Is Gamma-Less Transmutation Possible?

-The Case of Metal plus TSC and BOLEP-

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Abstract: Very speculative modeling and discussions are made for considering a nuclear physics possibility of Iwamura-type (A, Z)-selective transmutation without hard gamma-rays. The BOLEP (burst-of-low-energy-photons) energy damping mechanism from very highly excited intermediate nucleus by the 4D/TSC-min capture to host metal nucleus is basic idea, after the analogy of ^{8}Be* nucleon halo model for the BOLEP energy damping to ^{8}Be ground state. The very highly excited intermediate nucleus ^{141}Pr*(Ex = 50.49 MeV) by 4D + ^{133}Cs capture reaction may have a two-alpha-halo rotation-vibration deformed state, which would make avalanche energy damping via BOLEP.
Keywords: Gamma-less transmutation, two-alpha halo model, BOLEP, Iwamura transmutation

1. Introduction

The extraordinary claim of discovery of selective transmutation with mass-charge (A, Z) sifting was reported by Iwamura et al [1], by deuterium-gas permeation through Pd/CaO multi-layer film on which surface ^{133}Cs was deposited. The claimed nuclear transmutation is ^{133}Cs to ^{141}Pr, namely (A+8, Z+4) selective sifting, as typical data are shown in Fig.1. Several replication experiments were done to confirm the phenomenon positively [2, 3]. Especially, the latest study [3] by Hioki et al reported convincing data of ^{141}Pr production with anomalously large (relatively in order of magnitude) amount. So the claim of observation looks real.

However, if the observation was by real nuclear transmutation reactions, there remain unresolved puzzles and questions: 1) Why (A, Z) selective sifting happens? 2) Why it happened only for surface-deposited Cs, not for other elements as Pd, Ca and O? 3) What is the role of CaO layer, supposing Pd might has some effect on unknown condensed matter nuclear reactions? 4) Why no intense hard gamma-rays were observed, if nuclear transmutation by capturing 4D or 2-alphas capture to ^{133}Cs? And some other questions arise. The author focuses on the question 4) in this work to try to find some rational path to damp very highly excited nuclear energy of medium-heavy nucleus to its ground state without emitting hard (high energy) gamma-rays.

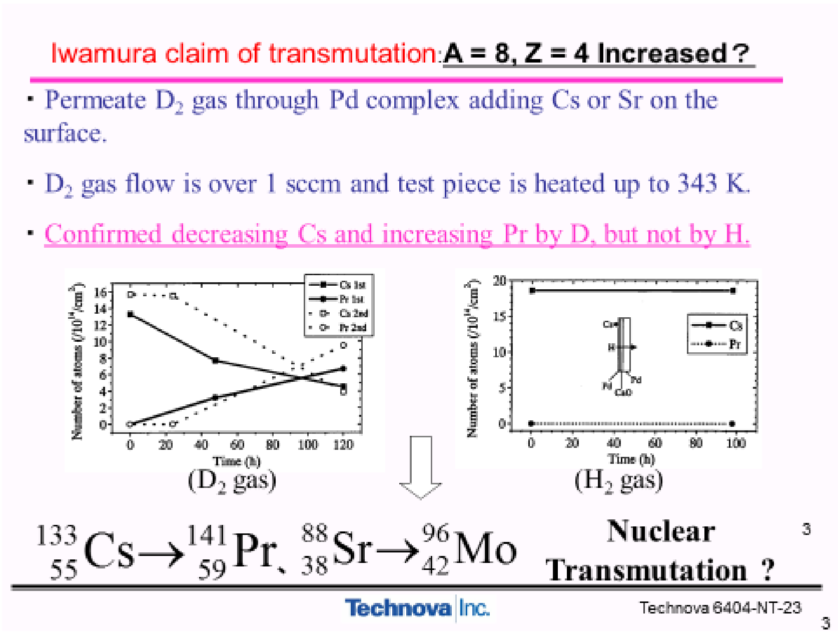

Fig.1: Selective transmutation data claimed by Iwamura et al [1]

Is Iwamura 'Transmutation' a real nuclear reaction? It is mystery with unknown theoretical mechanism. A model of selective transmutation of ^{133}Cs by A-8 & Z-4 increase by 4D/TSC capture was proposed [4] to explain possible nuclear mechanism of the phenomenon. This model answers why the (A, Z)-selective transmutation can happen. However, it could not resolve the 'head-ache issue': why hard gamma-rays were not emitted. In the conventional sense of nuclear physics, such transmutation should damp its ^{141}Pr* nuclear excitation energy of intermediate compound nucleus by mass defect (50.49 MeV) by some electro-magnetic transition. But how does it go without emitting high energy gamma-rays? Is the BOLEP (burst of low energy photons) from nucleon-halo state [5] as proposed for ^{8}Be* after 4D/TDC fusion applicable to the Iwamura transmutation?

