Neutron Spectra in CMNS - Model Predictions and Past Data –

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Abstract: According to the recent SPAWAR claim on $^{12}C(n,n')3\alpha$ detection due to 14 MeV neutrons by D-T reaction in a D_2O/Pd co-deposition cell, we reminds our old discussion on observed neutron spectra from CMNS/CF cells in the past. Structure or shape of neutron spectra should give important (decisive) evidences on underlying physical mechanisms on possible deuteron-related nuclear fusions in PdDx systems. This paper discusses plausible neutron spectra as consequences of major theoretical model predictions.

1. Introduction

According to the recent SPAWAR claim on $^{12}C(n,n')3\alpha$ detection due to 14 MeV neutrons by D-T reaction in D_2O/Pd co-deposition cell, we reminds our old discussion on observed neutron spectra from CMNS/CF cells in the past. Structure or shape of neutron spectra should give important (decisive) evidences on underlying physical mechanisms on possible deuteron-related nuclear fusions in PdDx systems. This paper discusses plausible neutron spectra as consequences of major theoretical model predictions.

2. The SPAWAR Claim

Mosier-Boss et al. have observed triplet tracks in CR39 detectors used in their co-deposition Pd/D_2O electrolysis type CMNS/CF experiments[1]. They claimed the triplet tracks should be due to forward-peaked emission of three alpha-particles from $^{12}C(n,n')3\alpha$ reactions by D+T fusion reactions as byproducts of D+D reactions in the co-deposition experiments. The $^{12}C(n,n')3\alpha$ reaction has however threshold at 7.8MeV of incident neutron energy[7]. The author conceives that the explanation by secondary d + t reactions after d + d fusions is not plausible, because the yield of d + t reactions by one 1MeV triton slowing down in PdDx matter is very small on the order of 10^{-5}, d + d → p(3.015MeV) + t (1.005MeV)+ 4.02MeV for the conventionally known DD fusion. Estimation using available neutron cross sections (JEDL3 for instance)[7], one $^{12}C(n, n')3\alpha$ event needs about 100 fluence of 14MeV neutrons getting into the used CR39 track detector by SPAWAR. This should correspond to 10^7 neutrons of 2.45MeV by the d + d reactions. If we had 10^7 neutrons emitted from CF cells, we could detect very easily significant counting events and their recoil-proton-tracks of 2.45MeV neutrons. These can easily be detected, but has never been observed with so high 2.45 MeV neutron yield, by CR39 dtectors. The author concerns that the conclusion of secondary D+T fusion by SPAWAR for triplet tracks is not plausible.

3. Model Prediction Case-1

[Case-1]: Some theoretical models[8-11] conceiving the d + d to ^4He + lattice energy (23.8MeV) processes have been thought as possible explanation for the CMNS/CF phenomena since 1989, in spite of very negative view from the nuclear physics point of view[12].

If the “Dream” of the **“d+d to ^{4}He + lattice energy (23.8MeV)”** [8-12] were taking place, the doping tritons make “d + t to ^{5}He + lattice energy” reactions, in the same path and we shall have neutron emission by,

- ^{5}He → n(0.716MeV) + ^{4}He(0.179MeV)

14 MeV neutrons are not major products in consequence of this theoretical model, but **low energy neutrons (0.716 MeV)** should be detected with the tritium doping of micro-Curie/cc-DTO; doping in experimental CMNS/CF cells. These “low” energy neutrons could not be detected by a CR39 detector because recoil-proton energies are too small to cause enough large ionization tracks. We shall use special neutron spectroscopy systems to detect and identify the 0.716 MeV neutrons.

4. Model Prediction Case-2

[Case-2]: Our **4D/TSC fusion model**[13-15] predicts 23.8MeV/^{4}He energy deposit in PdDx lattice as main product by the major channel 4D → ^{4}He + ^{4}He + 47.6MeV reactions. Minor branch products of triton and higher energy neutrons from 4D fusion are predicted as a product of symmetric fragmentation of ^{8}Be* via excited state of ^{4}He*(Ex=20.21 MeV: first excited state) as shown in ‘Fig.1’.

