New vision about a controllable fusion reaction D+D->He with efficient energy yield

S. Sarg

ISBN 0-9730515-2-3

Abstract BSM theory provides a different view about vacuum and matter. Cross analysis from different fields of physics indicates that the vacuum is not a void space but possessing a underlying grid structure of small super dense sub-elementary particles combined in nodes. Such space possesses unique characteristics and quantum features. The new approach allows cross analysis of phenomena from different fields of physics with preserved logical understanding providing results in excellent agreement with the experimental and observational data. Such analysis allows to unveil the physical structures of the elementary particles and the atomic nuclei. The nuclei and atomic structure of the elements appear quite different than the existing planetary model, while providing the same energetic interactions used in the Quantum mechanics. The analysis of the radioactivity and the results of some fission experiments indicates that the emitted alpha particles are obtained by fusion of deuterons previously existing in the atomic nucleus. Consequently the most effective fusion reaction $D + D \rightarrow He$ is possible at room temperature if proper conditions are created.

1. Short overview

We live in time of energy deficiency and ecological problems. In the same time unlimited energy is locked by the Nature. Each litter of water contains about 2 gram of deuterium, that is equivalent to the energy of 3000 litters of gasoline if a controllable fusion reaction of type $D + D \rightarrow He$ is achieved. Such process with enough energy yield has not been achieved so far, despite some 40 years of worldwide efforts. The current attempts are concentrated mostly on achieving of high temperature plasma in a range of hundred millions of degrees in order to create conditions similar to those in the stars. Very limited efforts are concentrated for alternative methods. According to the existing scientific concept this type of reaction is not possible at lower temperature. Alternative physical study, however, indicates that such reaction is possible between counter propagated deuterons ions if additional proper conditions of their spin momentums are applied.

2. The new point of view of BSM theory

A new theoretical study, provided by BSM theory, indicates that the vacuum is not a void space. It possesses an underlying grid of sub-elementary particles of superdense intrinsic matter with node distance in order of $1x^{10\text{-}20}$ m. This automatically makes some of the adopted basic physical laws and postulates not universal. The new concept, however, broadens our vision about the space-time and matter-energy relations. The discovered structure is named a Cosmic Lattice (CL), so the vacuum is referenced in BSM as a CL space.

Applying a new physical approach and using the discovered CL space grid as a frame of reference BSM theory successfully provides logical explanations of the rules in Quantum mechanics and the Relativistic effects. In the same time it uncovers the real physical structures of the atomic and subatomic particles. The Bohr atomic model appears to be only a mathematical model providing correct energy levels, but it is not identical to the physical one. When taking into account the vacuum structure and the structure of elementary particles, the physical models of the Hydrogen and all stable elements looks quite different. Using the vacuum grid as a frame of reference the BSM theory was able to separate the space from time parameters at low level of matter organization and to perform physical analysis in a real three dimensional space. From a BSM point of view, the interpretation of the scattering experiments does not provide correct real dimensions, because the vacuum and particle structures are not taken into account. BSM analysis found that the stable particles like proton, neutron and electron (and positron) posses well defined spatial geometry and denser internal lattice. They are built of complex but understandable 3 dimensional helical structures whose building blocks are the same as those forming the vacuum structure. Analysing the interaction between the vacuum and matter structures, the BSM theory was able to derive number of useful equations, like the light velocity - expressed by the CL space parameters, Newtonian mass (the mass we are familiar with), vacuum energy (zero point energy), and relation between CL space parameters and the known physical constants. BSM provides also an understandable physical explanation of what is an elementary electrical charge (why it is constant) and pure magnetic energy.

Analysing the experimental data from different fields of the physics, but by the new point of view, it was possible to unveil the parameters of the oscillating CL nodes and the structure and dimensions of the stable elementary particles: proton, neutron, electron and positron. The CL nodes oscillates in a complex spatial way in which two frequency are identified. One is a resonance frequency and a second one is the Compton frequency. The common mode oscillation of the CL nodes exhibit specific parameters related with the permeability and permittivity of the vacuum. The analysis of electron motion in CL space (Chapter 3 and 4 of BSM) allows to unveil its structure. The electron is a system of three helical structures one inside another as illustrated by Fig. 1. Two of them possess internal lattices (not shown in Fig. 1).