M(metal-nucleus) + 4D/TSC fusion may take place with much higher rate than M + 4H/TSC reaction, because of 'very long' life time (a few ms or more) of ^{8}Be* cf. a few fs life of 4H/TSC-minimum: ratio is $10^{-3}/10^{-15} = 10^{12}$: and <W> value is much larger too. (This may explain why 'transmutation by H-gas was not observed by Iwamura.)

Damping very high-energy (ca. 50 MeV) excitation of compound nucleus of metal plus 4D/TSC-min (^{8}Be*) by the BOLEP mechanism might be a possibility. Very high spin rotation/vibration mode of 2-alpha-halo state of intermediate excited nucleus is a candidate model. However, the model is very speculative and is yet to study more detailed possible transition channels

2. Brief Summary of 4D/TSC + Metal Interaction

Let us remember the original model [4] briefly. According to the results of QM-Langevin code calculations for cluster condensation [6, 7, 8], 4D/TSC may get into the collapse state with so small size as 20 fm keeping charge-neutrality in several fs after the start of condensation. Such a very small charge-neutral entity may pass through the multi-layer shell of electron cloud of target host metal atom to approach at the core nucleus of metal atom, behaving something like a 'neutron'. An image is shown in Fig.2 for the charge-neutral small entity of 4D/TSC-minimum penetrating through the multi-shell electron cloud of target metal atom which will have the inner-most K-shell electron orbit about 1 pm radius which is much larger than the size ca. 20 fm of 4D/TSC-minimum.

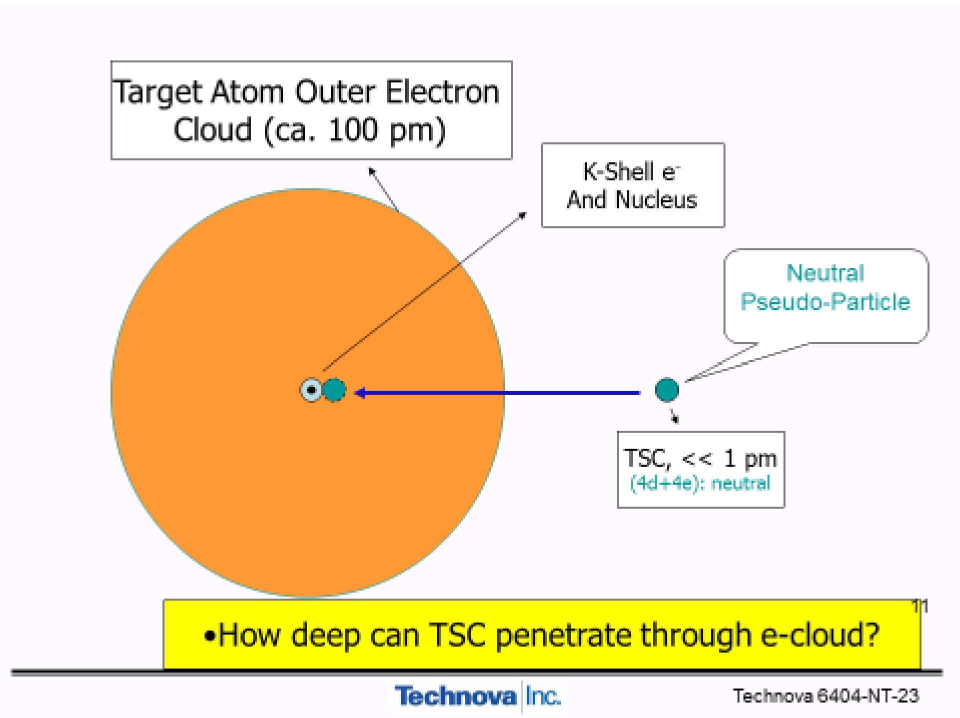

Fig.2: Image of penetration of charge-neutral 4D/TSC-minimum through the electron cloud of target metal atom to approach the core nucleus

Considering the elongated life time of intermediate compound nucleus $^{8}Be^{*}$ by 4D/TSC fusion [5], with status shown in Fig.3 for surrounding left 4 electrons of TSC, supposed 4D/TSC plus metal-nucleus fusion rate may become much larger for 4D/TSC than the 4H/TSC [9] plus metal-nucleus interaction rate. This might explain why Iwamura observed transmutation dominantly for deuterium gas and non-visibly for protium gas (see Fig.1). In Fig.4, image of fusion strong interaction of 4D/TSC and Cs is shown.

