146]

- Magnetic moments induced by nucleons:

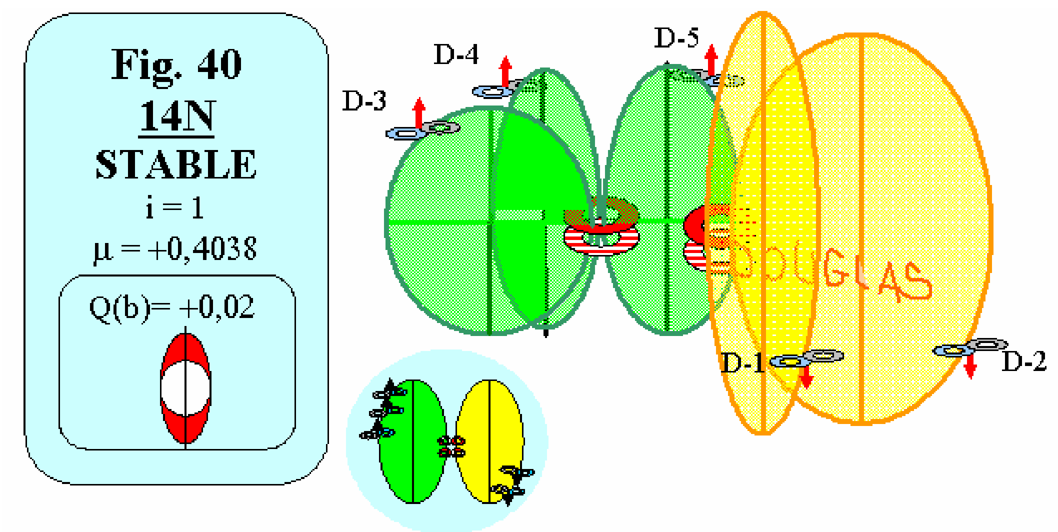
As there are three deuterons with parallel spins, there should be need to apply the reduction factor Mfe= 4,2 (Fig. 34). However, for 5B10 the Mfe= 4,2 cannot be applied, as explained ahead.

As the side Douglas is empty in 5B10 and it has three deuterons with strong spin-interaction in the side Ana, the shrinkage is so big that it cancels about 95% of the manifestation of the multiplication factor phenomenon. This occurs because the three deuterons in the side Ana have a vertical pyramidal shape, whose horizontal cross-section is a triangle. The strong spin-interaction between the three nucleons actuates the shrinkage of the triangular area. In the case of a triangular layout of deuterons the forces due to spin-interactions points out to the center of the triangle, causing a

shortening the orbit radii. Other isotope with empty Douglas is 4Be7. However the orbits of the proton and the deuteron in 4Be7 are aligned along a straight line (they do not form a geometrical figure with surface, subject to suffer shrinkage by the action of the spin-interaction, as the triangular are of the 5B10). Therefore, in 4Be7, although the side Douglas is empty, there is no shrinkage in the orbit radius, and the multiplication factor phenomenon occurs and is manifested. Unlike, as in 5B10 the three deuterons form a triangle, it is subjected to have strong shrinkage, and it is so big that it reduces drastically the effect of the multiplication factor. It occurs but manifests itself only minimally.
So, let's calculate the magnetic moment of 5B10 with considering no multiplication factor phenomenon.
The negative magnetic moment induced by each outer deuteron is: μ= –0,236 (see Table 1) And as there is shrinkage in the orbit radius, we will not consider the growth of the radius given by $R= 1{,}25xA^{1/3}$, regarding the radius R=2,391 of 3Li7.
The induced magnetic moment by the three deuterons is:

μ= –3x0,236 = –0,708 [147]
Therefore theoretical mag. mom. of 5B10 is: μ= +2,571 –0,708 [148]

Magnetic moment of 5B10: μ= +1,863 [149]



4.10.2- Isotope 7N14
The structure shown in Fig. 40 is corroborated by the Q(b)= +0,02 measured in the experiments. Although the unbalance of masses in 7N14 is lower compared with 5B10, however 7N14 has Q(b) lower than Q(b)= +0,0847 of 5B10. because in 7N14 the five deuterons form a vertical area with rectangular shape with large width (the diameter of the 7N14), while in 5B10 the vertical cross-section is shorter (the radius of the 5B10).

Fig. 41 points out an interesting evidence reinforcing the present nuclear model: the isotopes 5B10 and 5B9 have the same Q(b)= 1,800. As 5B10 and 5B9 compose respectively the sides Ana and Douglas of 7N14, they have to have the same Q(b), otherwise they could not meet together so that to compose the 7N14.

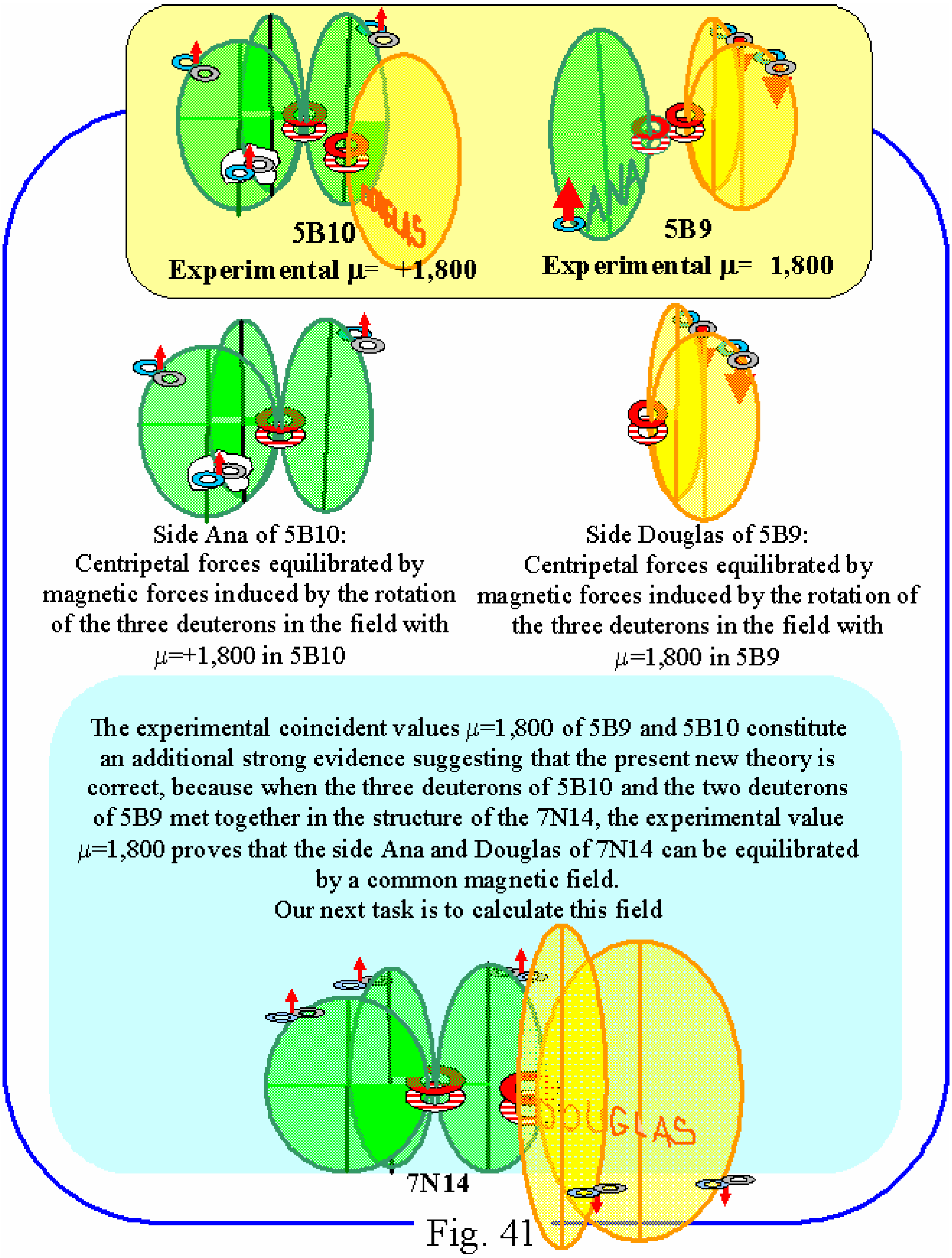


Fig. 41

A) **Method of equilibrium between nucleons**

The distance between the three deuterons in the side Ana have already been considered in the calculation of the magnetic moment of 5B10.

We don't know the distance between the two deuterons in the side Douglas. But as they have the same charge and the same mass, it is reasonable to hope they form an equilateral triangle with side R , as shown in the blue triangle of the Fig. 42.