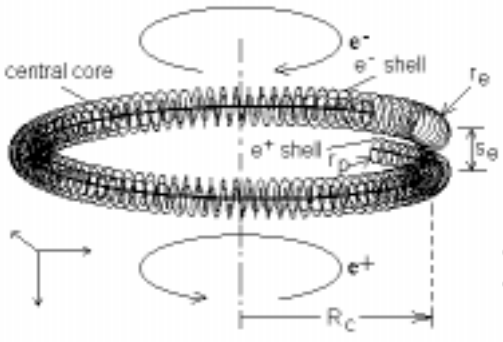

Fig. 1

Oscillating electron

The internal lattice of the most external helical structure modulates the CL nodes and creates an electrical field. So the electron has two proper frequencies, one of which is the Compton one while the second one is three times higher. They are identified by analysis of FQHE (Chapter 4).

It is unveiled that in conditions of optimal confined motion of electron as a screw its first proper frequency is equal to one of the oscillating frequencies of the CL node. This is the Compton frequency. Then the tangential velocity is equal to the light velocity, while the axial velocity is equal to $V_{ax} = \alpha c$. The corresponding electron energy is 13.6 eV. The helical step, s_e, is involved in the following relations:

$$s_e = \frac{2\pi R_c \alpha}{\sqrt{1-\alpha^2}} = \frac{\lambda_c \alpha}{\sqrt{1-\alpha^2}} = 1.7706\times10^{-14} \text{ (m)} \qquad [(3.9)]$$

$$s_e = g_e r_e = 2.00231\ r_e \qquad [(3.12.a)]$$

where: R_c - is the Compton radius, α - is the fine structure constant, g_e - is the gyromagnetic factor, λ_c - is the Compton wavelength (CL space parameter).

From the analysis of the Fractional Quantum Hall experiments in Chapter 4 it is found that: $r_p/r_e = 2/3$. So all the geometrical parameters of the electron are determined.

In confined motion of the oscillating electron in CL space (as a screw) strong quantum interactions with oscillating CL nodes appear for electron's energies of: 13.6 eV, 3.4 eV, 1.51 eV, 0.85 eV and so on. The characteristic parameters of dynamical interactions of oscillating electron are shown in Table 1. **Table 1**

No	E (eV)	V_{ax}	V_t	r_{mb}	l_{ql}	L_q (A)
1	13.6	αc	c	$\sim R_c$	$2\pi a_0$	1.3626
2	3.4	$\alpha c/2$	$c/2$	$2R_c$	$2\pi a_0/2$	0.6813
3	1.51	$\alpha c/3$	$c/3$	$3R_c$	$2\pi a_0/3$	0.4542
4	0.85	$\alpha c/4$	$c/4$	$4R_c$	$2\pi a_0/4$	0.3406
5	0.544	$\alpha c/5$	$c/5$	$5R_c$	$2\pi a_0/5$	0.2725

where: E - is the electron energy, V_{ax} - is the axial velocity, V_t - is the tangential velocity of the rotating electron structure, r_{mb} - is the value of the boundary electron magnetic radius in plane normal to V_{ax} vector, c - is a light velocity, R_c - is the Compton radius, a_o - is the Bohr radius, l_{ql} - is the trace length of motion in closed loop (single quantum loop), L_q - is the length size of the quantum loop as Hippoped curve with parameter $a = \sqrt{3}$.

The magnetic radius r_{mb} in plane normal to V_{ax} is defined from the conditions that the rotating IG field of the internal lattice of the electron helical structure (that modulates the CL space) could not exceed the light velocity. The magnetic radius for 13.6 eV is verified from the analysis of the quantum magnetic field (see Chapter 3, §3.11): $\Phi_0 = h/q_o$ The accurate value of r_{mb} for 13.6 eV is slightly larger than R_c, due to a finite thickness of the electron helical structure.

For all possible quantum loops a number No is assigned and called a **subharmonic number**, because the electron rotation rate decreases with the consecutive increase of this number. The length of quantum loop for No 1 is verified for a Hydrogen molecule in Chapter 9 of BSM. The analysis of the confined motion of the electron leads to conclusions:

- **For all possible single quantum loops the central core of the electron structure makes 56335 complete cycles.**
- **The circumference length of the boundary of the magnetic radius in a plane normal to $_{ax}$ of the electron in confined motion is equal to a whole number of λ_c that is a characteristic parameter of the Zero Point Waves in CL space.**

The investigation of Balmer series in Chapter 7 confirms the trace length and the shape of quantum loop No 2. The same quantum loop exists also in Deuteron. The BSM model of Hydrogen is different than the Bohr model, but all type of quantum numbers are identifiable (Chapters 7 and 8).