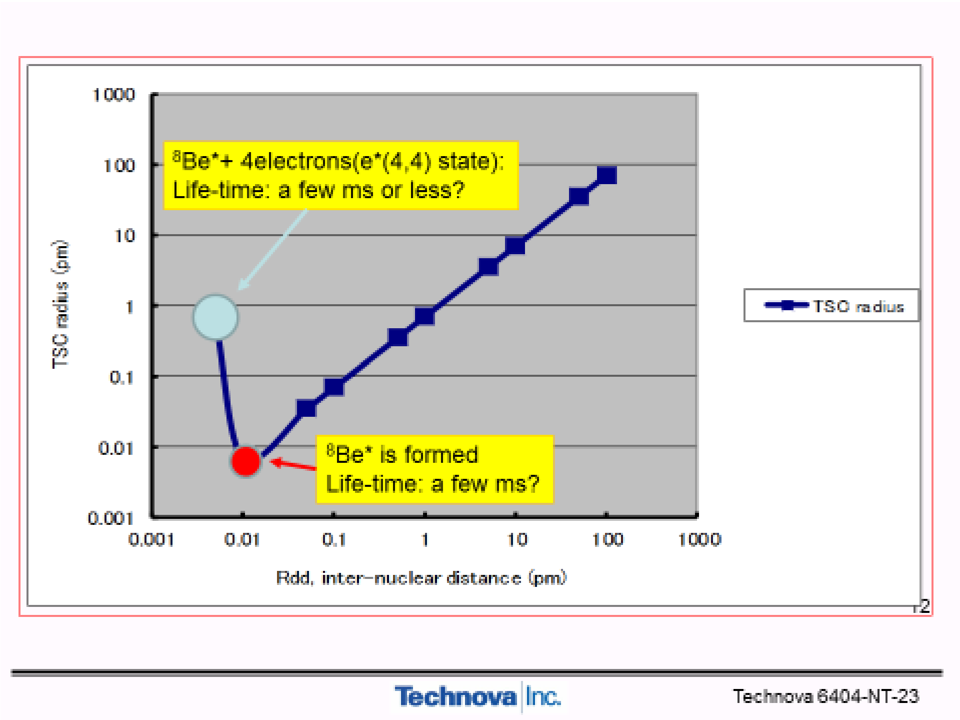

Fig.3: Image of 4D/TSC condensation-collapse and ^{8}Be* state with bosonized electrons

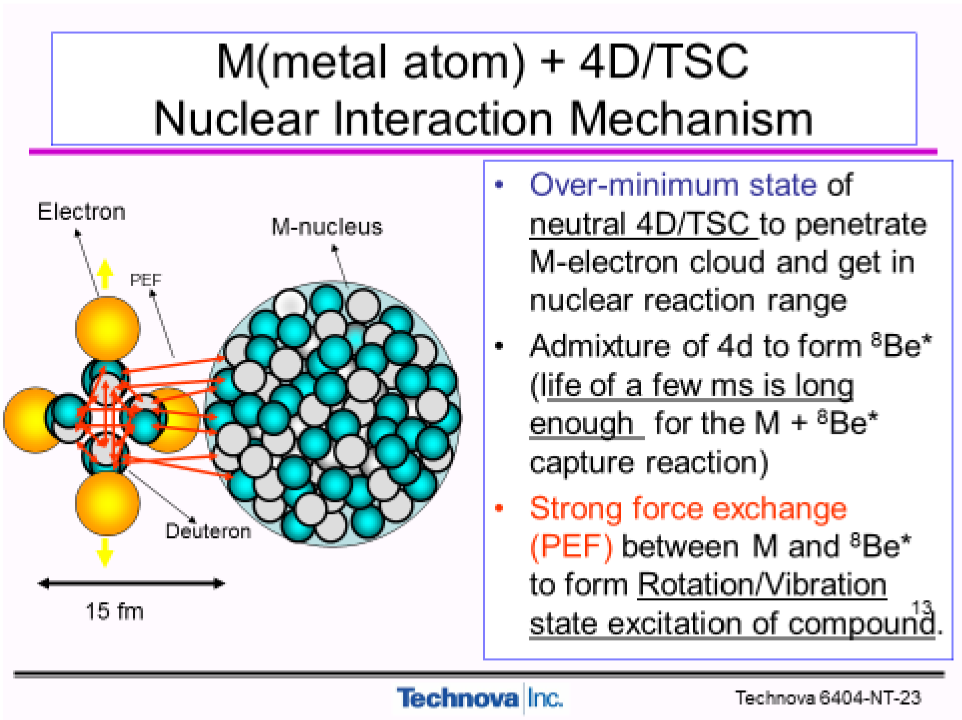

Fig.4: Image of strong interaction of ^{8}Be* and metal-nucleus, many PEF strings between p-n pion exchanges to induce ^{8}Be* + heavier-nucleus fusion event

The fusion rate was estimated by the sudden tall thin barrier approximation (STTBA) [4], as the view graph is copied in Fig.5. Rate estimation is shown in Fig.6.

