Nuclear Mesomerie

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Abstract
The nucleus is made with **nuclear matter**. This nuclear matter apparently looks like **a gas**, a Thomas – Fermi [1] gas, or like **a liquid** drop Bohr [2], or like **a solid** [3] (for the nuclei decaying through super deformed bands of gamma rays). We try to understand these apparent forms of nuclear matter through: the cumulative interaction [4], [5] in the nuclei (a three body nuclear special interaction) and by using the Heisenberg transformation (based on the uncertainty principle on energy and time of the nuclear matter). These cumulative interactions can transform the "**gas**" nuclei or the "**liquid**" nuclei or "**solid**" nuclei in nuclear matter.
For a short interval of time, we imagine a Heisenberg partial or total dissolution (transformation) of the nucleus in a "solid" or a "liquid" or a "gas" nucleus. The free nucleons will condense through the cumulative interactions and will reconstruct the quantum structure of the nucleus. These many different states of the bi- or tri- nuclear phases are the mesomeres states of the nucleus with the given total energy, angular momentum, etc. Through these mesomeres states we try to understand the stability of the nucleus in terms of their maximum number.
The Heisenberg partial or total dissolution of the nucleus followed by a partial or total quantum reconstruction are an oscillatory movement from chaos (disorder) to the order [7] going through mesomeres states. More are their number bigger is the stability and to the lifetime of the nucleus.
A theoretical approach to the mesomeres states can follow the Strutinsky recipe [8], where the quantum Shell Model correction simulates Heisenberg dissolution process.
Keywords: nuclear dynamic, stability, cumulative interaction.

1. Introduction

The chemistry and physics are two sciences that try to describe the same object: the matter. To explain the changes in physical status of the matter, we are using physical laws of movement, energy or momentum conservation, with the prescription of Newton, Maxwell, Einstein, etc. For the statistical comportment of the enormous quantity of atoms and molecules the physicist introduce the statistical equilibrated notions like: temperature, pressure, and we are speaking of an average energy of a molecule and the temperature of a collection of large number N of molecules (N of the order of hundreds at list).

The laws that permits to explain the changes in chemical nature like: nature of molecules are named chemical laws. For example: when salt in water is split in ions of sodium and chloral we have dissolution of the salt in water. To describe a comportment of large number of entity we are using chemical laws: Dalton law, chemical affinity, laws of Gibbs or Châtelier, etc.

Most of the time we are able to understand the chemical laws on a basis of basic physical laws: starting with Newton classical mechanical laws or with Maxwell laws of the electricity. There are also examples when the chemistry helped the physics (Mendeleïeff periodic table).

Nevertheless, the dream of the human kind is to explain everything with a smallest number of laws and equations (and parameters). With two words we resume that in: the "big unification".

To go forward in understanding the matter, the scientist accepted to do small, but sure steps. The Chemical Mesomerie is an easy tool to understand the great stability of many molecules like benzene or polyene, etc. Through the quantum mechanical calculation this stability was well defined, but in the complexes case the quantum explanation is difficult to achieved.

That notion "mesomerie" is well adapted to describe the stability and evolution of the nucleus without tremendous many body calculations. For the nucleus, by using the $\Delta E.\Delta t \geq \hbar$ uncertainty Heisenberg relation, we imagine a Heisenberg partial or total dissolution of the nucleus in a "solid" or a "liquid" or a "gas" nucleus (in himself). This is a part of mesomerie state. Once again, the cumulative interactions will reconstruct the nuclear matter in a quantum structure (shells) of the nucleus. These many different states of the bi or tri nuclear phases are the mesomeres of the nucleus with the given total energy, isospin, total angular momentum. By evaluating these mesomeres states we try to understand the stability of the nucleus in terms of their maximum number.