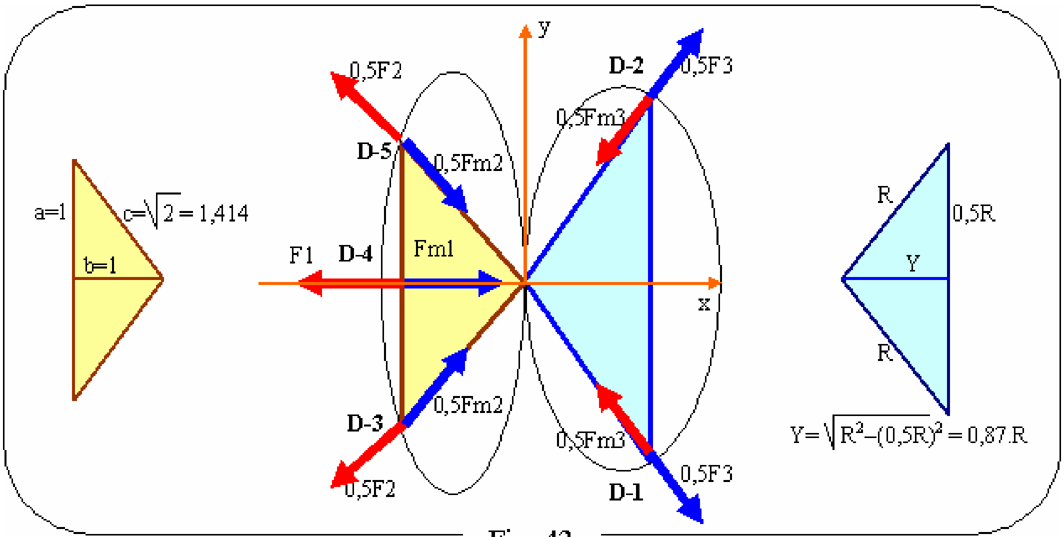


Fig. 42

<u>Side Ana</u>

For the calculation of the magnetic moment of 5B10 we had used the factor K= 8 , $\omega(8) = 1{,}461x10^{-19}$, and we will use it again for 7N14. But as the spin-interactions are different in the sides Ana and Douglas in 7N14, we have to take it in consideration, and we do it as follows:

- <u>Side Ana</u>: in the equations for Fm1 and Fm2 we use $\omega(A) = 1{,}461.\omega$ [150]
- <u>Side Douglas</u>: in the equations for Fm3 we use $\omega(D) = Z.\omega$ [151]

and the value of Z is calculated in the item B, (method of induced magnetic moments by nucleons).

We already had obtained the equations of the side Ana when we had done the calculation of the magnetic moment of 5B10. The equations are the following

Centripetal force on D-1:
$F1= m.\omega^2.R =$ $2{,}014.\omega^2.R$ [151.1]

Centripetal force on D-2 and D-3 along x-axis:
$F2= 0{,}707x2.m.\omega^2.R = 0{,}707x2x2{,}014.\omega^2.R =$ $2{,}848.\omega^2.R$ [151.2]

As $\omega(A) = 1{,}461.\omega$, we have:
Magnetic force on D-1
$Fm1 = 1{,}6x10^{-19}.\omega.1{,}461.R.\mu =$ $2{,}34x10^{-19}.\omega.R.\mu$ [152]

Magnetic force on D-2, D-3 along x-axis:
$Fm2 = 0{,}707x2x1{,}6x10^{-19}.\omega.1{,}461.R.\mu =$ $3{,}30x10^{-19}.\omega.R.\mu$ [153]

<u>Side Douglas</u>

We will consider the orbit radius in the side Douglas a little longer than in the side Ana, because of the shorter shrinkage of orbits in that side.
Let's consider r= 1,1R in the side Douglas.
The component of forces along the x-axis for the deuterons D-1 and D-2 is Y/R = 0,87 (Fig. 41).

Centripetal force on D-1 and D-2 along x-axis:

$F3= 0,87x2.m.\omega^2.1,1.R = 0,87x2x2,014.\omega^2.R = \quad 3,854.\omega^2.R$ [154]

As $\omega(D) = Z.\omega$, we have:
Magnetic force on D-1, D-2 along x-axis:
$Fm3 = 0,87x2x1,6x10^{-19}.Z.\omega.1,1.R.\mu = \quad 3,062x10^{-19}.Z.\omega.R.\mu$ [155]

<u>The two sides Ana & Douglas:</u>
The equilibrium of forces considering the both sides is:
$F1 +F2 +Fm3 = F3 +Fm1 +Fm2$ [156]

$2,014.\omega^2.R +2,848.\omega^2.R +3,062x10^{-19}.Z.\omega.R.\mu =$
$= 3,854.\omega^2.R +2,34x10^{-19}.\omega.R.\mu +3,3x10^{-19}.\omega.R.\mu$ [157]

$\mu = \ (2,014 +2,848 -3,854).\omega/ (2,34 +3,3 -3,062.Z)x10^{-19}$ [158]

For the side <u>Douglas</u> we will use a level K= 5:
$\omega(D)= \ \omega(5) = 0,653x(822/653)^{(5-1)/2} = \ 1,035$ [159]

The number Z represents the relation between the levels of the side Ana and Douglas, because from eq. 150 and 151 we have:

$\omega(A)/1,461 = \omega(D)/Z$ [159.1]

$Z= 1,461.\omega(D) / \omega(A)$ [159.2]

But $\omega(D) = \omega(A) / 1,257$ (see eq. 180) [159.3]

Then $Z = 1,461 / 1,257 = 1,1623$ [159.4]

Putting the value of Z in eq. 158 we have:
$\mu = \ (2,014 +2,848 -3,854).\omega/ (2,34 +3,3 -3,56)x10^{-19}$ [160]

$\mu = \ 1,008.\omega/ 2,08x10^{-19}$ [161]

In eq. 161 , ω is the common factor for both sides of 7N14:
$\omega= \omega(7N14) = \ \omega(A)/1,461 = \ \omega(D)/1,1623$ [162]
As $\omega(D)= \ 1,035$ (eq. 159) [162.1]
then we get $\omega(7N14)$:
$\omega(7N14)= \ \omega(D)/1,1623 = 1,035/1,1623 = 0,89x10^{-19}$. [162.2]

From eq. 161 and 162.2 we get μ :
$\mu = \ 1,008x0,89/ 2,08x10^{-19} \ = 0,43$ [162.3]

Magnetic moment of 7N14: $\mu = 0,431$ [162.4]

B) **Method of induced magnetic moments by nucleons**

With 7N14 there is an appreciable growth in the number A=14, regarding to the value A=8 of the isotope 5B8 (from where was obtained Mfe = 4,2), and there is need to introduce a correction in the radius of the orbit by the equation $R=1,25xA^{1/3}$.
Correction due to the growth of the obits from 5B8 to 7N14:

- Radius of 5B8: $R = 1,25x8^{1/3}$ = 2,5 [163]
- Radius of 7N14: $R = 1,25x14^{1/3}$ = 3,01 [164]
- 3,01 /2,5 = 1,204 [165]

As we will use Mfe= 4,2 obtained from 5B8, we have to use the external magnetic moment of deuteron in 5B8, μ= 0,1923 (calculated in the Fig. 34), and not μ= 0,236 of the Table 1, obtained from 3Li7.
μ of external deuteron in 7N14: μ = 0,1923x1,204 = 0,2315 [166]

- Magnetic moments due to nucleons:

μ = +0,857 [167]

- Magnetic moments induced by nucleons:

Considering the 5B9 as reference of levels, and dividing ω by 10^{-19} , we have:

$\omega(1) = 0,653$	5B9 (see eq. 194)	[168]
$\omega(2) = 0,653x1,121$		[169]
$\omega(3) = 0,653x1,121^2$	5B8 (calculated Mfe=4,2)	[170]
$\omega(4) = 0,653x1,121^3$		[171]
$\omega(5) = 0,653x1,121^4$	side Douglas of 7N14	[172]
$\omega(6) = 0,653x1,121^5$		[173]
$\omega(7) = 0,653x1,121^6$		[174]
$\omega(8) = 0,653x1,121^7$	side Ana of 7N14	[175]
$\omega(8) = 0,653x1,121^7$	5B10	[176]

The relations between levels by considering 5B8 as reference are the following;

- Side Douglas of 7N14 is $1,121^2$ times higher than 5B8 [177[
- Side Ana of 7N14 is $1,121^5$ times higher than 5B8 [178]

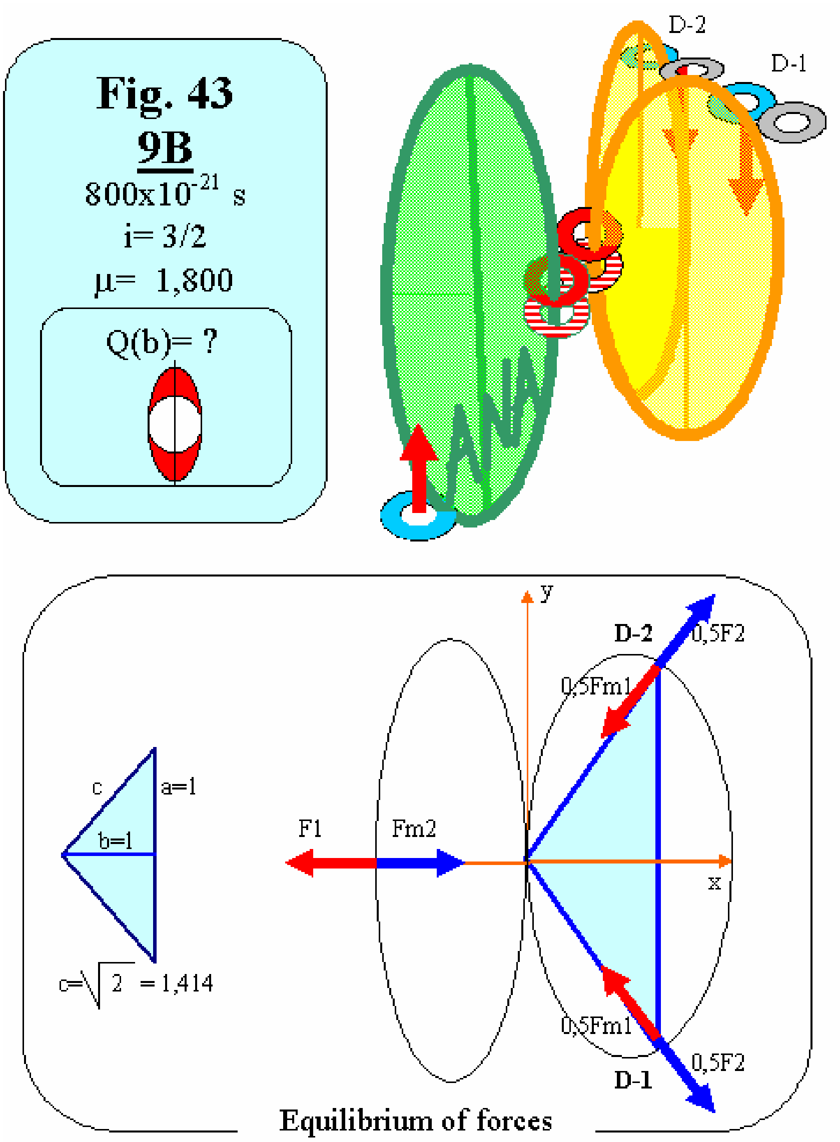
So, we could think that in 7N14 the side Ana is $1,121^3$ times higher than Douglas.
However, consider the following:

a) 5B9 has lowest angular velocity than both sides Ana and Douglas of 7N14
b) 5B10 has faster angular velocity than both side Ana and Douglas of 7N14
c) But when 5B9 and 5B10 met together in 7N14 they have to move with the same angular velocity. Therefore the portion 5B9 of 7N14 has to increase its rotation, while the portion 5B10 has to decrease its speed.
d) The angular velocity changes by quantized degrees:
$\Delta= 1,121^n$, n= 0, 1, 2, 3... [179]
e) Then the portion 5B9 of 7N14 increases its speed by 1,121, while its portion 5B10 decreases its speed by 1,121, since the two portions gyrate with the same speed.
f) Therefore the relation of the sides Ana and Douglas within the 7N14 is actually:
$\omega(A)/ \omega(D) = 1,121^3 /1,121 = 1,121^2 = 1,257$ [180]
g) Therefore the Mfe= 4,2 must be divided by 1,257 in the side Ana, because of the stronger shrinkage of the orbit radius in that side:

Mfe in the side Ana of 7N14:	Mfe= 4,2/1,257 = 3,34		[181]
D-3, D-4, D-5:	−3,34x3 x 0,2315 =	−2,319	[182]
D-1, D-2 :	+4,2x2x0,2315=	+1,945	[183]
	Σ =	−0,374	[184]

Magnetic moment of 7N14: μ = +0,857 −0,374= **+0,483** [185]

4.11- Isotope 5B9



A) **Method of equilibrium between nucleons**:
As the centripetal force on the two deuterons in the isotope 5B9 is stronger than the centripetal force on the two protons in the isotope 5B8, it is reasonable to expect that the distance between the two deuterons in 5B9 be shorter, because the centripetal force

tends to shrinkage the isosceles triangle. So, in 5B9 the component of forces along the x-axis for the deuterons is the leg a= 1 over the hypotenuse c= 1,414:

R=1 / 1,414= 0,707 [186]

Centripetal force on the proton:

$F1= m.\omega^2.R = 1{,}007.\omega^2.R$ [187]

Centripetal force on the two deuterons:

$F2= = 0{,}707x2.m.\omega^2.R = 0{,}7x2x2{,}014.\omega^2.R = 2{,}848.\omega^2.R$ [188]

Magnetic force on the two deuterons:

$Fm1 = 0{,}707x2x1{,}6x10^{-19}.\omega.R.\mu = 2{,}262x10^{-19}.\omega.R.\mu$ [189]

Magnetic force on the proton:

$Fm2 = 1{,}6x10^{-19}.\omega.R.\mu = 1{,}6x10^{-19}.\omega.R.\mu$ [190]

The total force F1+Fm2 on the proton must be equal to the total force F2+Fm1 on the deuterons. So, writing the equation of equilibrium:

F1 + Fm2 = F2 + Fm1 [191]

we have:

$1{,}007.\omega^2.R + 1{,}6x10^{-19}.\omega.R.\mu = 2{,}848.\omega^2.R + 2{,}262x10^{-19}.\omega.R.\mu$ [192]

$(1{,}007 -2{,}848).\omega = (2{,}262-1{,}6)\ x10^{-19}.\mu$ [193]

When the portion 5B9 is composing the side Douglas in 7N14, that 5B9 gyrates with the angular velocity ω(7N14)= $0{,}89x10^{-19}$, which is the velocity of rotation of the isotope 7N14 (see eq. 162.2). Obviously the angular velocity of the isotope 5B9 is lowest than that of the isotope 7N14, ω(5B9)< ω(7N14), because the portion 5B10 in the side Ana of 7N14 contributes for the isotope 7N14 to have a faster angular velocity. As the isotope 7N14 gyrates with ω(7N14)= $0{,}89x10^{-19}$ and the isotope 5B9 gyrates slowly, then let's consider that the isotope 5B9 has K=1, $\omega(1)= 0{,}653x10^{-19}$ [194]

$\mu= (1{,}007 -2{,}848)x0{,}653 / (2{,}262-1{,}6)$ [194.1]

Magnetic moment of 5B9: μ = –1,816 [195]

B) <u>Comparison between 3Li8 and 5B9</u>:

- 3Li8 with inner (D+2n): spin i=2 K=1 [196]
- 5B9 with outer (p+2D): spin i= 3/2 K=1 [197]

Therefore, as it seems that the angular velocity stays the same in 3Li6, 3Li8 and 5B9, then it seems that:

- 3Li8 - the phenomenon is caused by the growth of the intensity of the flux n(o), because the orbit radius is short, and so the velocity v of the deuteron is low.
- 5B9 - the phenomenon is caused by the growth of the velocity v of the proton and the two deuterons, because they are in the outer side.

C) **Method of induced magnetic moments by nucleons**:

- Magnetic moments yield by nucleons:

μ = +2,793 –2x0,857 = +1,079 [198]

- Magnetic moments induced by nucleons:

As we will use Mfe= 4.2 for D-1 and D-2 with parallel spins in the side Douglas, we have to use the Fig. 34.

μ of external proton in 5B8 = 0,627 [199] (not subject of being applied Mfe=4,2 on it, because it's alone in the side Ana)

μ of external deuteron in 5B8 = 0,192 [200]

Considering the 5B9 as reference of levels, we have:

$\omega(1)$ = 0,653	5B9		[201]
$\omega(2)$ = 0,653x1,121			[202]
$\omega(3)$ = 0,653x1,121^2	5B8	(calculus of Mfe=4,2)	[203]

The relation of levels is:

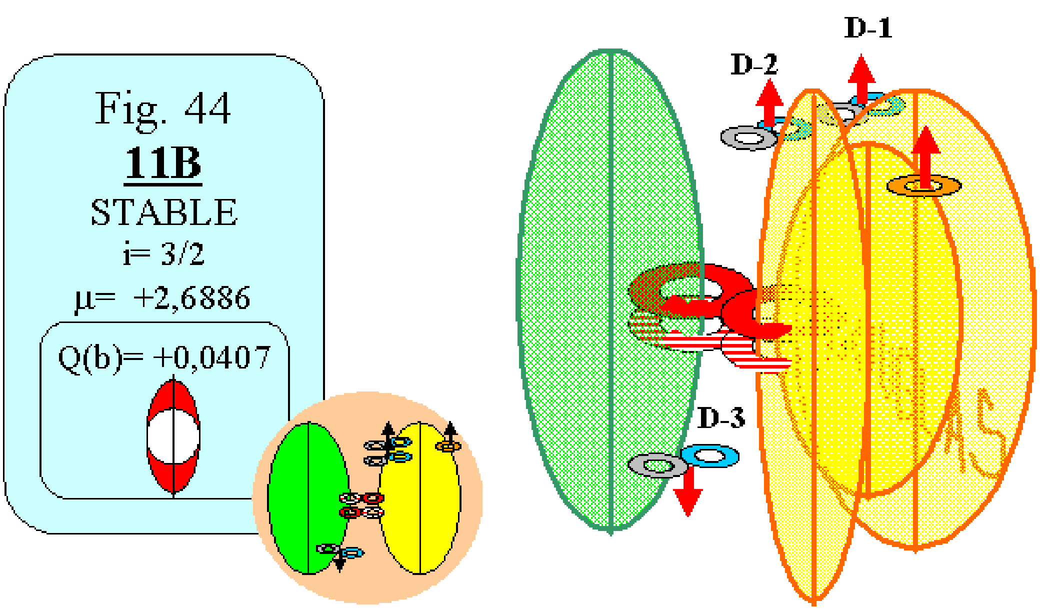
$\omega(3) / \omega(2)$ = 1,121^2 = 1,257 [204]

Then for 5B9 we have to apply Mfe = 4,2/1,257 = 3,341 [205]

D-1, D-2:	+3,341x2x0,192 =	1,283	[206]
Proton:		–0,627	[207]
	Σ=	+0,656	[208]

μ of 5B9 = +1,079 +0,656 = **+1,735** [209]

4.12- Isotope 5B11



A) **Method of equilibrium of forces**

Radius of 5B11: R= $1{,}25x11^{1/3}$ = 2,78 [210]

Radius of 3Li7: R= $1{,}25x7^{1/3}$ = 2,39 [211]

2,78 / 2,39 = 1,16 [213]

There is strong spin-interaction between D-1, D-2, and the neutron. .

