The puzzle of the tritium beta spectrum and blackbody model for nuclear fermi-gas

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Annotation

The shape of the energy spectrum of tritium beta decay depends on the experimental conditions. The tritium beta spectrum in the KATRIN experiment can be represented as a superposition of three spectra with peak energies of ~ 0.1 KeV, 2.2 KeV, and 6.6 KeV. It is possible that the spectrum with E_{peak}~0.1 KeV corresponds to beta decay of tritium with the formation of thermal neutrinos.

Experimental spectra of beta decay of tritium

Figure 1 shows the tritium beta spectra obtained in the KATRIN experiment [1] and in the work of C. Marshall et al [2]. The spectra differ by the source of tritium and the registration method. Spectra similar to KATRIN were also obtained in [3,4].

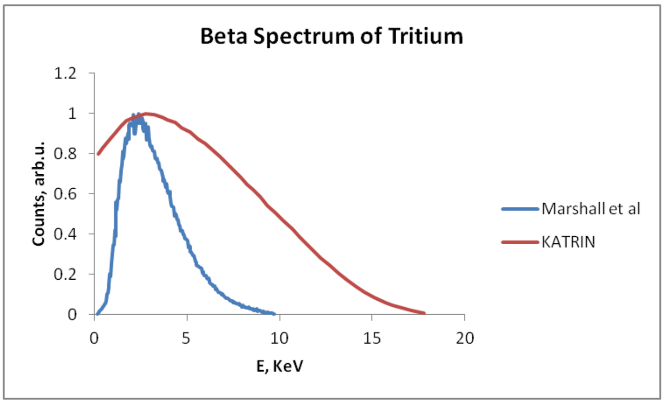

Fig. 1. Experimental energy spectra of beta decay of tritium.

Blackbody model for tritium beta decay spectrum

The blackbody model for a nuclear fermi-gas was considered in [5]. The following is a fragment of a mathcad file with the simplest blackbody formula for the tritium spectrum from an article by Marshall et al [2]. A comparison of the experimental spectrum with the model one is shown in Fig. 2.

$$fm := 10^{-15}m \quad AMU := 1.66053886\cdot 10^{-27}\cdot kg \quad h := 6.6260693\cdot 10^{-34}\cdot J\cdot s$$

$$k_b \equiv 1.3806505\cdot 10^{-23}\cdot \frac{J}{K} \quad m_e := 5.486\cdot 10^{-4}AMU$$

$$eV \equiv 1.602176565\cdot 10^{-19}J \quad KeV \equiv 10^3 eV$$

$$m_{3H} := 3AMU \quad r_{3H} := 1.23fm\cdot\sqrt[3]{3} \quad r_{3H} = 1.774\,fm \quad t05 := 12.3yr$$

$$n_{fg} := \frac{1}{r_{3H}^{\ 3}} \quad n_{fg} = 1.791\times 10^{44}\frac{1}{m^3}$$

fermi-gas concentration in 3H

$$E_{peak} := 2.20KeV \quad T_K := 0.80\cdot 10^7\cdot K$$

$$PD(E, T_K) := \frac{E^2\cdot n_{fg}}{h}\cdot\frac{1}{e^{\frac{2\cdot E}{3\cdot k_b\cdot T_K}}+1}$$

black body formula
for beta spectrum 3H

$$PD(E_{peak}, T_K) = 3.575\times 10^{45}\frac{W}{m^3} \quad PDa(E, T_K) := \frac{PD(E, T_K)}{PD(E_{peak}, T_K)}$$

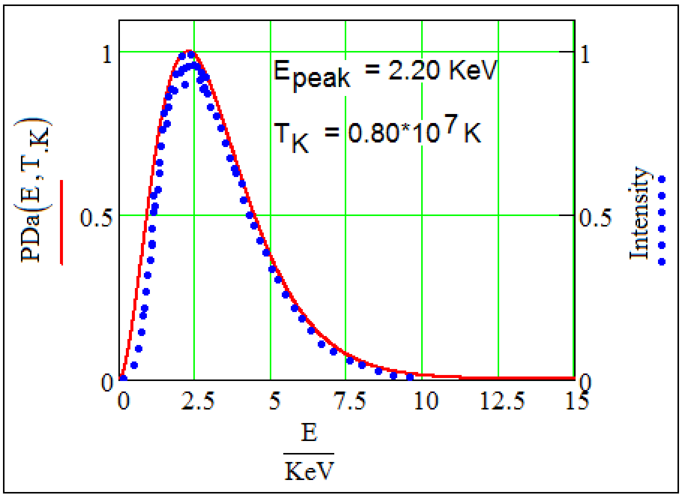

Fig. 2. The energy spectrum of tritium beta decay according to blackbody formula (red line) and experimental spectrum from Marshall et al (blue dots).