The Heisenberg partial or total dissolution of the nucleus followed by a partial or total quantum reconstruction are a kind of oscillatory movement from chaos (disorder) to the order [7] going through many mesomeres states. We try to give some hints for a theoretical approach to the mesomeres states follow the Strutinsky recipe [8] where the quantum shell model corrections simulate our Heisenberg nuclear dissolution process.

2. Chemical Mesomerie

Faraday discovered the benzene in 1828. Initially the molecule was assigned with CH. But the carbon has four bonds and finally the chemists suggested C_6H_6. This molecule seems to be a very stable one. Kekule proposed the right spatial configuration in 1858. Six electrons are in π states and they are different bond.

The movement of these six electrons "around the cycle" is named chemical mesomerie. Physical explanation of this phenomenon (resonance) is obtained through the quantum mechanics (or simplified Hükel model). Real process is "dissolving" an electron of an atom in a continuum of the carbon ring and next reconstruction of the "new atom" by cumulative effect. Here we have only three distinct positions. This reinforces the stability of the carbon ring of the benzene by almost 150 kJ mol^{-1}.

Another example is the aniline. The actual structure of aniline, the two unshared electrons of the nitrogen would reside entirely on that atom. Since the real structure is a hybrid that includes contributions the other canonical forms shown, the electron density of unshared pair does not reside entirely on the nitrogen, but is spread over the ring. This decrease in electron density at one position (and corresponding increase elsewhere) is called **mesomeric** (resonance) **effect**. We loosely say that the NH_2 contributes or donates electrons to the ring by a mesomeric effect, although no actual contribution takes place.

3. Nuclear Mesomerie

The nuclear mesomerie is a new concept of the dynamical nuclear states which transform nuclear matter continuously from chaotic (liquid drop or gas model like) one to quantum ordered one (shell model like). Nevertheless the mesomeres states are much more complicated than the chemical ones, the principal point is that their evolution are cyclical like in chemistry. For the moment is difficult to put in evidence them. But, in order to understand this kind of states, or to find their dynamics and the equations satisfied by this kind of movement of nuclear matter, we have to remember few of classical nuclear data, which support our supposition of the existence of nuclear mesomeric states.

3.1. Nuclear Models

3.1.1 Liquid Drop Model

In the history of nuclear science the liquid drop model (LDM) was the first model to be proposed to explain different properties of the nucleus. This LDM is a phenomenological model, based on physical observation of saturation properties and from the very low compressibility and a well-defined surface. In the other respects a nucleus does not bear very much resemblance to an ordinary liquid. In a nucleus of few fm ($1\text{fm} = 10^{-15}\text{m}$) the nucleons are in average 2.4 fm apart much larger than distance of inter-particle force of 0.7fm, reason for this is that the nucleons obey Fermi statistics and a nucleus is a quantum fluid. The Pauli principle prevents the nucleons coming too close (no collisions). The scattering events are very scarce in a quantum fluid, whereas in an ordinary fluid they are predominant.
The mean free path of the nucleons inside of a ground-state nucleus is of the order of the nuclear dimensions and we have a kind of non-interacting gas.
Most important result in the LDM is a simple (analytical) formula for the binding energy of a nucleus B(Z,N). Like we underline in [4] the binding energy of a nucleus is the most important characteristic of the nucleus; this binding energy can give us important part of the nuclear physics, "nuclear life".
In fact, the total binding energy B(Z,N) where Z and N are the protons and neutron, respectively, grows with the number of nucleons, A , A=Z+N, in a such a way that the binding energy per particle B(Z,N)/A stays fairly constant for A>12:

$$B(Z,N)/A \approx -8{,}5 \text{ (MeV/nucleon)} \tag{1}$$

The binding energy can be attributed to the saturation property of the nuclear force: one nucleon interact only a limited number of nucleons (short range nuclear forces and the combined effect of the Pauli and uncertainty principles).
The saturation property also explains qualitatively the features found experimentally:

a) rough constant density, b) relatively sharp surface:

$$R = r_0 A^{1/3} \qquad (2)$$

where $r_0 = 1{,}2$ fm.
The best-known formula to reproduce the behaviour of B/A as function of Z and N (A=Z+N) is the semi-empirical formula of Bethe and Weizsäker [10], [11]

$$B(Z,N) = a_V + a_S A^{2/3} + a_C Z^2/A^{1/3} + a_I \{(N-Z)^2/A\} - \delta(A) \qquad (3)$$

where: $a_V = -15.68$ MeV ; $a_S = 18.56$ MeV ; $a_C = 0.717$ MeV ; $a_I = 28.1$ MeV

and $\delta(A)$=($34A^{-3/4}$ for even-even; 0 for even-odd; and $-34A^{-3/4}$ for odd-odd nuclei)

First term in (3) is volume term; the second one is surface term; the third is Coulomb (repulsion of the protons) and the fourth term symmetry energy (in the Fermi gas model [12]); the δ term is due to the so-called pairing effect.

As we mentioned in the LDM the surface of the nucleus is a sharp one, spherical or can undergo to dynamical shape or surface oscillations. To study the surface oscillations (about a spherical shape) or rotations and vibrations for deformed shapes, we follow usual rules of canonical quantized form of collective motion:

$$H\ coll = \Sigma_{\lambda\mu}\, \hbar\, \Omega_\lambda (B_{\lambda\mu}^{+} B_{\lambda\mu} + 1/2) \qquad (4)$$

with the frequencies:

$$\Omega_\lambda = (C_\lambda / B_\lambda)^{1/2} \qquad (5)$$

and B_λ, C_λ being related to the surface parameters of the nucleus α_0, α_2, α_4, or in function of multi-polarity λ, number of masse A, number of charges Z, electrical charge of the proton e, nucleon masse m, nuclear (spherical) radius R and coefficient of surface tension σ:

$$B_\lambda = (3/4\pi\lambda)\, A\, m\, R^2 \qquad (6)$$

$$C_\lambda = (\lambda-1)(\lambda+2) R^2\sigma - ((3(\lambda-1)/2\pi(2\lambda+1))(Ze)^2)/R \qquad (7)$$

We underline that observed gamma transitions are related only with the surface of the nucleus. The nucleons inside are in a chaotic movement. These are small vibrations around the equilibrium shape.

LDM was successfully applied to understand the phenomenon of nuclear fission. Six months after the experimentally discovery of the fission induced by neutrons by Hahn and Meitner, Bohr and Wheeler [13] gave the theory of the phenomena in May 1939.

In fact, a uniformly charged classical drop is only stable against fission if the Coulomb energy does not exceed a certain critical value. The Coulomb repulsion wants to deform the drop, the particles then being, on average, further apart. The surface energy, on the contrary, being proportional to the surface of the drop, wants to keep it spherical. It is thus a subtle process of balance between these two effects (each being several hundred MeV in magnitude), which tells us whether there will be fission or not, according to a classical calculation.

The only parameter that characterises the nucleus is so-called fissibility parameter x. From the definition of x we find:

$$x = E_C(0)/2E_S(0) = (Z^2/A)/(Z^2/A)_{crit} \tag{8}$$

where:

$$(Z^2/A)_{crit} = (40\pi/3)(r_0^3\sigma/e^2) \approx 50 \tag{9}$$

3.1.2. The Shell Model

The LDM describes collective phenomena, such as vibration and rotations, where all the nucleons are involved. A completely different approach, a shell model approach, is obtained if we consider the nucleons in a nucleus like independent particles moving on almost unperturbed single particle orbits in a mean field of all the nucleons of nucleus. It is argued that based on the action of Pauli and Heisenberg uncertainty principles, the nuclear density is rather week, the nucleons "feel" only the tail of the attractive part of the nuclear forces. Nevertheless, the motion of the nucleons will be considerably different in the interior of the nucleus, where it is more or less force free, from the one at the surface where the Pauli principle ceases to act and the particles feel a force confining them to the interior of the nucleus.