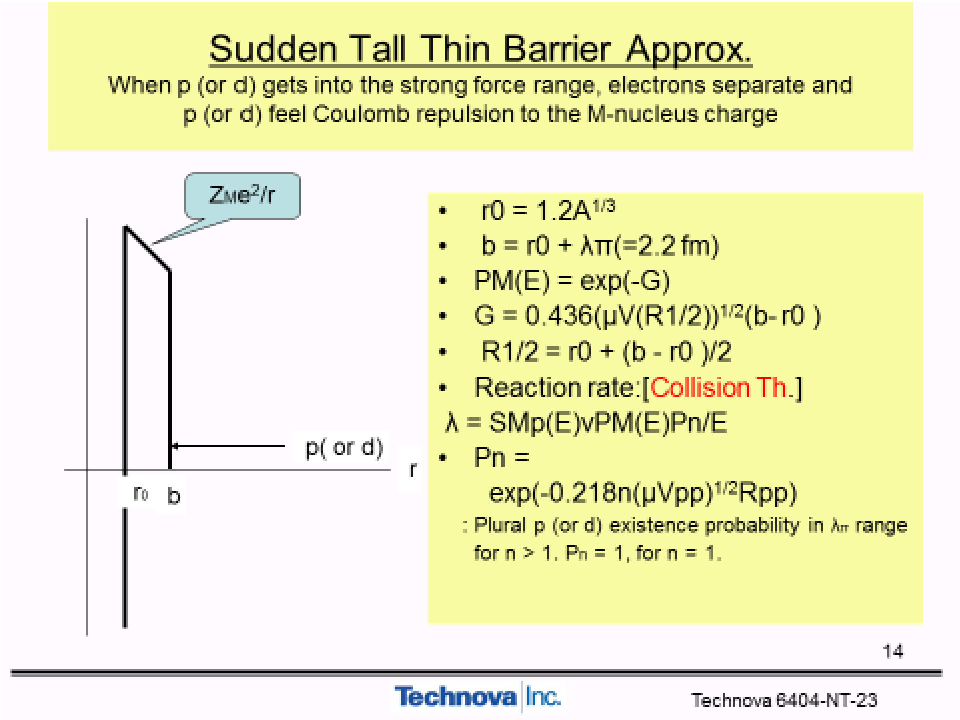

Fig.5: TSC + metal-nucleus fusion rate is approximately estimated by STTBA

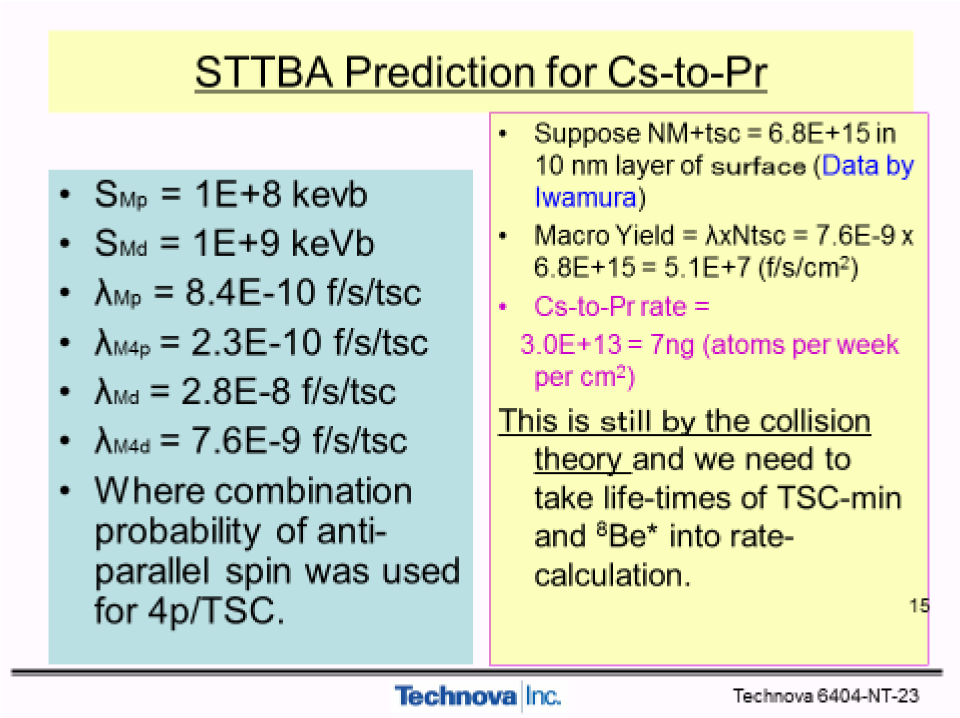

Fig.6: Estimated 4D/TSC + ^{133}Cs fusion rate by STTBA, numerical values are changed after discussion with Iwamura after [4]