Rn= 1,7 (because of the shrinkage, the neutron is pulled by [D-1,D-2], due to their strong spin-interaction, so it has not R=2,78) [214]

D-1, D-2:, R = 0,66 (they are pulled by the neutron and by the strong centripetal force, because K=3) [215]

D-3 , R= 0,42 [215.1]

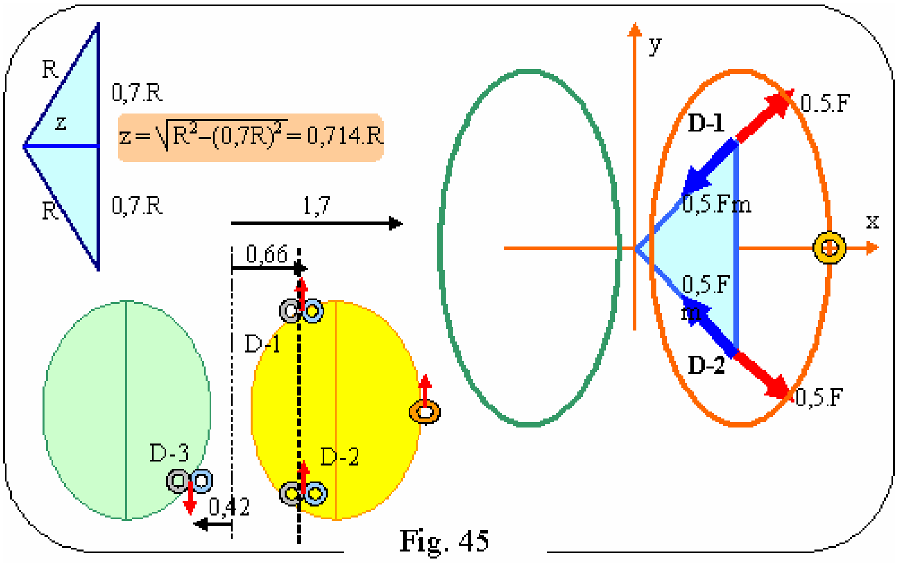


Fig. 45

Centripetal force on D-1 and D-2 along x-axis

The component of F1 along the x-axis is F1.z , where z = 0,714 (Fig. 45), is:

F1 = $2x0{,}714.R.m.\omega^2$ = $2x0{,}714x0{,}66x2{,}014.\omega^2$ = $1{,}898.\omega^2$ [216]

Centripetal force on D-3

F2 = $m.\omega^2.R$ = $2{,}014x0{,}42.\omega^2$ = . $0{,}846.\omega^2$ [217]

Centripetal force on neutron:

F3 = $m.\omega^2.R$ = $1{,}0087.\omega^2.1{,}7$ = $1{,}715.\omega^2$ [218]

Magnetic force on D-1 and D-2 along the x-axis:

Fm1 = $2x1{,}6x10^{-19}.\omega.0{,}714.R.\mu$= $2x1{,}6x0{,}714x0{,}66x10^{-19}.\omega.\mu$ = $1{,}508x10^{-19}.\omega.\mu$ [219]

Magnetic force on D-3:

Fm2 = $1{,}6x10^{-19}.\omega..R.\mu$ = $1{,}6xx0{,}42x10^{-19}.\omega.\mu$ = $0{,}673x10^{-19}.\omega.\mu$ [220]

Writing the equation of equilibrium:

F1 +F3 +Fm2 = F2+ Fm1 [221]

we have:

$1{,}898.\omega^2 + 1{,}715.\omega^2 + 0{,}673x10^{-19}.\omega.\mu = 0{,}846.\omega^2 + 1{,}508x10^{-19}.\omega.\mu$ [222]

With $\omega(3)$= $0{,}822x10^{-19}$ we have: [223]

Magnetic moment of 5B11: μ = **2,721** [224]

B) **Method of induced magnetic fields:**

- Mag. mom. due to nucleons:

μ = +0,857 + 1,913 = +2,770 [225]

- Mag. mom. induced by the nucleons:

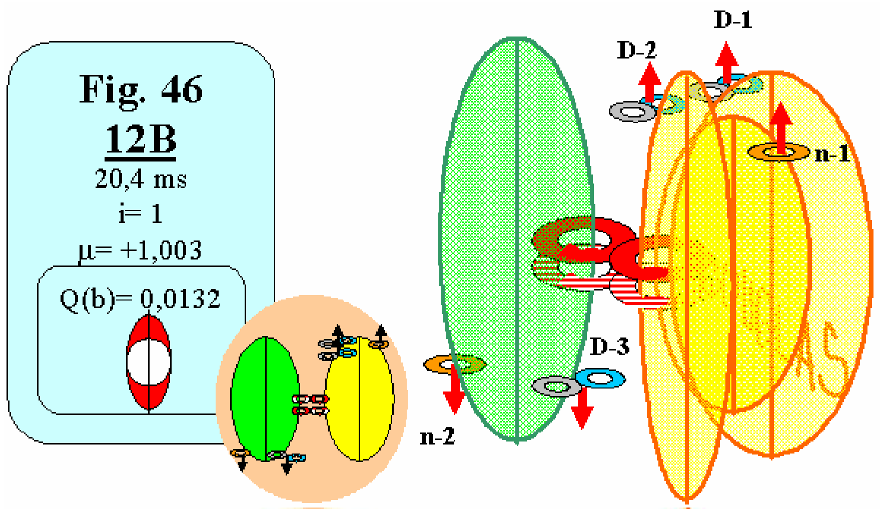
As D-1, D-2, and n are with parallel spins, we will apply Mfe= 4,2 for n (outer) and Mfi=12,905 for D-1 and D-2 (both inner). As Mfe was obtained from the values of the Fig. 4, we will use it for the deuterons, and as Mfi was obtained from the values of the Table 1, we will use it for the neutron. For D-3 we use Table 1, because there is no Mf on it.

D-1, D-2 :	-2x12,905x0,035x(0,66/0,355) =	–1,679	[226]
n:	+4,2x0,429x(1,7/1,951) =	+1,570	[227]
D-3:	+0,035x(0,42/0,355) =	+0,039	[228]
	Σ=	–0,068	[229]

Magnetic moment of 5B11:

μ = +2,770 –0,068 = **+2,702** [230]

4.13- Isotope 5B12



A) **Method of equilibrium of forces**

Orbit radius of 5B12: R= 1,25x12$^{1/3}$ = 2,86 [231]

n-1 , R= 1,8 [232]

D-1, D-2:, R = 0,68 [233]

D-3 , R= 1,5 [234]

n-2 , R= 1,8 [235]

As we will see (eq. 242) 5B12 has K=3, and so D-3 and n-2 also yield the multiplication factor, because have parallel spin and K>1 .
In spite of the equation R= $1{,}25.A^{1/3}$ gives the value R= 2,86, however we have considered R=1,8 for n-1 and n-2, because of the shrinkage of the orbit radii in both sides. In the side Ana, D-3 and n-2 have a strong interaction, that's why D-3 has a big increase in its orbit radius, and the orbit of n-2 has a great shrinkage.

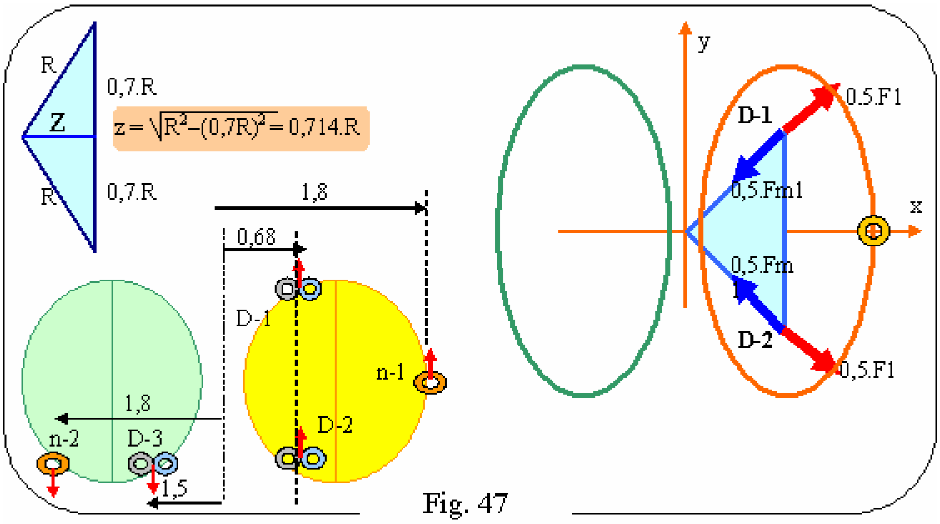


Fig. 47

Centripetal force on D-1 and D-2 along x-axis
The component of F along the x-axis is F.z , where z = 0,714 (Fig. 47), is:
$F1 = 2x0{,}714.R.m.\omega^2 = 2x0{,}714x0{,}68x2{,}014.\omega^2 =$. $1{,}956.\omega^2$ [236]

Centripetal force on D-3
$F2 = m.\omega^2.R = 2{,}014x1{,}5.\omega^2 =$. $3{,}021.\omega^2$ [237]

Centripetal forces on n-1 and n-2
One cancels each other

Magnetic force on D-1 and D-2 along the x-axis:
$Fm1 = 2x1{,}6x10^{-19}.\omega..R.\mu = 2x1{,}6x0{,}714x0{,}68x10^{-19}.\omega.\mu = 1{,}554x10^{-19}.\omega.\mu$ [238]

Magnetic force on D-3:
$Fm2 = 1{,}6x10^{-19}.\omega..R.\mu = 1{,}6x1{,}5x10^{-19}.\omega.\mu =$ $2{,}4x10^{-19}.\omega.\mu$ [239]

Writing the equation of equilibrium:
$F1 + Fm2 = F2 + Fm1$ [240]
we have:
$1{,}956.\omega^2 + 2{,}4x10^{-19}.\omega.\mu = 3{,}021.\omega^2 + 1{,}554x10^{-19}.\omega.\mu$ [241]

With $\omega = 0{,}822x10^{-19}$ we have: [242]

Magnetic moment of 5B12: μ = **1,035** [246]

B) **Method of induced magnetic fields:**

- Mag. mom. due to nucleons:

μ = +0,857 [247]

- Mag. mom. induced by the nucleons:

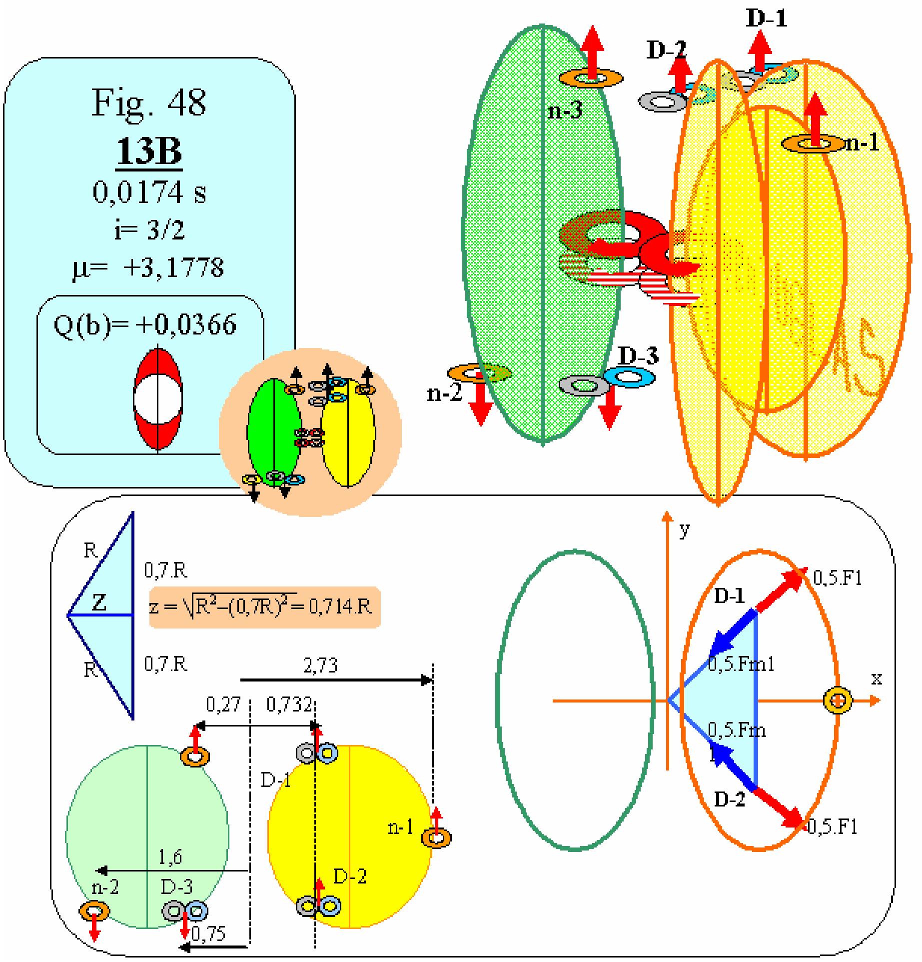
As D-1, D-2, and the neutron are with parallel spins, we will apply Mfe= 4,2 for the neutron (outer) and Mfi=12,905 for D-1 and D-2 (both inner), remembering that for Mfe=4,2 we apply the Fig. 34 , and for Mfi=12,905 we apply the values of the Table 1.

D-1, D-2 :	–2x12,905x0,035x(0,68 / 0,355) =		–1,73	[248]
n-1:	+4,2x0,429x(1,8 / 1,951) =		+1,662	[249]
D-3:	+12,905x0,035x(1,5 / 0,355) =		+1,908	[250]
n-2:	-4,2x0,429x(1,8 / 1,951) =		-1,662	[251]
		Σ=	+0,178	[252]

Magnetic moment of 5B12:

μ = +0,857 +0,178 = **+1,035** [253]

4.14- Isotope 5B13



A) **Method of equilibrium of forces**

n-1 , R= 2,73 [254]
n,2: R= 1,6 [255]
D-1, D-2:, R = 0,732 [256]
D-3 , R= 0,75 [257]
n-3 , R= 0,27 [258]

As n-3 has broken the multiplication factor phenomenon in the side Ana, D-3 left away its strong spin-interaction with n-2, and went back to a place near to that it had occupied in 5B11.

D-1 and n-3 pull one each other, and n-3 has a very short orbit radius.

Centripetal force on D-1 and D-2 along x-axis

The component of F along the x-axis is F.z , where z = 0,714 (Fig. 49), is:

$F1 = 2x0,714.R.m.\omega^2 = 2x0,714x0,732x2,014.\omega^2 = 2,105.\omega^2$ [259]

Centripetal force on D-3

$F2 = m.\omega^2.R = 2,014x0,75.\omega^2 = . 1,510.\omega^2$ [260]

Centripetal force on n-1

$F3 = m.\omega^2.R = 1,0087x2,73.\omega^2 = . 2,754.\omega^2$ [261]

Centripetal force on n-2

$F4 = m.\omega^2.R = 1,0087x1,6.\omega^2 = . 1,614.\omega^2$ [262]

Centripetal force on n-3

$F5 = m.\omega^2.R = 1,0087x0,27.\omega^2 = . 0,272.\omega^2$ [263]

Magnetic force on D-1 and D-2 along the x-axis:

$Fm1 = 2x1,6x10^{-19}.\omega..R.\mu = 2x1,6x0,714x0,732x10^{-19}.\omega.\mu = 1,672x10^{-19}.\omega.\mu$ [264]

Magnetic force on D-3:

$Fm2 = 1,6x10^{-19}.\omega..R.\mu = 1,6x0,75x10^{-19}.\omega.\mu = 1,200x10^{-19}.\omega.\mu$ [265]

Writing the equation of equilibrium:

F1 +F3 +Fm2 = F2 +F4 +F5 + Fm1 [266]

we have:

$2105.\omega^2 +2,754x.\omega^2 +1,200x10^{-19}.\omega.\mu =$

$= 1,510.\omega^2 +1,614.\omega^2 +0,272.\omega^2 +1,672x10^{-19}.\omega.\mu$ [267]

With K=5, $\omega(5) = 1,0351x10^{-19}$ [269]

we have:

Magnetic moment of 5B13: μ = **3,202** [270]

B) **Method of induced magnetic fields**

- Mag. mom. due to nucleons:

$\mu =$ +0,857 +1,913= +2,77 [271]

- Mag. mom. induced by the nucleons:

There are parallel spins in the side Douglas only, since n-3 has broken the phenomenon in the side Ana.. So we apply Mfe= 4,2 for n-1 (outer) and Mfi=12,905 for D-1 and D-2 (both inner).

Multiplied by Mfi and Mfe:

n-1:	+4,2x0,429x(2,73 / 1,951) =	+2,521	[272]
D-1, D-2 :	–2x12,905x0,035x(0,732 / 0,355) =	–1,883	[273]

Without Mf:

D-3:	+0,035x(0,75 / 0,355) =	+0,074	[274]
n-2:	–0,429x(1,6 / 1,951) =	-0,352	[275]
n-3:	+0,429x(0,27 / 1,951) =	+0,059	[276]
	Σ=	+0,44	[277]

Magnetic moment of 5B13:

μ = +2,77 +0,44 = **+3,21** [278]

4.15- Comparison on the Q(b) of the isotopes 5B11, 5B12, 5B13

In Fig. 49 it’s done the comparison between the Q(b) of 5B11, 5B12, and 5B13 by considering the following:

- Diameter Φ = diameter of the nucleus
- Width L = the distance between D-3 and (D-1,D-2) along the horizontal
- Factor K (faster the angular velocity, increase in the shake along x-axis)
- Mass unbalance U = the sum of each mass multiplied by its orbit radius in the side Douglas divided by the result of the side Ana.

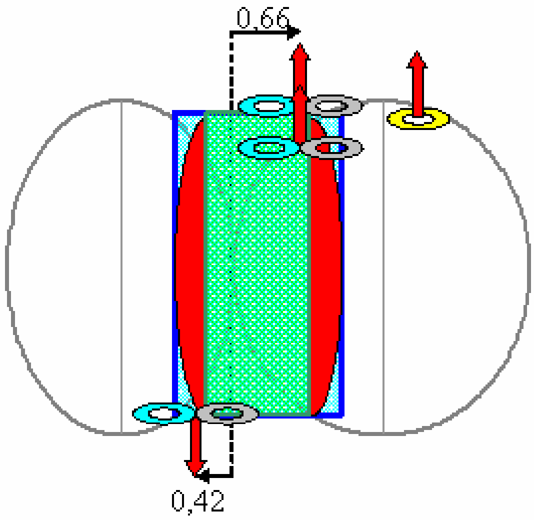
The relation Φ / L contributes for positive Q(b)
The product L.K.U contributes for negative Q(b)

It was considered the following:

- The positive contribution Cp is proportional to $(\Phi\ / L)^2$
- The negative contribution Cn is proportional to $(K.U)^{1/2}$
- Cp/Cn = $(\Phi /L.)^2 / (K.U)^{1/2}$ [ ]

The results, shown in Fig. 49, are corroborated by the values of Q(b) measured by experiments:

- 5B11: experimental Q(b) = +0,0407 , Cp/Cu = 2,5 [279]
- 5B12: experimental Q(b) = +0,0132 , Cp/Cu = 1,2 [280]
- 5B13: experimental Q(b) = +0,0366 , Cp/Cu = 1,8 [281]