The strongest motivations for the formulation of a nuclear shell model is the occurrence of the so called experimental magic numbers 2, 8, 20, 28, 50, 82 and 126 The magic and double magic nuclei are exceptionally strongly bound. The nucleus is very stable against excitations to the first 2^+ state for example.

With the simple potential V(r) of the Woods Saxon or Square well (infinite walls) or Isotropic oscillator is not possible to explain the magic numbers 28 and higher. In 1949 Mayer, Haxel, Jenssen and Suess [14] came with their decisive idea to incorporate a strong spin-orbit term into the single particle Hamilton operator. The new Hamilton operator is:

$$(-\hbar^2/2m\,\Delta + V(r) + \lambda/r\,(dV(r)/dr))\,\Phi_i(r) = \varepsilon_i\,\Phi_i(r) \tag{10}$$

where the term $\lambda/r\,(dV(r)/dr)$ (with $\lambda = -0.5$ (fm^2)) is the spin orbit potential, yields from using the Skyrme forces (where tree body interaction are taken into account).

The shell model can be used as a basis for more elaborate many body theories, which is a quantum mechanical system, where the velocities are small and we can neglect the relativistic effects ($(v/c)^2 = 0.1$) and its believed that the interaction between the nucleons has a two body character.

Through the shell model we can explain the single particle (hole) states, electromagnetic moments and transitions. By taking into account the deformed potential like in Nilsson model we can use the deformed shell model to explain the rotational bands, very large quadrupole moments, fission isomers. To describe the fission phenomena a two centre shell model was developed, or by using folded Yukawa potential or generalised Woods Saxon.

Our article tries to demonstrate that the cumulative interactions play an important role in nuclear matter being the driving force towards the stability.

3.1.3 Fermi Gas Model

Starting with the N nucleons (gas of nucleons) in a box of the volume V in equilibrium with the temperature T, we can find the probability of a nucleon to have the energy E:

$$F(E) = 1/(1 + \exp((E-E_F)/kT)) \quad (11)$$

is the Fermi distribution and k is the Boltzmann constant and E_F is the Fermi energy of the system. The E_F is related to the momentum p_F of this gas by:

$$E_F = p_F{}^2 /2m \quad (12)$$

By counting the number of the elementary cells where a particle has a momentum between p_F and $p_F + dp_F$ is

$$d\nu = (V\, 4\pi\, p^2\, dp)/h^3 \quad (13)$$

With the spin $s = ½$ the multiplicity is ($g = 2s+1$) and we find N particles by integration from 0 to p_F momentum.

$$p_F = \hbar\, (3N/8\pi V)^{1/3} = \hbar\, (3\pi^2 N/V)^{1/3} \quad (14)$$

And the Fermi energy in a non-relativist case:

$$E_F = p_F{}^2 /2m = \hbar^2/2m\, (3\pi^2 N/V)^{2/3} \quad (15)$$

If we define thermal wave length (De Broglie) for that gas like:

$$\lambda_T = \hbar/p = \hbar/ (2mkT)^{½} \quad (16)$$

then we have a degenerated Fermi gas if:

$$n\lambda_T^3 > 1 \tag{17}$$

With $R = r_0 A^{1/3}$ and $r_0 = 1{,}1$ fm and supposing that N=Z=A/2 we find

$$E_F(n) = E_F(p) = \hbar^2/2m\, r_0^{\ 2}\ (9\pi/8)^{2/3} = 37 \text{ MeV} \tag{18}$$

And by calculating the kinetic energy per nucleon by the integral:

$$T(N) = \Sigma\, T_i = \int p^2/2m(2\ V4\pi p^2/\hbar^3)\, dp\ = 3/5\ N\ E_F \tag{19}$$

hence: T(A)/A

$$T(A)/A\ = 3/5\ E_F\ =\ 21\text{MeV} \tag{20}$$

To calculate the binding energy we have:

$$B\ =\ (-37 \text{ MeV} + 21 \text{ MeV})\ /2 = -\ 8 \text{ MeV (roughly the experimental value).}$$

In conclusion Fermi gas of the nucleus give a good approximation of reality. The fact that despite these considerations the nucleus develops a very well defined surface, contrary to a gas, is due to a very subtle interplay of the nuclear forces and the Pauli principle.