The electron with unveiled structural parameters is used as a probe for estimation of the CL space parameters. One of them is the Zero Point Energy. **The vacuum permeability is related with Zero Point Waves, who are connected with the CL node dynamics and always present in CL space.** In Chapter 5 the zero point energy is theoretically derived. It is related to the parameter background temperature, whose derived equation is:

$$T = \frac{N_A^2 h \nu_c (R_c + r_p)^3 L_{pc}^2}{S_W 2 c R_c r_e R_{ig}} \left(\frac{\mu_e}{\mu_n}\right) \qquad [(5.8)]$$

$S_W = 1$ (m^2) - a reference surface area for all units in SI where: N_A - is an Avogadro's number, h - Plank's constant, ν_c - Compton frequency, L_{pc} - core length of the proton (neutron), R_{ig} - ideal gas constant, μ_e and $\mu_{\bar{n}}$ magnetic moments of electron and neutron, respectively).

The theoretical value obtained by Eq. [(5.8)] is 2.6758K - pretty close to the experimentally estimated temperature 2.72 K from a "relict radiation".

The proton and neutron structures are unveiled fro cross analysis in Chapters 6, 7, 8, 9. The proton envelope is a twisted torus with a shape close to a figure 8, while the neutron is a same structure but in shape of double folded torus. More accurately the plane projection of the proton is quite close to a Hippoped curve with parameter $a = \sqrt{3}$. The shapes of the proton and neutron are shown in the nuclear structure of Deuteron (Fig 2).

The interactions between the proton, neutron and electron as physical entities with the vacuum structure are investigated in BSM thesis and their geometrical parameters are expressed by the known physical constants. The dimensions are given in the Atlas of ANS, part I. (for the proton: length 0.667 A; width 0.1925 A, thickness 0.0078 A). The electrical field of the neutron is locked by IG field in the proximity range to its envelope and is not detectable in the far field. This is a result of the overall shape symmetry. The locking mechanism of IG field, however, does not work well when the neutron is in confined motion in the structured vacuum, so it exhibits a magnetic moment. The electrical field of the proton is always unlocked due to its different overall shape. So in the far range the proton electrical field appears as emerging from a point, but in the near field it is distributed over the pro-

ton envelop. The proton and neutron both have exactly the same internal structure but are distinguished by their overall shape (and slight difference in the structural twisting).

Fig 2 shows the spatial geometry of the Deuteron, where: *p* - is the proton and *n* - is the neutron. The neutron is centred over the proton saddle and kept by the Intrinsic Gravitation (IG) field and the proximity electrical fields of the neutron and proton. In such conditions the neutron is kept stable (it could not be unfolded and converted to a proton).

Fig. 3 illustrates the protons and neutrons arrangement in the nucleus of He. In such close distance the internal lattices of the proton's helical structures are kept by IG forces that are inverse proportional to the cube of the distance. The He nucleus is the most compact atomic structure. So its influence on the CL space parameters is strongest. As a result the helium nucleus possesses the largest binding energy between the involved protons and neutrons.

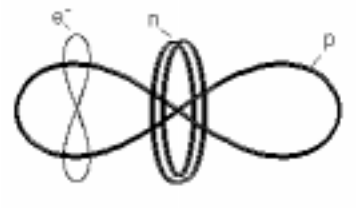

Fig. 2. Deuteron with electron in Balmer series according to BSM physical model

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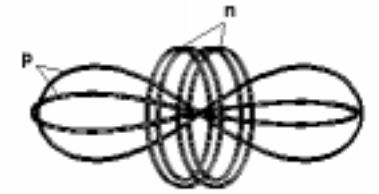

Fig. 3. Helium nucleus according to BSM physical model

When taking into account the two features of the proton: a finite geometrical size and the distributed proximity electrical field it is evident that the Coulomb law is valid down to some limit, defined by the finite size of the proton structure. This is verified by the model of Balmer series in Hydrogen presented in Chapter 7. Then in conditions of proper axial and spin alignment the integration energy for fusion of deuterons into He should not by calculated by the classical way with a classical Coulomb law down to a range of 10E-15 (m). Some larger equivalent range (in order of 0.2E-10 *m* determined by the proton finite size, mentioned above) should be considered instead. This makes a big difference in the theoretical estimation of the necessary energy for a successful fusion reaction.