5B11: Q(b)= +0,0407

Rn = 1,7 => Φ = **3,4**

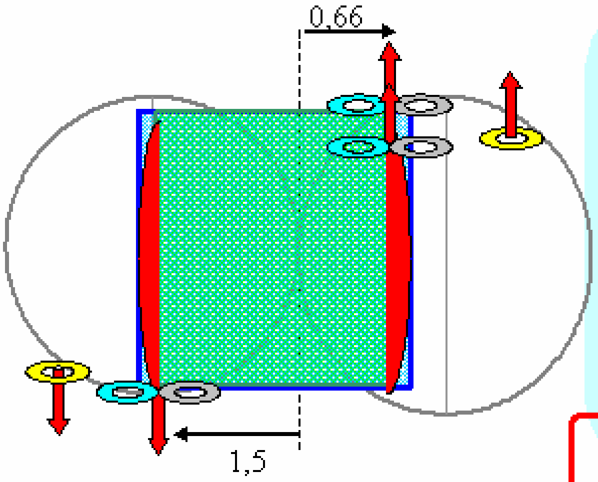
D-1, D-2: R = 0,66

D-3: R= 0,42

- Width : **L**= 0,66+0,42= **1,08**
- Factor **K**= **3**: $\omega(3) = 0{,}822\mathrm{x}10^{-19}$

Mass Unbalance: **U** = $\dfrac{1\mathrm{x}1{,}7+4\mathrm{x}0{,}66}{2\mathrm{x}0{,}42}$ = **5,16**

$(\Phi/L)^2/(K.U)^{1/2}=(3{,}4/1{,}08)^2/(3\mathrm{x}5{,}16)^{1/2}=$ **2,5**



5B12: Q(b)= +0,0132

n-1 , R= 1,8 => Φ = n-1+n-2 = **3,6**

D-1, D-2:, R = 0,68

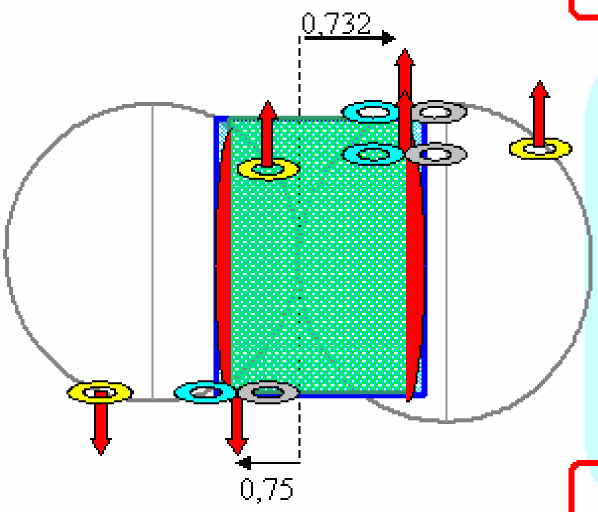
D-3 , R= 1,5

n-2 , R= 1,8

- Width : **L**= 0,68 +1,5 = **2,18**
- Factor **K**= **3**: $\omega(3) = 0{,}822\mathrm{x}10^{-19}$

Mass Unbalance: **U** = $\dfrac{4\mathrm{x}0{,}68}{2\mathrm{x}1{,}5}$ = **1,81**

$(\Phi/L)^2/(K.U)^{1/2}=(3{,}6/2{,}18)^2/(3\mathrm{x}1{,}81)^{1/2}=$ **1,2**



5B13: Q(b)= +0,0366

n-1, R=2,73 , n-2, R=1,6 : Φ = **3,33**

D-1, D-2:, R = 0,732

D-3 , R= 0,75

n-3 , R= 0,27

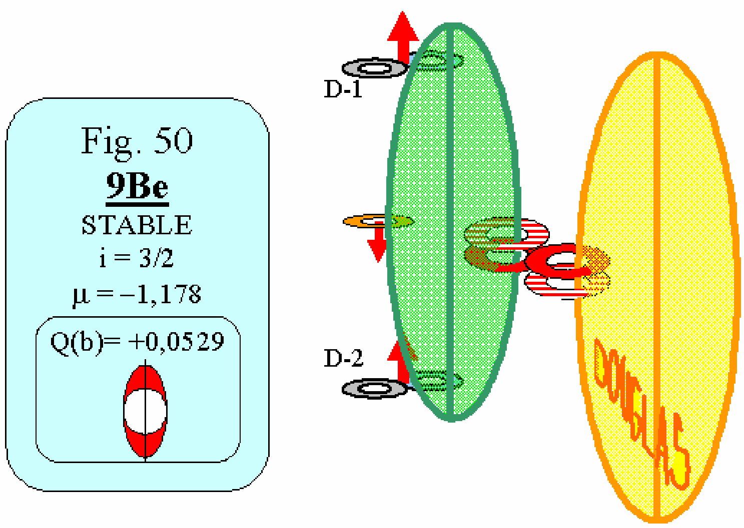
- Width : **L**= 0,732+0,75= **1,482**
- Factor **K**= **5**: $\omega(5) = 1{,}035\mathrm{x}10^{-19}$

Mass Unbalance: **U** = $\dfrac{2{,}73+4\mathrm{x}0{,}732}{0{,}27+1{,}6+2\mathrm{x}0{,}75}$ = **1,67**

$(\Phi/L)^2/(K.U)^{1/2}=(3{,}33/1{,}482)^2/(5\mathrm{x}1{,}67)^{1/2}=$ **1,8**

Fig. 49

4.16- Isotope 4Be9



The structure of the Fig.50 is corroborated by the experimental Q(b)= +0,0529. It has a high unbalance of masses, but it also a very high positive contribution for Q(b), because the two deuterons are along a straight vertical line.

A) **Method of equilibrium of nucleons:**

Neutron : m= 1,0087u , q=0 , r= R [282]

Deuteron: $q= 1,6x10^{-19}$, m= 2,014u, r= R [283]

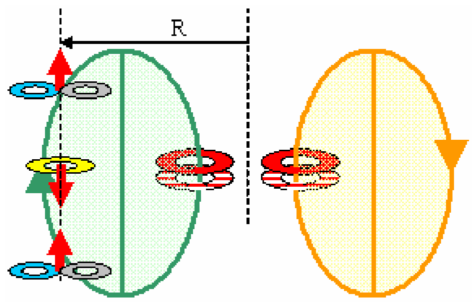


Fig. 51

Centripetal force on the neutron:

$F1= m.\omega^2.1,1R = 1,0087.\omega^2.R =$ $1,0087.\omega^2 R$ [284]

Centripetal force on the two deuterons:

$F2= = 2.m.\omega^2.R = 2x2,014.\omega^2.R =$ $4,028.\omega^2.R$ [285]

Magnetic force on the two deuterons:

$Fm = 2x1,6x10^{-19}.\omega.R.\mu =$ $3,2x10^{-19}.\omega.R.\mu$ [286]

As F1 + F2 = Fm we have:

$1,0087.\omega^2 + 4,028.\omega^2 =$ $3,2x10^{-19}.\omega.\mu$ [287]

Considering K=2 , $\omega(2)= 0,653x(0,822/0,653)^{(2-1)/2}x10^{-19} = 0,7326$ [288]

$\mu = (1,0087 + 4,028)x0,7326x10^{-19}/3,2x10^{-19}$ [289]

Magnetic moment of 5Be9: μ = **1,153** [290]

B) **Method of induced magnetic moments by nucleons:**

- Mag. mom. of nucleons: +0,857x2 – 1,913 = –0,199 [291]

From Table 1:

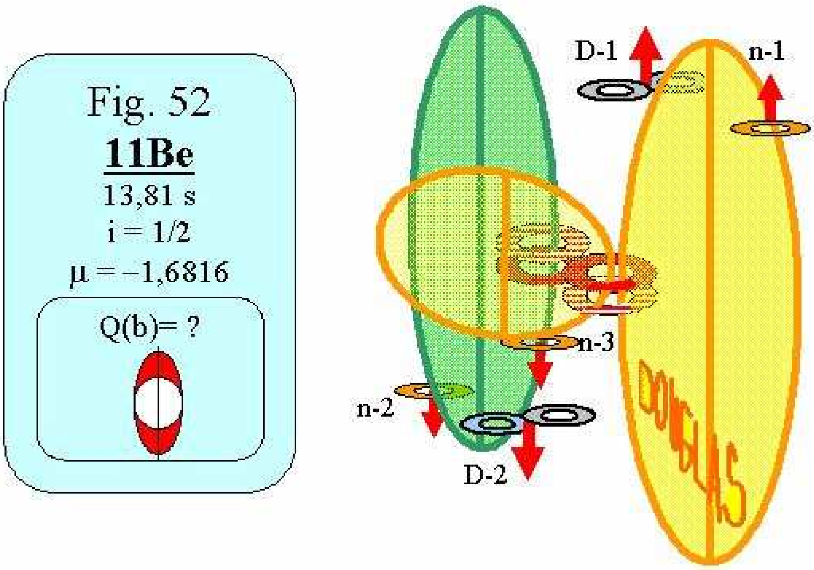
- Magnetic moments induced by nucleons:

D-1 , D-2:	–0,236x2 =		–0,472	[292]
Neutron:			–0,526	[293]
		Σ=	–0,998	[294]

Mag. mom. of 4Be9: μ = –0,199 –0,998 = **–1,197** [295]

5- Halo neutron 4Be11

Nuclear tables do not give information on the electric quadrupole of 4Be11. Probably it is because it has no defined Q(b), because along its half-life the orbit radius of the halo neutron is increasing, and so also the shake of the nucleus about its rotation axis.