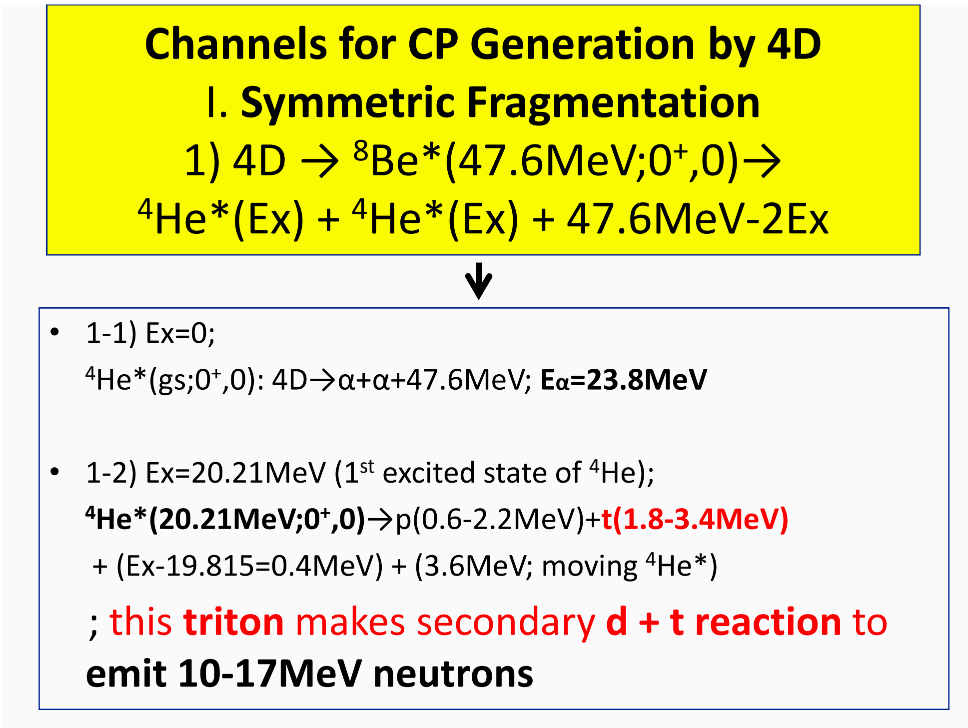


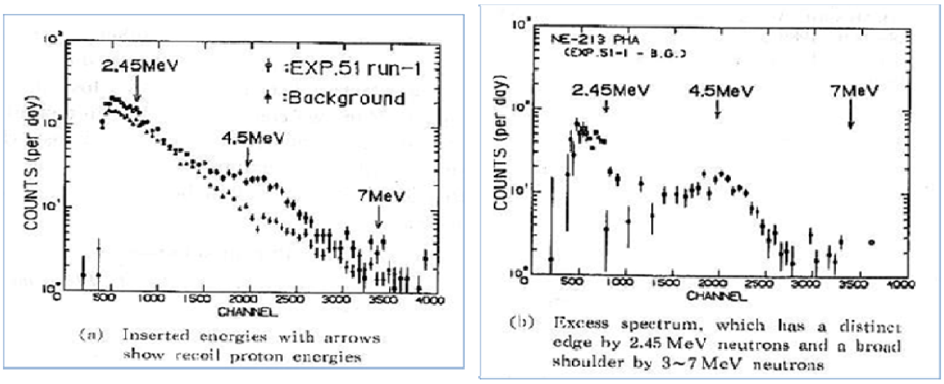
Fig.1 - Generation of triton by a symmetric fragmentation of ^{8}Be* by 4D fusion and its secondary t + d reaction to emit high energy neutrons in a 10 – 17 MeV region which may correspond to the SPARWAR result.

Secondary t + d reactions, during the slowing down of thus produced tritons in PdDx matter, produce a 10-17MeV high energy component as observed by SPAWAR[1]. In the symmetric fragmentation, higher excited states such as Ex=21.01MeV(0^{-},0), 21.84MeV(2^{-},0), 22.33MeV(2^{-},1), 23.04MeV(1^{-},1), from which neutrons can be emitted, are forbidden by odd parity (spin-parity conservation – selection rule).

If we make a doping of tritium (on the level of micro Curie) in the process, (3D+T)/TSC makes ^{9}Be*(43.01MeV) intermediate compound state to break up as,

- ^{9}Be*(43.01MeV) → ^{4}He(22.53MeV) + ^{5}He(18.01MeV)
- ^{5}He → n + ^{4}He + 0.895MeV (for ^{5}He at rest)

Neutron energy appears in 0.41 to 6.79 MeV (emitted from the break-up of moving ^5He of 18.01MeV kinetic energy, as calculated by kinematics). We may predict the broad higher energy spectrum in 0.4 to 7MeV region as major component (minor component in much higher energy region) by the tritium doping into on-going CMNS/CF cell experiments. This is the consequence of TSC model[13-15]. Obviously we can verify which theoretical model, Case-1 or Case-2 matches the observed phenomena of neutron emission in CMNS/CF experiments.



Two components: 2.45MeV peak and 3-7 MeV Higher Energy Group

Fig. 2 - Two component neutron spectra observed by the past Pd/D_2O electrolysis experiments, copied from published paper[2)]

5. Our Past Data of Neutron Emission and Discussions

We refer now our past measurements[2-6] of neutron spectra from CF-electrolysis experiments to be discussed under the above predictions. A typical result of measured neutron spectra from Pd/D_2O electrolysis cell[2] is copied in 'Fig.2'.