3. Atlas of Atomic Nuclear Structures

One of the most useful result of BSM theory with practical importance is the Atlas of Atomic Nuclear Structures (ANS). It shows that the protons and neutrons in the atomic nuclei of the elements follow a strict spatial order with well defined building tendency related with Z number. The signature of this tendency matches quite well the row-column pattern of the Periodic table, the Hund's rules and the Pauli exclusion principle. The Atlas of ANS provides nuclear configurations of the elements from Hydrogen to Lr (Z = 103). For drawing simplification of the nuclear structures the protons and neutrons are presented by simplified patterns reminding their shape. The left part of Fig. 4 shows the patterns used for the proton, deuteron, tritium and helium, while the right part shows the most common shapes of the quantu orbits. The dimensions of the quantum orbits and the proton and neutron are given in one and a same scale.

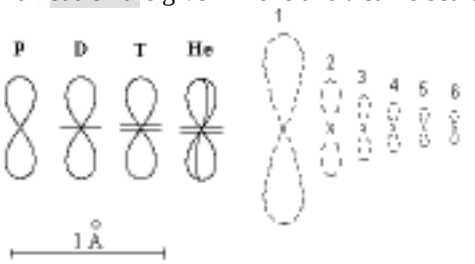

Fig. 4

Patterns for simple elements and quantum orbits

Polar axis can be identified in any atomic nucleus. It is defined by the long symmetrical axis of one or more He nuclei in the middle of atomic nucleus. The atomic nuclei posses also twisting features due to the proton twisting (not shown in the drawings). In the Atlas of ANS additional symbolic notations are used for the unveiled types of protons bonding and pairing in which IG and EM fields are involved. It is evident from the nuclear structure that the positions of the electron orbits are strictly determined by the protons positions and the conditions of quantum orbits provided by Table 1. So the electron orbits are not shown in the Atlas of ANS but their positions are easily identifiable.

4. Physical mechanism of alpha decay.

BSM theory provides an evidence that the alpha particles from a radioactive are result of a fusion process between previously aligned deuterons.

Fig. 8.6 and 8.7 (from Chapter 8 of BSM) show views of the nucleus of Gd and Rn, respectively. In the polar section views the protons and neutrons lying in proximity to the section plane are only shown..

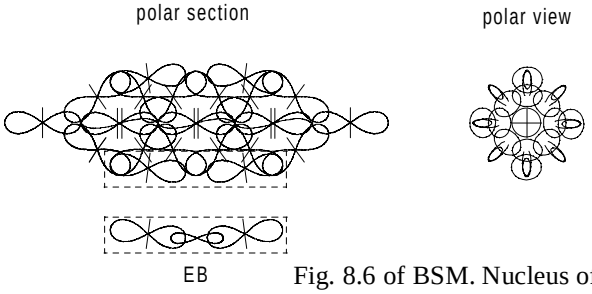

Fig. 8.6 of BSM. Nucleus of Gd

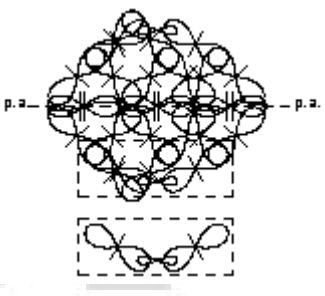

Fig. 8.7 of BSM. Sectional view of Rn nucleus. For a 45^{o} rotation around p.a. axis the sectional view is a mirror image

In both figures two axially aligned deuterons are shown in the extracted box below the axial views of the nuclei. These deuteron pairs occupy the equatorial region of the nuclei for the elements with Z > 59. If investigating the building tendency with Z number of the elements, we see that this equatorial structures are built in the Lantanides. In the building trend following the z number after the element Hf they are still in the same positions, slightly bent (due to a nuclear complicating) and partly overlapped by a new external shell of deuterons, as shown in Atlas of ANS. These pairs of aligned deuterons namely provide emission of alpha particles in radioactive decay. The possible sequence of formation of alpha particles (He nuclei) from deuterons is the following.

