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Low energy nuclear fusion observation due to dineutron formation in the $^{159}Tb(n, {}^2n)^{158}Tb$ nuclear reaction

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Abstract

Low energy nuclear fusion reactions (LENFR) are considered at possible occurrence owing to dineutron formation in the outgoing channel of a neutron induced nuclear reaction on ^{159}Tb. Due to dineutron presence and disintegration, the dineutron or it's decay products may interact with ^{158}Tb nuclei to transform them into ^{160}Tb or directly to ^{160}Dy. We assumed that accumulation of $^{160}Tb/^{160}Dy$ activity results from weak-strong or purely strong processes via nuclear reactions at room temperature. The theoretical estimates, experimental measurements and observations of terbium sample radioactivity versus time are presented and discussed to prove a transformation of ^{158}Tb into $^{160}Tb/^{160}Dy$, showing the surplus difference between accumulated and expected activity of $^{160}Tb/^{160}Dy$ in more than 5 times after 2.5 years since irradiation completion.

Keywords: Terbium; Neutron induced nuclear reactions; Dineutron; Low energy fusion reactions

1. Introduction

This paper is dedicated to research in the domain emerging from a bound dineutron formation near the surface of much heavier nucleus and further transformation of this nucleus into another one with additional two nucleons by equivalent. Such process is similar to previously named Low Energy Nuclear Reactions (LENR) if no extra energy is supplied for projectiles by

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accelerators, radioactive sources etc. The concept of LENR has been a very popular paradigm for more than 30 years to develop a sustainable, clean and cheap source of energy. Up to now, there is no fully reasonable explanation of this phenomenon, accepted by the world's scientific community. In any case, current understanding of LERN is based on the consideration of the solid-state lattice – nuclear processes. Therefore, LENR in such particular cases should be rather titled Lattice-Enabled Nuclear Reactions [1], keeping the same abbreviation. In spite of so many contradictions and even fraud declarations with regard to LENR in press and scientific publications, some of experimental results are certainly convincing [2]. From another side, the latest publication proves no signs of LENR detected [3].

Contrary to [3], covering three of the most promising options to produce excess of energy, our study is targeted at purely nuclear or weak-strong transformations within a very specific nuclear system, representing a satellite dineutron located at up to 2 fm distance from the surface of the residual nucleus in the outgoing channel of a nuclear reaction, possibly observed earlier in the $^{159}Tb(n,^2n)^{158}Tb$ nuclear process [4]. Such configuration was predicted by A. Migdal [5], when the two paired-up neutrons in s-state, leaving the potential well of the compound nucleus, are being trapped at one of the single-particle resonance levels still within the potential well, but beyond the radius of the residual nucleus in a nuclear reaction. This case relates to a very specific nuclear reaction mechanism with two or even more nucleons in the outgoing channel with kinetic energies, much lower of nucleons interaction energy.

Presence of a bound dineutron near the surface of the massive nucleus then greatly facilitates the process of the strong interaction with the residual nucleus, leading to possible transformation of this heavy nucleus, which is observed when corresponding irradiations can be detected. As the dineutron located in free space [6], it might be susceptible to β^--decay with e^- and $\tilde{\nu}_e$ escape as well as deuteron formation. If an electron and the electron antineutrino are emitted with their intrinsic spins being antiparallel (singlet state), the nuclear spin change ΔI must be zero and this process follows the Fermi selection rule. Then the deuteron must be formed in an unbound s-state, too, and may be kept at one of the single particle levels, predicted by A. Migdal, and also earlier occupied by the dineutron. Such configuration makes it possible to keep a bound deuteron in s-state for a long time under the strong interaction, predominating over a Coulomb repulsion. Contrary to the Fermi transitions, if electron and antineutrino spins are parallel (triplet state), $\Delta I = -1, 0, +1$ with forbidden $0 \rightarrow 0$ transitions, the Gamov-Teller selection rule is applicable. In this case, the deuteron will be formed in a bound triplet state without any need to be kept at any single particle level within the potential well. Then, most likely, a configuration "the massive nucleus and a lighter particle near the nuclear surface" will disappear. We also made an assumption in [6] about possible electromagnetic interaction between electron, showing up due to dineutron disintegration, and the massive nucleus. Direct evidence of such possibility is available from the well-known fact about depletion/enrichment of β^+/β^--spectra of beta-decaying nuclei in a low-energy range, accordingly. Then electromagnetic attraction between electron and the massive nucleus may be followed by the weak interaction, to some extent similar to EC process.

Therefore, the subject of our interest in this paper is to observe whether in the instrumental gamma-spectrum some extra radioactivity could be detected and assigned to ^{160}Tb decay into ^{160}Dy or directly to ^{160}Dy formation due to accumulation from ^{158}Tb. To do so we considered several Tb-irradiated sample countings with specific attention to the induced activity of $^{160}Tb/^{160}Dy$ nuclei.

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