Radius of 4Be11: R= $1,25 \times 11^{1/3}$ = 2,78 [296]
Radius of 3Li7= $1,25 \times 7^{1/3}$ = 2,391 [297]
Radius of deuteron in 3Li7: R= 0,405 [298]
2,78/2,391= 1,16 [299]

The neutron n-3 is captured by D-2 and goes to the side Ana, but it belongs to the flux n(o) of side Douglas. As already explained, n-3 induces positive magnetic moment in spite of its spin down (see Fig. 7)

Orbit radii:

D-1, R= 0,96 (due to the fast angular velocity and the interaction [300]
with n-1, the nucleon D-1 is pulled and its orbit radius

is larger than an expected 0,405x1,16 = 0,47)

D-2, R= 0,67 (D-2 is pulled by n-3). [301]

n-1 , R= 2,9 (pulled together with D-1 by the strong centripetal force) [302]

n-2, R=2,45 (pulled by D-2 and by the strong centripetal force on the contrary direction) [303]

n-3, R= 0,36 (tied to the side Douglas by the flux n(o)). [304]

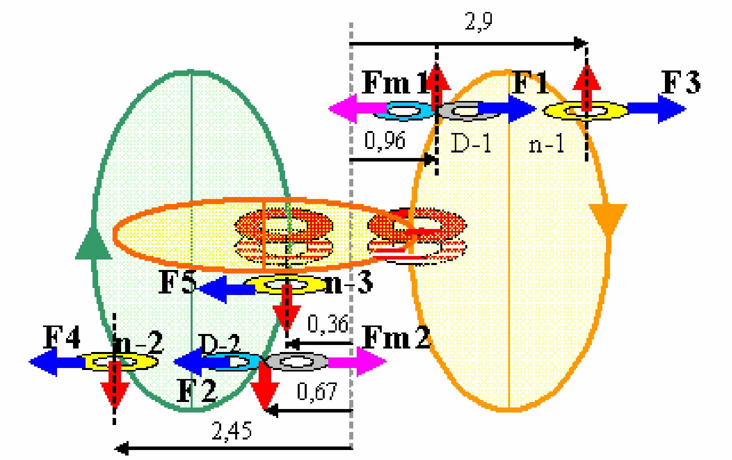


Fig. 53

A) **Method of equilibrium of nucleons**:

Centripetal force on the D-1

$F1= m.\omega^2.R = 2{,}014.\omega^2.0{,}96 = \quad 1{,}933.\omega^2.$ [305]

Magnetic force on the D-1:

$Fm1 = 1{,}6x10^{-19}.\omega.R.\mu = 1{,}6x10^{-19}.\omega.0{,}96.\mu = \quad 1{,}536x10^{-19}.\omega.\mu$ [306]

Centripetal force on the D-2

$F2 = m.\omega^2.R = 2{,}014.\omega^2.0{,}67 = \quad 1{,}349.\omega^2$ [307]

Magnetic force on D-2:

$Fm2 = 1{,}6x10^{-19}.\omega.R.\mu = 1{,}6x10^{-19}.\omega.0{,}67.\mu = \quad 1{,}072x10^{-19}.\omega.\mu$ [308]

Centripetal force on n-1:

$F3= m.\omega^2.R = 1{,}0087.\omega^2.2{,}9 = \quad 2{,}925.\omega^2$ [309]

Centripetal force on n-2:

$F4= m.\omega^2.R = 1{,}0087.\omega^2.2{,}45 = \quad 2{,}471.\omega^2$ [310]

Centripetal force on n-3:

$F5= m.\omega^2.R = 1{,}0087.\omega^2.0{,}36 = \quad 0{,}363.\omega^2$ [311]

Equation of equilibrium:

F1 + F3 + Fm2 = Fm1 +F2 +F4 +F5 [312]

$1{,}933.\omega^2 + 2{,}925.\omega^2 + 1{,}072x10^{-19}.\omega.\mu =$

$= 1{,}536x10^{-19}.\omega.\mu + 1{,}349.\omega^2.R + 2{,}471.\omega^2 + 0{,}363.\omega^2$ [313]

With K= 6, $\omega(3) = 1{,}161x10^{-19}$ [314]
we get:
Magnetic moment of 4Be11: μ = **1,688** [315]

B) **Method of induced magnetic moment by nucleons**
Because K >1, D-1 and n-1 also are yielding multiplication factor
Remembering that for nucleons multiplied by Mfe= 4,2 we apply the values of Fig. 34, and multiplied by Mfi=12,905 we apply the values of Table 1, we have:

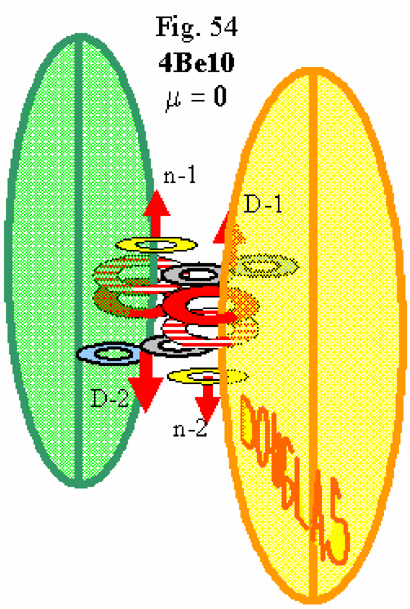
- Magnetic moment due to nucleons: μ= -1,913 [316]

- Magnetic moments induced by nucleons:

D-1:	-12,9x0,035x(0,96 / 0,355) =	-1,221	[317]
n-1:	+4,2x(2,9 / 1,951) =	+2,678	[318]
D-2:	+12,9x0,035x(0,67 / 0,355) =	+0,852	[319]
n-2:	+4,2x(2,45 / 1,951) =	-2,262	[320]
n-3:	+12,9x0,09(0,36 / 2,391) =	+0,175	[321]
	Σ =	+0,221	[322]

Magnetic moment of 4Be11: μ= -1,913 + 0,225 = **-1,691** [323]

C) **Interpretation on the 2009 experiment**
The half-life of 4Be8 is $6{,}7x10^{-17}$s , and such extremely short time life is because it has μ=0, and so there is no magnetic force for the aggregation of its nucleons, and the spin-interaction between the two deuterons is not enough to get their aggregation. The isotope 4Be10, also with μ=0, has half-life of $1{,}39x10^{6}$ years thanks to the strong spin-interaction between the two deuterons and the two neutrons, because the distance between (D-1,n-1) and (D-2,n-2) is very short (see Fig. 54). So, in 4Be10 (D-1,n-1) are kept thanks to their spin-interaction working together with the flux n(o), which works like a string tying them to the central 2He4. The same occurs with (D-2,n-2).
With the capture of the neutron n-3 by the isotope 4Be10, in the newborn 4Be11 the neutron n-2 goes to the outer side of Ana, and it pulls D-2 and n-3 to the positions shown in Fig. 52, in order that it is broken the strong spin-interaction between the two deuterons and their neutrons partners, existing in 4Be10.



In 4Be8 and 4Be11 there is no strong spin-interaction between the deuterons. As 4Be8 has μ=0, that's why its half-life is very short. The 4Be11 half-life is 13,81 seconds, very larger than $6{,}7 \times 10^{-17}$s of 4Be8, is because 4Be11 has not μ=0, and so it survives along 13,81s thanks to the magnetic forces Fm on the two deuterons.
But 4Be11 is no stable because due to the Pauli's principle D-2 cannot interact with n-2 and n-3, and the partnership between the three nucleons violates the Least Action Principle.. As n-3 is nearest to D-2, they get strong spin-interaction, and so it's n-2 which is subjected to have decay. As 4Be11 has high factor K= 6 , possibly the fast angular velocity contributes for n-2 to be expelled quickly by the centripetal force, and its radius orbit starts to grow up by discrete jumps. Also, while D-2 and n-3 both induce positive magnetic moments, n-2 induces negative μ , and such opposite tendency between (D-2,n-3) and n-2 is no satisfactory for the stability of 4Be11 by considering the Least Action Principle, and so n-2 must be expelled.

When a classical ballerina spins with the leg stretched horizontally and she collects the leg her speed rotation increases, due to the conservation of the angular momentum. Therefore, when the neutron n-2 starts its journey leaving out the cluster, we have:

1. The orbit radius of n-2 increases and the angular velocity of 4Be11 decreases (because as the neutron has no charge so that to restore the angular velocity (as a deuteron is able to restore when its radius orbit grows pulled by a neutron, as happens in the formation of 3Li7 by the capture of a neutron by the 3Li6) and then the magnetic moment of the 4Be11 do not change, because the induced magnetic moments due to nucleons do not change.
2. The growth of the neutron's orbit radius is non continuous, it grows by quantized ΔR, and the decrease of the angular velocity is also quantized.
3. 4Be11 has μ= -1,6816, and the halo neutron n-2 contributes with μ= -1,913, which means that the cluster has μ= +0,231. Then there is magnetic force attraction between the magnetic moment of the halo neutron and the magnetic moment of the cluster. But the centripetal force is stronger, and the radius orbit continues increasing by quantized steps.