The two deuterons are polar bonded, while their second clubs are connected by electronic bonds (a quantum orbit containing a pair of electrons with opposite QM spins). The polar bonding means that the Intrinsic Gravitational (IG) energy modes of the internal RL(T) structures of FOHS (see Chapters 2, 6 and 8) of the protons in polar range are in synchronization. For the whole atomic nuclear system, however, the intrinsic energy balance (the balance between the intrinsic gravitational field and the EM fields) is not stable for a long term (statistically related to the half time decay). In some particular moment determined by a large number of internal mode cycles in the nucleus the polar bond fails. The released IG energy occurs quite big in the EM field energy scale. It disturbs the vacuum structure parameters for a short moment and the repulsive electrical forces between the two oriented protons are also disturbed. Then the IG forces that are inverse proportional to the cube of the distance (in a classical empty space) attract the alined deuterons and they merge into a He nucleus. The bonding electrons are lost from the process of high energy release. So the obtained He nucleus is a positive ion. Part of the released IG energy goes for emission of gamma radiation, while another part provides energy momentum to the He nucleus and the released electrons

5. Experimental evidence about the positions of the aligned deuterons

The structures of all atomic nuclei posses well defined polar axis of rotational symmetry and twisting. The twisting is defined by the twisting of the single proton and this feature is propagated in all stable nuclei. The polar symmetry is quite evident from the Atlas of ANS, while the twisting is not shown due to the drawing difficulties. The both features however play important role in the confined motion of the atom and especially for the motion of accelerated atoms in focusing magnetic field. In the confined motion of the atomic nucleus its polar axis is well aligned to the tangent of its trajectory, so the nucleus gets a spin momentum due to interactions with the vacuum structure. In such conditions the Broglie wavelength is a characteristic parameter.

The ternary fission effect is well known in the fission experiments with heavy atoms. Number of such experiments clearly show that the released alpha particles are predominantly emitted in a spatial angle centred (with some small shift) around the equatorial plane with respect to the fission axis. Fig. 5. presents a typical angular distribution of the emitted alpha particles in respect to the fission axis.

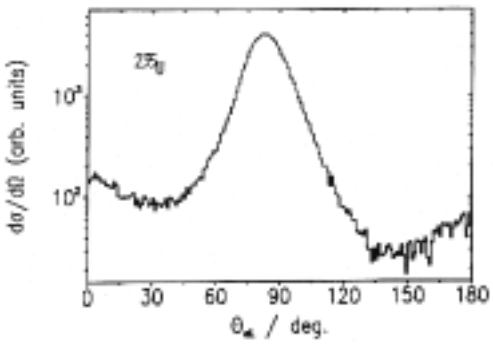

Fig. 5
Ternary alpha particle yields as a function of the emission angle with respect to the direction of light fission fragments. (From Theobald, J., Report IKDA 85/22 Technische, Darmstadt. FRG, 1985)

The observed angular distribution, from the point of view of BSM model, indicates that the emitted alpha particles originate from the aligned deuterons existing for all elements with Z > 59 (built in the Lantanides). Consequently the emitted alpha particles are result of a fusion process. In the fission experiments such process is actively provoked, but the concept of fusion from aligned deuterons is the same as in the alpha radioactive decay. **Then the alpha production in both cases: the natural and the provoked one indicates that the fusion reaction of deuterons could be achieved at room temperature.**

6. Conditions and requirements for a successful fusion reaction at room temperature

The binding energy of proton and neutron into a deuteron is calculated by approximative method in Chapter 9, §9.12.1 of BSM thesis. The calculated energy, according to BSM concept is 2.145 MeV. This is pretty close to the experimentally determined binding energy of 2.2245 MeV. The method of calculation applies a disintegration approach of the neutron along the proton polar (long) axis. The binding energy is calculated by using of IG energy balance in which one of the needed IG parameter has been obtained by the analysis of molecular vibrations in Chapter 9 of BSM. The applied method also indicates that the energy of the interacting proximity electrical fields of the neutron (locked) and the proton (unlocked) is part of the IG energy. Relying of the same method an approximative estimation of the necessary energy for the fusion could be based on the use of the classical Coulomb law but the distributed charges of the two protons in the He nucleus configuration are preliminary converted to two point charges with a proper initial distance between them. Then the necessary energy is obtainable by integrating from the initial finite distance to infinity. The obtained total energy is quite

below 1 MeV. This result, however, could be practically valid if the following requirements are fulfilled:

(a) The counter propagated deuterons are axially aligned and posses opposite linear momentums

(b) The difference between the spin angular frequency of the counter propagated deuterons immediately before the fusion is close to zero:

$$\omega_1 - \omega_2 \to 0 \qquad (1)$$

The condition (1) could be achieved more easily if positive D^+ and negative D^- deuteron ions are accelerated and collided as counter propagating beams, **but their relative spin momentum has to be actively controlled.**

The requirements (a) and (b) are demonstrated by Fig. 6 where two counter propagated D^+ and D^- are shown (p - proton, n - neutron).