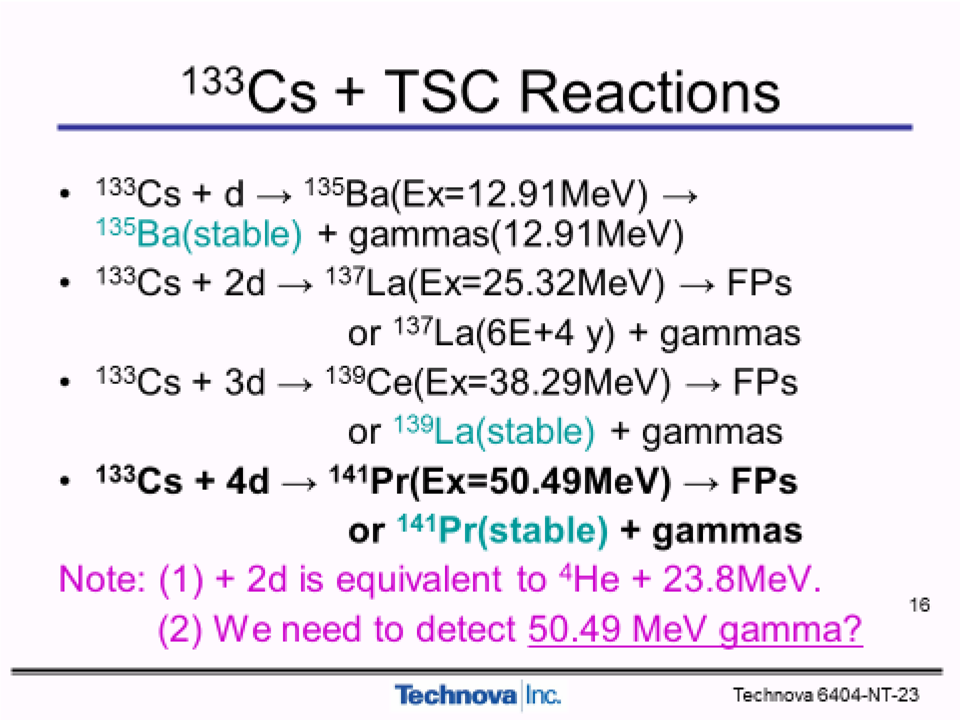

Fig.7: Considerable fusion reactions between 4D/TSC-min and ^{133}Cs nucleus

Probable fusion reactions between 4D/TSC-minimum and ^{133}Cs nucleus is shown in Fig.7. Considering the supposed longer life time of ^{8}Be* nucleon halo state and its strong PEF coupling, ^{133}Cs + 4d fusion would be major reaction.

3. Two-alpha Halo Model and BOLEP

By the conventional nuclear physics view, excited states of medium-heavy (A = 50 – 200) nuclei have major EM (electro-magnetic) transition decays emitting hard gamma-rays. The known energy level scheme of ^{141}Pr is shown in Fig.8, with insertion of very highly excited state by the 4d + ^{133}Cs fusion (capture) reaction. Excitation energy levels Ex < 1657.6 keV are known (evaluated). From excited states, EM transitions (E1, E2, E3, M1, M2, M3) happen in cascade scheme to emit known discrete energy gamma-rays in 0.14 to 1.7 MeV range. Upper energy levels more than 1.7 MeV are not given.

We see the 50.49 MeV level is too far away above that 1.7 MeV known upper-most level. Is the similar EM transitions from that high level a rational nuclear physics mechanism? It might be or might not be. We have no concrete knowledge. The cluster nuclei capture like 4d + Cs generates (by mass defect of strong force rearrangement of intermediate compound nucleus) very highly excited states as Ex = ca. 50 MeV, for other medium heavy nuclei also. This is the new aspect that TSC-induced nuclear reactions may introduce into the unknown field of nuclear physics, as is the case of ^{8}Be*(Ex = 47.6 MeV) highly excited low mass nucleus halo state. In general, the main stream nuclear physics study would not have been extended to such very highly excited cases.