3. 2. Cumulative Interactions

We presented in [4] experimental evidence for emission of the light particles: protons, alphas etc. with very high energies, near the kinematics limit in a given reaction. It means that the "compound nucleus" formed in the heavy ion reaction become cold, all the kinetic energy being given to the light particle. Example:

$$^{20}\text{Ne (174 MeV)}\ +\ ^{232}\text{Th} \longrightarrow \alpha\text{ (156 MeV)}\ +\ ^{248}\text{Fm}$$

in the forward direction.

To explain these experimental facts we postulate the existence of a new kind of interaction: **cumulative interaction** [5]. We remember that is a special three body collision when three free parts of nuclear matter (1, 2, 3) interact by this cumulative interaction and we obtain two new parts, a new 4 (4 $= 1\ \Theta\ 2$ for example) **binded** one and the 5 (in general is the same 3) which take the energy resulted from binding process of 1 and 2.

To better understand this cumulative interaction we recall the laser process suggested by Einstein for coherent light emission: an excited atom (an electron in an excited state $E^* = h\nu$) is resonating with a γ quanta (of the same frequency ν passing near by), and the excited atom is decaying by emission of new γ quanta (of the same frequency ν) became more binded. The number of γ quanta (of the same frequency ν, same energy) are doubled etc.

The process can continue up to create the final non-excited nucleus plus a particle with an enormous kinetic energy (particle near kinematics limit) that will be "evaporated – ejected" to cool the nuclear matter. When energetically favoured the process can go through the fission where the nucleus release up to two hundred MeV or more at once.

The third particle can leave the nucleus at any time if the conditions are fulfilled.

The process can continue by emission of gamma ray, electromagnetic decay of the nucleus.

To have some hints about these interactions we look to the Skyrme force [6] where is introduced three body interaction with approximate 5% of total intensity. In the case of cumulative interactions we have a creation of the new particle of nuclear matter and the interaction is much more focused than in three bodies, which is spread over the three particles. We don't have particle hole creation or scattering like usual. We have in total five peaces (initial three which go into final two), which conserve the energy, parity and other quantum number (like isospin and angular momentum).

The general expression of the potential: $V_{1,2,3} = g\ f(1\Theta 2, 3)\delta(r_1-r_2)$ where g is for intensity of this potential interaction. F can be express in the form $f_a * f_b$ and f_a is dependent of Qgg(1,2).

3. 3. Heisenberg Dissolution of the Nucleus

The nuclear matter obeys to the quantum mechanics. To each peace of nuclear matter we can associate a wave with a de Broglie length λ, and the general principles of the quantum mechanics must be fulfil. The Pauli principle and the Heisenberg uncertainty law:

$$\Delta E.\Delta t \geq \hbar \qquad (21)$$

This was successful applied to calculate the lifetime of resonance characterised by the energy E and the width ΔE. For example a isobaric analogue resonance has a width of 65.8 keV. Than the lifetime is obtained by the formula:

$$\Delta T_{1/2} = \hbar / \Delta E \qquad (22)$$

$\Delta T_{1/2} = 10^{-20}$ s is a rather short time ($\hbar = 6.58\ 10^{-22}$ MeV s,).
For the neutron resonance, of the order of 6,58 eV, $\Delta T_{1/2} = 10^{-16}$ s, almost measurable.