Fast neutron spectroscopy was done by measuring recoil-proton pulse height distribution of NE213 liquid scintillator with an n-gamma pulse shape separation technique[4)]. The background spectrum has "near-exponentially decreasing" recoil-proton pulse height distribution which was of spallation neutrons of cosmic-ray-origin showing similar spectrum as the fission-neutrons having a near Maxwellian distribution with a nuclear temperature 1.4MeV. High energy protons by cosmic rays induce spallation reactions with nuclei in the matter surrounding the detector. The near Maxwellian spectrum has therefore a high energy tail in En>10MeV. The excess neutrons observed has two components in its energy spectrum: one is of 2.45 MeV neutrons, very probably by the D+D fusion reactions. The other broad component in the 3-7 MeV region (and we might expect higher energy- more than 7 MeV- tail to observe if statistics of experiment is improved) is unidentified origin (See Fig.2). In our past papers[2,3,16], we speculated that the higher energy component could be the product of the secondary high energy d + d reactions after the primary d + d+ d three body fusion in PdDx-lattice; D+D+D → d(15.9MeV) + ^4He(7.9MeV) ; In the slowing down process of 15.9MeV deuterons, d + d reactions in PdDx produce higher energy component of neutrons seen in the 3-10MeV region.

Now, we have to reconsider this explanation by referring our other past results shown in 'Fig.3'. In our reconsideration, the higher energy neutron component might have been the 0.4-7MeV neutron emission by the (3D+T)/TSC 4-body fusion reaction in PdDx lattice dynamics (Case-2), because we had seen the significant accumulation of tritium atoms in the electrolyte (curve c) in Fig.2: This was already a kind of T-doped experiment which happened by chance. However, 4D fusions may emit much higher energy neutrons in the 10-17 MeV region, from minor out-going channels emitting tritons, as predicted in this paper. These high energy neurons are considered to have caused the triplet tracks in CR39 detectors used in the SPAWAR experiments.

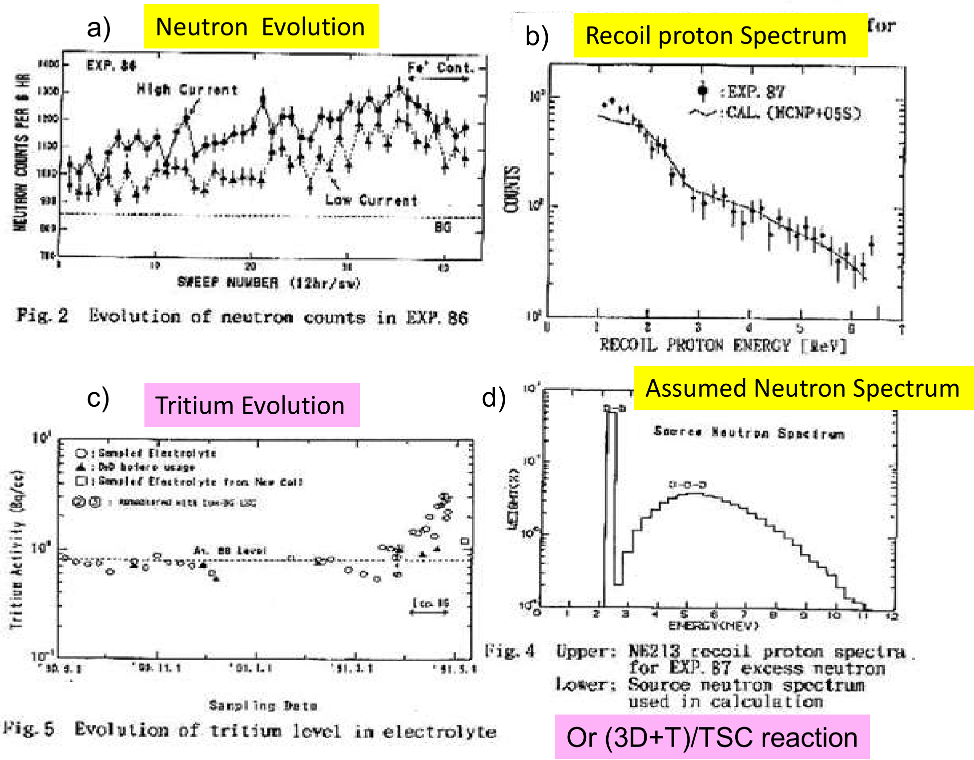


Fig. 3 - Our past data, copied from published prints[3,16], of neutron emission and evolution of tritium concentration in Pd/D_2O pulsed electrolysis experiments; a) evolution of excess neutron counts, b) recoil-proton pulse height spectra for excess neutrons, c) evolution of tritium concentration measured by LSC with sample electrolyte and d) assumed two component neutron spectrum for folding calculation of model.

6. References

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