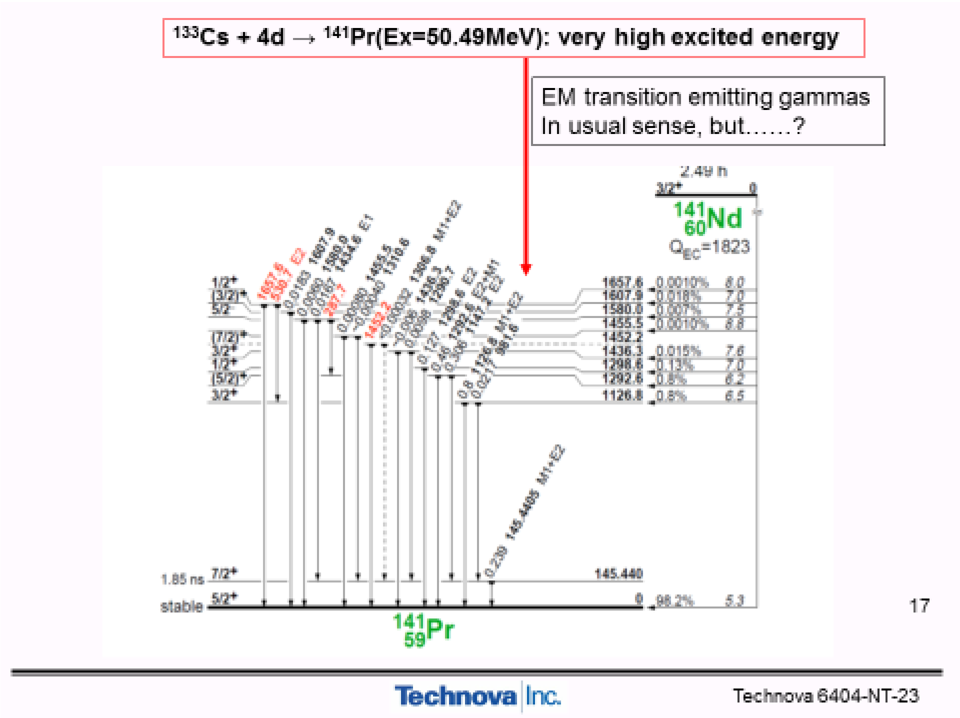

Fig.8: Energy-levels and gamma-decay scheme of ^{141}Pr*, after Table of Isotopes 8th edition

So far, we may have a chance to see some new states of energy transition there. When nucleus is highly excited, deformation of nucleus shape becomes larger, deviating more and more from the ground state near spherical shape. The deformation is mathematically drawn by using spherical harmonics pictures (see the case of ^{8}Be* [5]). In our special case of initial state interaction between 4D/TSC (^{8}Be*) and medium-heavy nucleus as ^{133} Cs, we may consider the initial condition of ^{8}Be* existence may cause the state of deformation of intermediate excited nucleus as ^{141}Pr*, as we imagine by Fig.9. We may imagine rotation of ^{8}Be-cluster around core nucleus, combined with vibrational motion between the two. Such rotation-vibration combined deformation will cause the so called band-state of many narrowly gapped discrete energy levels. We may guess the deformation state of Fig.9 to be much lower energy state than the 50.49 MeV state, considering the number of effectively coupling PEF values (8-10) is not large enough to sustain the very highly excited state of 50.49 MeV. Such speculation is possible from analysis of ^{8}Be* excited states and possible inner nucleons-clustering (alpha, h and t clusters) as a function of PEF values [5]. So, we need to consider more deformed states.

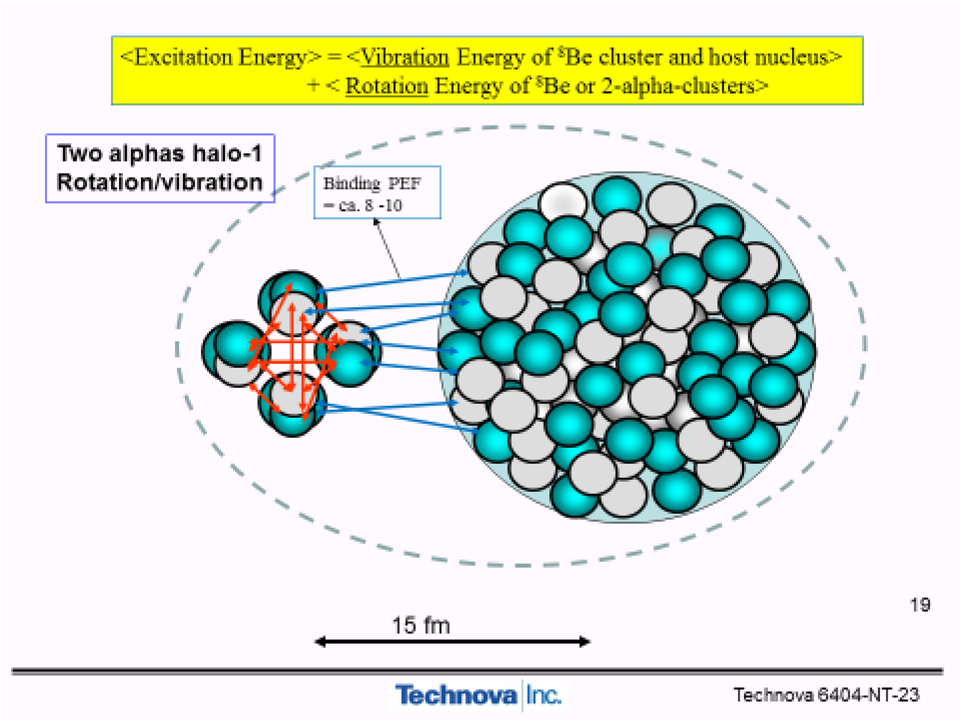

Fig.9: Image of the initial state strong interaction between $^{8}Be^{*}$ and medium-heavy nucleus