Attempts for fusion of deuterons projectiles has been performed perhaps quite extensively, but the requirement (b) has not been obvious, before the analysis provided in BSM thesis. If this requirement is not fulfilled a less efficient reaction only may occur. One of most successful experiments of this type is reported by the EarthTech International, Inc. by using of Fransworth Fusor [3]. The following text is extracted from a posted report document:

"*By carefully adjusting the D2 pressure to around 10-15 millitor and applying about 20,000 volts across the grids a thin glow discharge can be established. The current is typically around 6 milliamps. Under these conditions,* ***the system produces D+D fusion in the center due to head-on collision between ~ 20 KeV deuterons****. .....Under the optimal operating conditions mentioned above, our fusor consumes about* 10^2 *watts of power from HV supply. With this input it stimulates enough D+D fusion to create about* 10^4 *neutrons/ sec. Each of the neutron-forming reactions releases 3.27 MeV. Presumably there are also an equal number of undetectable D+D reactions occurring that yield 3H, a proton and 4.03MeV. ...Counting the heat power generated by this experiment, the observed ratio of Pout/Pin is therefore 1.0000000001. Yes, EarthTech has finally observed the excess heat phenomenon*!"

Analysing this experiment from the BSM point of view it is evident that the condition expressed by Eq. (1) is not fulfilled. So a fusion process into ^{3}He or ^{4}He is not achievable (one of protons could not be inserted into another with rotational symmetry at 90 deg). What happens is: one neutron is slipped through the own proton saddle and is inserted over the other counter propagated deuteron. So the most probable result is one $^3H^+$ ion (the electrons could be easily lost) and one proton. Some slipped neutrons may not contribute to ^{3}H so scattering neutrons are also possible. The balance difference from the the nuclear binding energy is released as gamma quants and also for contributing of energy momentums of the new fragments. The common orientation of the counter propagated D^- and D^+ ions in the moment before striking are illustrated in Fig. 6. The quantum orbit of D^- contains two opposite spin electrons (circling in counter propagating directions). This shown orbital orientation is expectable because its plane is normal to the beam direction, so the circling velocity is kept constant. Depending of the velocity of accelerated deuteron it might be No 2 or lower . In such case the pitch vector velocity of circling electrons could not exceed the light velocity. The velocity of 20 KeV deuteron is 1.38E6 (m), so it is still not relativistic. According to Table 1 the electron magnetic radius is increased when No > 1, so the angular frequency of D^- could be more effectively controlled with a proper arranged magnetic field in some section of the accelerating beam device.

In a normal environments the conditional relation (1) is not achievable, because the both protons have the same twisting (for example right handed), so they get spin direction from their confined motion in the Cosmic Lattice space. **External spin control is necessary in order to satisfy the conditional Eq. (1).**

The current technology of particle accelerators now possesses the technical means that may allow the fulfilment of the conditional Eq. (1) in order to obtain ^{4}He or ^{3}He. Additional consideration related with the relaxation constant of the vacuum structure, however, are also important and must be taken into account. They are not subject for discussion in this paper.

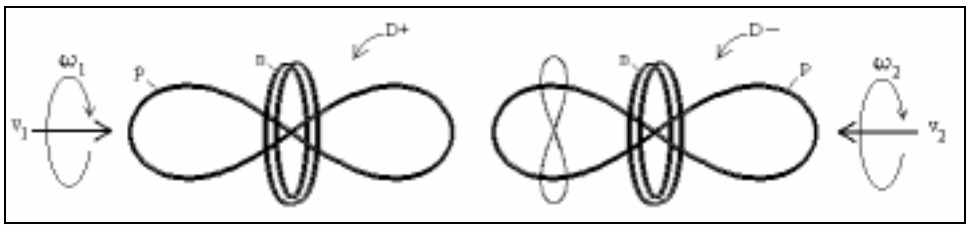

Fig. 6. Axial orientation and spin momentum conditions for counter propagated deuteron ions.

References:

1. S. Sarg, BSM theory, 2001
2. S. Sarg, Atlas of Atomic Nuclear Structures, 2001
www.helical-structures.org (BSM theory and Atlas of ANS)
(Both materials are archived also in the Electronic Collections of the National Library of Canada)
3. EarthTech's Farnsworth Fusor - Version/ 17Mar99
www.earthtech.org/experiments/default.ht

Notes:

(1) The BSM concept relies on analysis of broad range experimental data. Reference material about the used experimental data is provided in the BSM thesis.

(2) The equations put in square brackets have a same numbering as in the BSM thesis. The digit before the period indicates the chapter's number.