In the nucleus the states can fluctuate for short time and consequently their energy fluctuation ΔE can cover another state, altogether this fluctuation can give a continuum density of energy states, a chaotic situation where the nucleus is dissolute in itself. This happens in a very short time of the order of 10^{-23} s or less. The nuclei became a gas, a liquid or a solid state, with chaotic movements of the nucleons and with a rather high virtual excitation energy (hundreds or thousands of MeV).

We find that the nucleus appears in the forms of the nucleus studied before, and the experimental facts suggest taking in one of that model in consideration.

The nucleus formed by Heisenberg dissolution has the same (negative) binding energy, but virtually (positive) energy and give us the impression that the nucleus is composed of free nucleons.

3. 4. Cumulative Reconstruction of the Nucleus

The cumulative collisions (laser like) will act towards reconstruction of nuclear matter with bond nucleons and excess energy is concentrated on few part of nuclear matter, to cool down the virtual heated nucleus. This kind of nuclear part can be a gamma, proton, neutron, alpha particle, ^{14}C etc. If the final state of the mesomeric state has excitation energy the reconstructed nucleus go down through a transition, disintegration, or an electromagnetic decay, etc.

Once the transition finished the new state of the nuclear matter is achieved and the Heisenberg dissolution process start again.

The nuclear matter make oscillations in this manner all the time, searching to minimise the total excitation energy contained in the nuclear matter, it means to maximise the binding energy (example the fission of the transuranium elements – their binding energy 7 – 7,5 MeV/A is smaller than the binding energy of the two new part of nuclear matter of the order 8 - 8.5 MeV/A.

This minimisation take into account not only the energy but also the other entity like shapes, angular momentum, spin, isospin.

Nils Bohr [9] intuitively approach this phenomena and postulate the "compound nucleus (CN) " formation when a neutron reach a nucleus. A big number of neutron resonances can be observed in such experiment. The energy brought by the neutron is redistributed through all the constituents. This is the dissolution of the nucleus and cumulative reconstruction, a transition, a tiny resonance appear. In [15] we have a nice appreciation of the Bohr philosophy: "As for the quantum case, already the pioneering paper on compound nucleus by Bohr [9] contains on equal footing elements of both patterns, chaos and thermalization".

3. 5. Nuclear Mesomeric States

The nuclear states studied through the Hartree Fock, LDM, Shell Model, TDA (Tamm Dankof Approximation), RPA (Random Phase Approximation) etc., give the possibility to understand some of the excited states of the nucleus, which appears in the nuclear reaction like (p, p'), (d, p), (HI, xn), etc. The theories take into account the general principles: invariance of the particle Hamilton operator on the translations, rotations, conservation of the spin and isospin, conservation of the particle number, etc.

When dissolution of nucleus and the reconstruction of the nucleus take place the huge number of partition in different possible shapes is enormous and a statistical treatment is necessary.

All the states that participate from the dissolution final reconstruction of the nucleus are the mesomeric states because they obey to the general definition: they are solution of the Schrödinger equation, with final result maximisation in the frame of given condition (anticipation of the condition), to maximise the binding energy of the final nucleus.

3. 6. Experimental Evidence

From our understanding of the mesomeric process related to the decay of the nuclear excited states, we could think that our model will give hints to understand following experimental facts:

a) Particles emitted in nuclear collision with high and very high velocities (PNKL) [4]. That particles can be simple nucleons: proton or neutron, but also more complex particle like ^{4}He (α particles) or ^{14}C. From the energy spectra of the DITR we can see that almost all the products have a high-energy part; we can include them in the PNKL.
b) Many level schemes obtained from gamma decay of the excited nuclei present so-called shape coexistence phenomena. Our understanding of that is following: at one stage the mesomeric state have to choose between two shapes that are equal in Binding energy final result. The decay will present the both ways: shape coexistence.
c) In our days the SDB (super deformed bands) are studied for more than hundred nuclei and they don't present clearly a way in their decay to the ground state. For most of SDB there are not link with the ground state. Our interpretation of this missing gamma link is: that at the moment where the mesomeric state have to choose to follow the way toward the ground state the electromagnetic decay is more "expensive" in (energy) time, hence the "evaporation" of a neutron is faster and the final binding energy is maximal. It means that the chain of electromagnetic gamma ray decay are interrupted by an evaporation of a neutron (or few) and continued after that by other gamma rays (gamma, n, gamma). This process can be easy understood by our theory.
d) The calculation of width of alpha decay of a radioactive nucleus is realised through the formula [16]:

$$\Gamma(R) = \gamma(R)P(R) \qquad (23)$$

where the $\gamma(R)$ is the probability of the formation of the alpha particle at the distance R and P(R) penetration factor through the potential barrier (tunnel effect, firstly explained by Gamow in 1928. The physical process of the formation of alpha particle is now clear (in our theory), invocation of cumulative interaction. The binding energy of alpha particle is of 28MeV, therefore by "evaporation – decay " through alpha the nuclei is most rapidly cool down of the excited energy.

e) The shape of the nucleus is a special parameter in the Heisenberg dissolution reconstruction of the nucleus. In the process developed trough the mesomeric states the shape of the nucleus come in the natural way in calculation of the minimum excitation energy and maximise the binding energy. Bertsch [17] suggest an idea of jumping from a level to another, which somehow imitate our mesomeric states.

4. Theoretical Approach to Mesomeric States

To improve the estimations of the binding energies calculate through the formula (3) given by Bethe and Weizsäker [10], Strutinsky suggested to use in the calculation of the shell corrections of oscillatory part of binding energies a function of the form:

$$f(x) = P(x)\, w(x) \tag{24}$$

where $x = (\varepsilon' - \varepsilon)/\gamma$ (ε' being the continuum energy variable and ε the energy of the particular state, $\gamma = 1-1.5\ \hbar\omega_0$), P is a polynomial of degree 2M (formed by a product of orthogonal Laguerre polynomial) and for w(x) which play a role of weighting function can be an exponential expression like a Gaussian. The results of calculations will not depend of the parameter γ for a fixed M if "the plateau condition" [18] is satisfied, like was obtained also in [16] $\delta E_{sh}/\delta\gamma = 0$, E_{sh} being the smooth part of energy.

If we recall that $w(x) = (1/\sqrt{2})*\exp(-x^2)$ we can interpret the γ like ΔE from the Heisenberg uncertainty relation and hence we obtain an overlap of the levels. This superposition of the levels we named Heisenberg dissolution and give the possibility to have a continuum of energy, and the nucleons in that nucleus can be considered like "quasi free particles».

The theory of Strutinsky quantum shell corrections was used in relation to shell model and liquid drop model has been applied with great success to the calculation of the binding energies of the nuclei, or to estimate the fission life times of heavy or super heavy elements.

To calculate the isomeric states we can use the Strutinsky recipe and take the Hamiltonian of the general form:

$$H = H_{LDM} + H_{shell} - H_{sh} \tag{25}$$

where H_{LDM} is the Hamiltonian for collective movement, H_{shell} is the Hamiltonian tacking into account the single particle movement and H_{sh} is the Hamiltonian that simulates the Heisenberg dissolution. A statistics of the states, like a density levels type, will give a quantity proportional with the stability or lifetime of the nucleus.

5. Conclusions

The nuclear matter in the normal nucleus at the not so high-excited energy is an oscillating system. The energetically states of the nucleons are oscillating from chaotic (continuum) to ordered (quantized). Through the cumulative interactions and Heisenberg dissolution we understand these oscillations and we try to get more inside through the characteristics of the mesomeres states.

The mesomeric states, can be used to explain the super deformed band decay to the ground state: the most probable is a decay SDB through a neutron evaporation to the normal states, and less probable by a big transition or an huge amount of small Electro magnetically transitions.

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