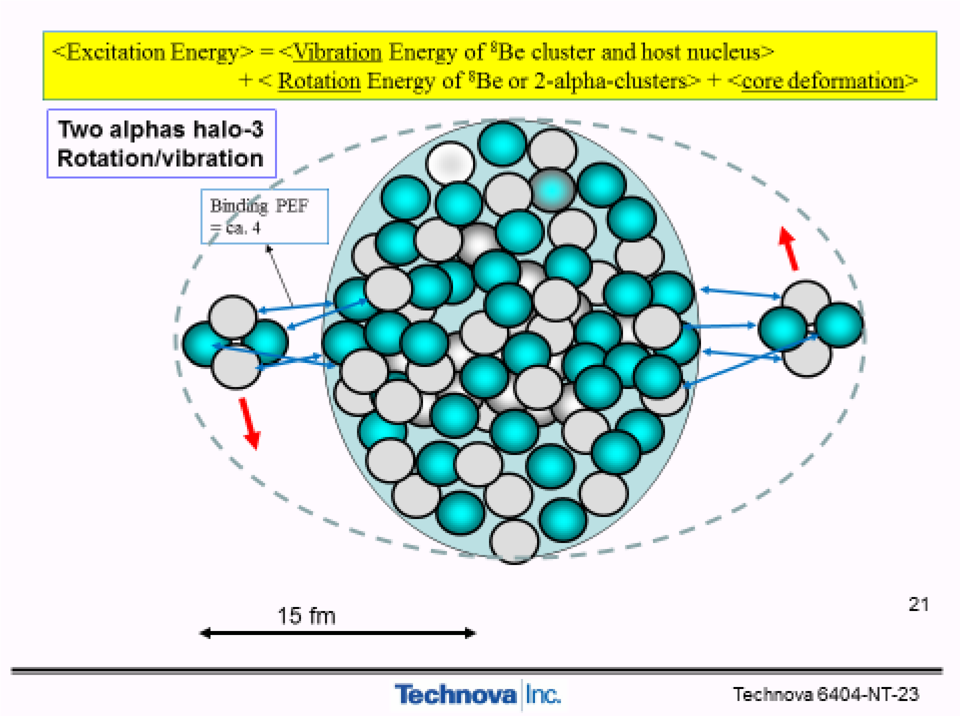

Fig.10: Two-alpha halo state of $^{141}Pr^{*}$ at highly excited deformation

As shown in Fig.10, two-alpha halo state may be sustaining high excitation energy by the rotation energy of two alpha halos, the rotation-vibration energy of elliptic core and the coupled vibration energy of alphas and core. There may appear so many boson-coupled discrete energy states, which may make avalanche energy damping by BOLEP (burst-of-low-energy-photons). Probably, more rational image is the dumbbell type deformation of core-cluster as shown in Fig.11. The author considers it most rational configuration to sustain that very high excitation energy of 50.49 MeV for ^{141}Pr*.