NOTE: The magnetic interaction between two loadstones A and B depend on the relative position of their south and north poles. If the north pole of A is close to the north pole of B there is repulsion. If the south pole of A is close to the north pole of B, there is attraction. The same happens with the nucleons. But when they are within the structure of an isotope, they do not experience magnetic interaction similar to that between the loadstones A and B, because the nucleons are between the two poles north and south of the isotope, since they are within its. Fig. 55 shows the difference:

- There is no magnetic interaction when the halo neutron is close to the custer, within the structure of 4Be11
- There is magnetic attraction between the halo neutron and the cluster when they are separated by a distance of 7fm

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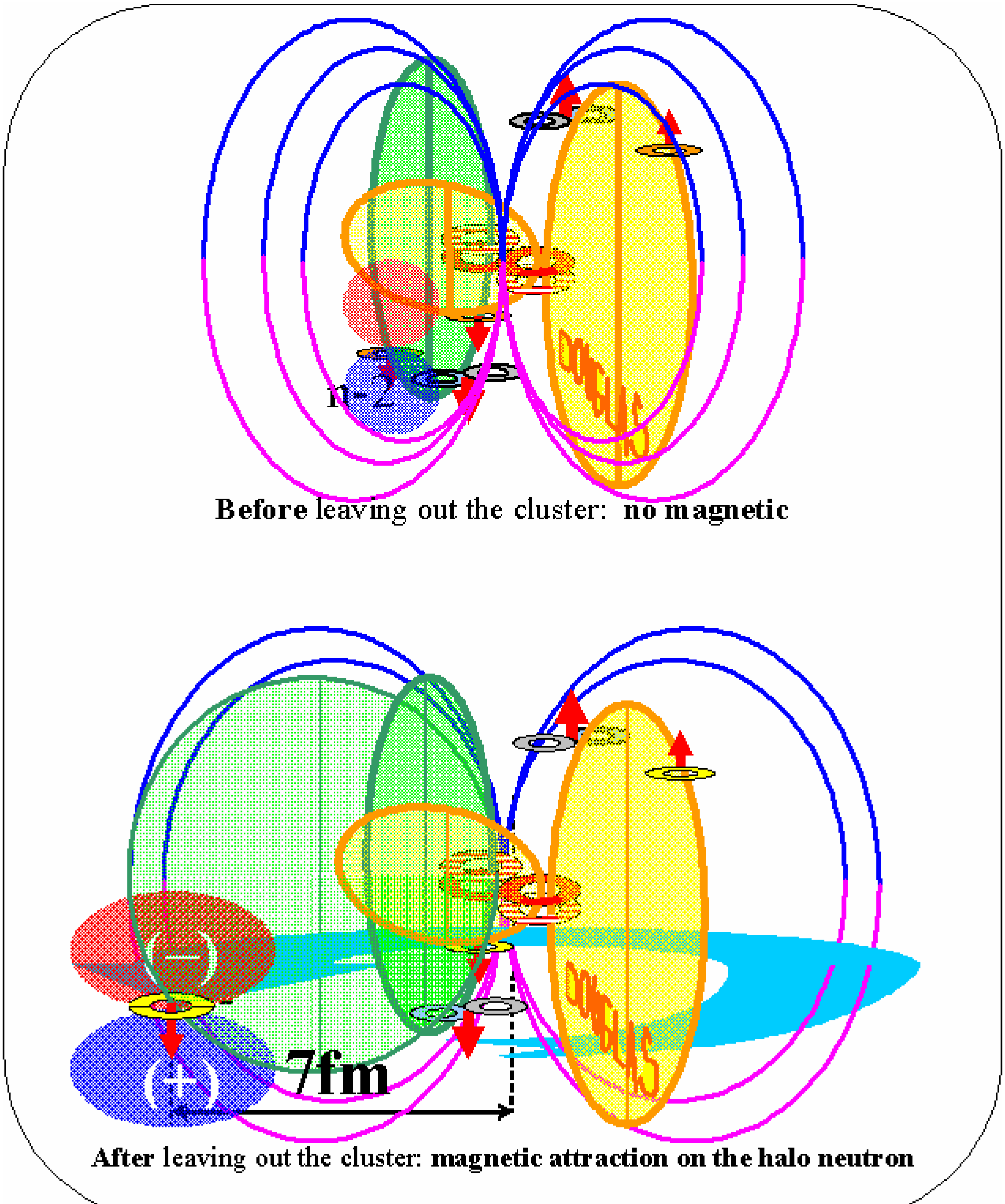

Fig. 55

Magnetic interaction before and after the neutron halo leaving out the cluster

4. As the angular velocity is decreasing, also decreases the centripetal force. But as the magnetic moment of the neutron do not decrease, when it arrives to the

orbit with radius R= 7fm the orbit radius stops to grow, because the centripetal force Fc= m.ω^2R decreases with the square of the angular velocity (which decreases up to the instant when Fm and Fc get equilibrium in the orbit with R= 7fm)

5. Finally the neutron n-2 stays orbiting the cluster with radius 7fm along 13,81 seconds, as shwon in Fig. 56. Wasted that time, the halo neutron n-2 decays emitting an electron.

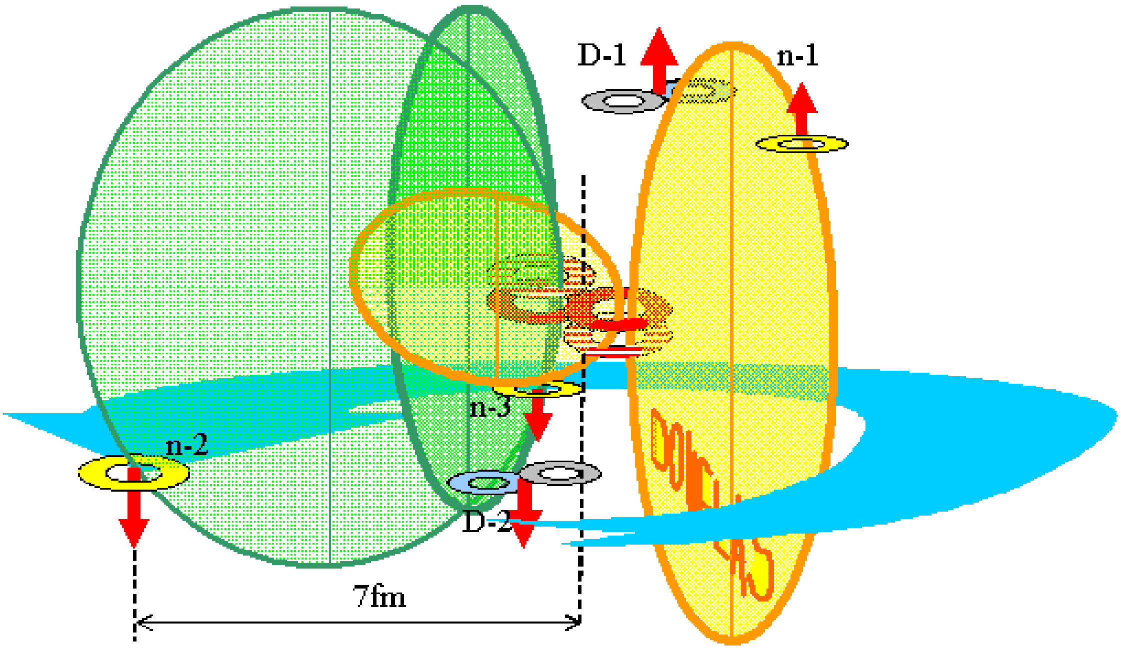

Fig. 56
Halo neutron orbiting the cluster in the 4Be11

In 97,1% of the decays, when n-2 emits the electron the newborn proton (because it has a charge) is submitted to a magnetic force Fm, because it gyrates within the magnetic moment μ=+2,6886 of the newborn 5B11, and so there is a force Fm= q.v.B on it. As the proton has the same mass of the neutron, the centripetal force stays the same in the orbit R= 7fm.. But as the magnetic force Fm between the proton and the cluster is stronger than the existed magnetic force of attraction between the halo neutron n-2 and the cluster, then the proton goes back to the nucleus. Back to the cluster the proton captures the neutron n-3, a new deuteron D-3 is formed, and the new stable 5B11 isotope is ready.
In 2,9% of the decays, when the proton goes back and captures the neutron n-3 the new deuteron D-3 fuses with the deuteron D-2, and the 2He4 formed leaves out the nucleus, remaining a 3Li7 isotope.

5- Conclusions

If the principles of the Standard Nuclear Physics are correct then of course it is possible to find a theory capable to describe with perfect accuracy the nuclear properties of the light nuclei. However it's hard to believe that along 80 years of attempt the theorists did not succeed to discover a satisfactory theory, in spite of the principles are correct. On another hand, if some principles are incorrect, obviously the theorists will never succeed in their enterprise, no matter how many years or centuries they will try it.

The experiments published in 2009 and 2012 are suggesting that some light isotopes do not follow some principles adopted in the standard theory. And so the theorists have to ponder with gravity about the matter, and decide if they either have to continue their attempt by keeping the principles or to change the method of investigation, and be receptive to new ideas.

The mathematical formalism of Quantum Mechanics was successfully applied to the atom, because in the atomic level the electron moves with the helical trajectory. In the atomic level the spin is probably a combination between the particle's motion with helical trajectory and its intrinsic spin, as supposed by Schrödinger. But within the nuclei, due to the confinement, the nucleons do not move with the helical trajectory, and so their behavior cannot be described by the equations similar to the used for the atom. The spin of the nucleons within a nucleus behaves as a classical spin, and this is one of the reasons why the quantum mechanics mathematical formalism applied successfully to the atom did not work for the nuclear level.

If the new nuclear model proposed in Quantum Ring Theory is really correct, as are suggesting the new 2009 and 2012 experiments and the theoretical evidences shown in this paper, then its publication by a reputable journal represents a starting point for new discoveries and new theoretical researches, because obviously the theorists will improve the mathematical formalism presented here, by developing a new dynamic Lagrangian with differential equations, etc. The present theory is phenomenological, because the magnetic moment of the 3Li6 (which is the starting point for all the calculations of magnetic moments of the other isotopes) was obtained via phenomenological way. But the theorists may develop a version based on magnetic moments calculated theoretically, after getting a good understanding of the principles that rule the behavior of the light nuclei shown here, and later they can be successfully be applied also for nuclei with $Z > 8$, by considering their agglutination by the strong spin-interaction, forming hexagonal floors. So, if the structure of this new nuclear model really represents the structure existing in the Nature, a New Nuclear Physics can be borning, if the theorists decide to consider seriously the strong evidences exhibited in this paper.

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