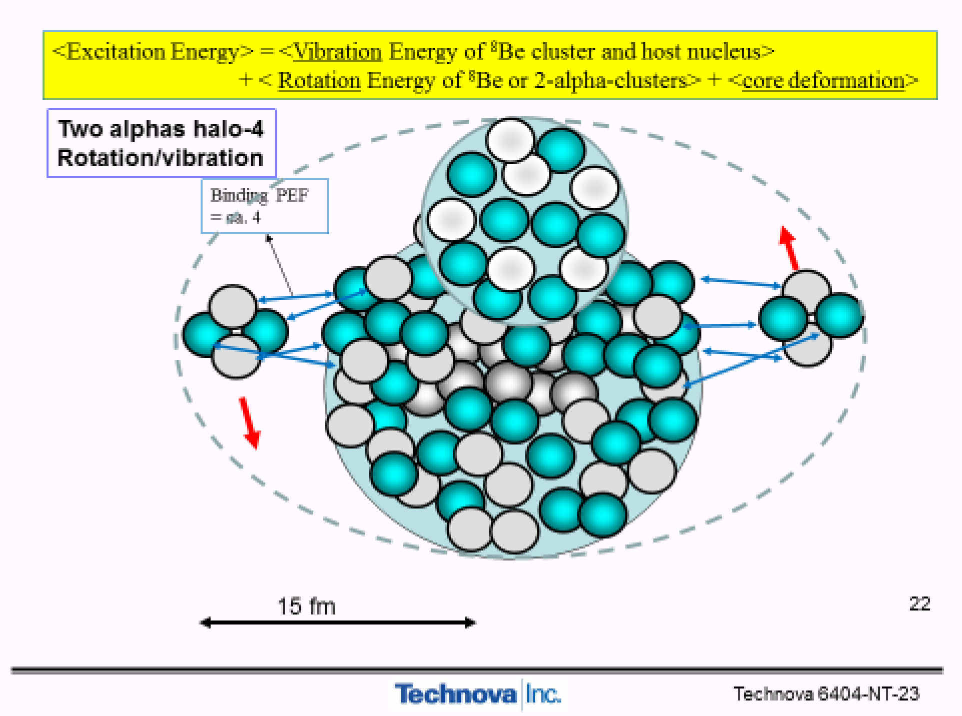

Fig.11: Two-alpha halo state with dumbbell deformation of core-cluster

We need rational information of the order of life time for such highly excited/deformed states. Considering very high spin-coupled states of rotation-vibration energy-band with very small gap energies (1-10 keV speculated) as nuclear phonons (bosonic coupling), life time may be much larger than 1 fs which is typical gamma-transition of low level excited states (maybe less than Ex = 10 MeV, comparable to nucleon binding energy). We do not know whether such very highly excited isomer state with 1 ps or longer life time can exist or not. However, we can say it might be possible. Thus we may expect BOLEP energy damping from ^{141}Pr* to ^{141}Pr ground state without emitting hard gamma-rays than BOLEP (soft X-ray range or matter-converted visible light). In competition to BOLEP, we will have to consider fission channel of dumbbell deformation [10] which was analyzed to produce clean (non-radio-active) stable isotopes mostly as ash.

There will be minor decay routes to be trapped intermediate lower excited energy states of ^{141}Pr along with BOLEP. So, the detail decay scheme of ^{141}Pr*(Ex = 50.49 MeV) is complex as drawn in Fig.12.

No concluding remarks should be said because the study is in very speculative stage.

Since the proposed issue of very highly excited states of nuclei from light to heavy mass region is yet to study mechanism of nuclear physics, we will need a long series of experimental and theoretical works to find full consistency between observed results and model predictions. We can say that the consistency study about the proposed nucleon-halo model [5] for the final state interaction of ^{8}Be*(Ex=47.6 MeV) born by the 4D/TSC process is the starting stage for the general direction of final state mechanism on such very highly excited nuclei.

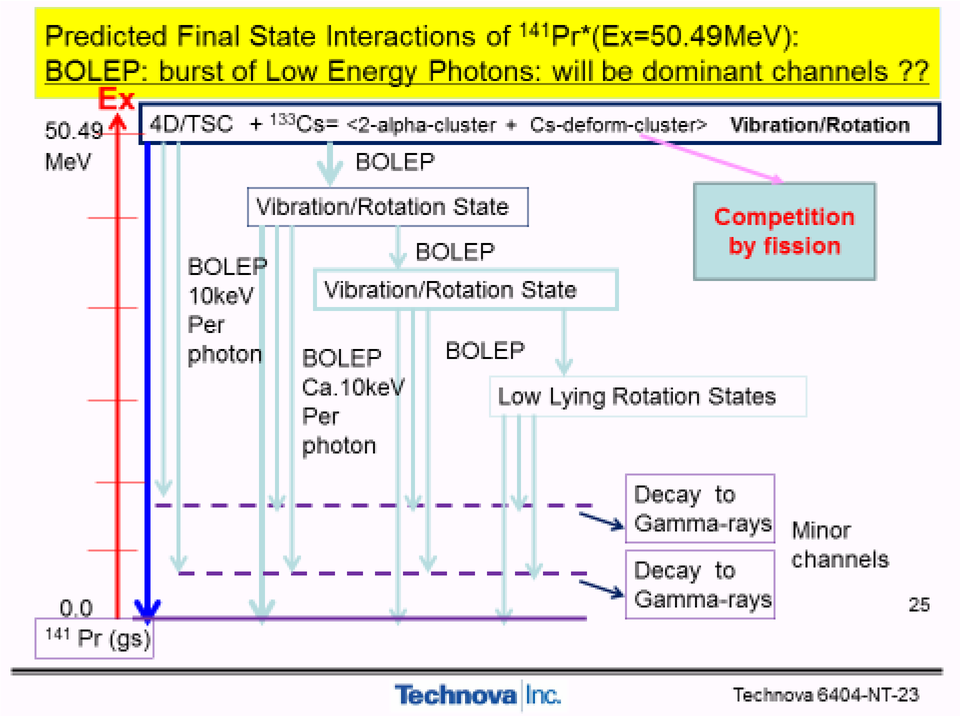

Fig.14: Presently modeled energy damping scheme of ^{133}Cs + 4d transmutation

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