The model satisfactorily describes the experimental spectrum. Therefore, the spectrum from the KATRIN experiment can be represented as a superposition of the Marshall spectrum with Epeak = 2.2KeV and two spectra with E_{peak} ~ 0.1 KeV and E_{peak} = 6.6 KeV obtained by subtracting the Marshall spectrum from the KATRIN spectrum, as shown in Figure 3.

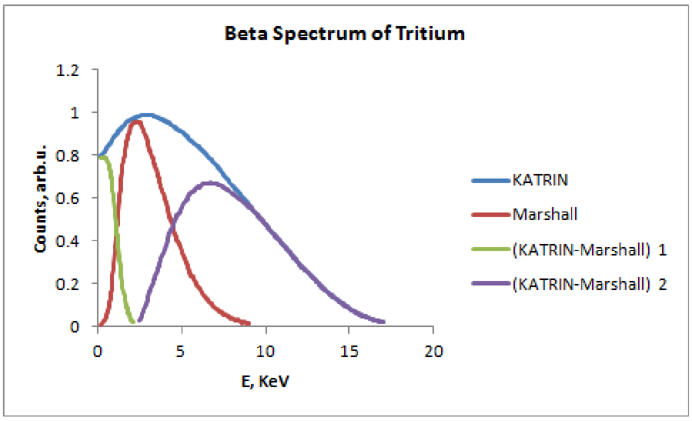

Fig. 3. The energy spectrum of tritium beta decay from the KATRIN experiment in the form of a superposition of three spectra according to the blackbody model for a nuclear fermi-gas.

The opportunity to present the KATRIN spectrum as a superposition of three blackbody spectra suggests a more complex character of beta decay than is accepted in today's interpretation, — in particular, a chain of intermediate stages. For example, the spectrum with Epeak ~ 0.1 KeV probably corresponds to the stage with the formation of a hypothetical “thermal” solar neutrino neutrino spectrum from an article by Boris Goryachev [6].

If this is so, then unexpected, attractive for us, interpretation possibilities open up — it is perfectly acceptable to identify thermal neutrinos with x-particles from the table of Nikolai Kobozev [7]. Then, in accordance with the Kobozev hypothesis, our neural brain system can respond to their effects and, therefore, to the effects of the Sun, since the diffusion coefficient or specific action for our neural network is D=166m^2/s=166(J·s)/kg and solar plasma ~ 100 m^2/s=100(J·s)/kg coincide in order of magnitude. By the way, - Nikolai Kobozev suggested by the value of D to characterize the level of activity of various life forms.

Table 6 from the book of Kobozev [7]

x-particles per neuron Z_x	x-particles concentration, n/cm^3	x-particle mass, g $\lg m_x$	x-particle mass in m_e	phase wavelength, cm	thermal speed, cm/s
1	$2 \cdot 10^6$	—38.8	$10^{-11.7}$	0.45	10^{13}
10^3	$2 \cdot 10^9$	—36.8	$10^{-9.8}$	$10^{-1.4}$	$10^{11.8}$
10^5	$2 \cdot 10^{12}$	—34.8	10^{-8}	$10^{-2.4}$	10^{12}
10^{7*}	$2 \cdot 10^{14}$	—33.4	$10^{-7.4}$	10^{-3}	$10^{10.2}$
10^{8*}	$2 \cdot 10^{15}$	—32,8	10^{-6}	$10^{-3.4}$	10^{10}
10^{9*}	$2 \cdot 10^{16}$	—32,2	$10^{-5,1}$	$10^{-3.6}$	$10^{9.6}$
10^{10*}	$2 \cdot 10^{17}$	—31.4	$10^{-4.4}$	10^{-4}	$10^{9.2}$

*- physically possible particles, according to Kobozev.

References

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3. https://www.nature.com/articles/162302a0.pdf
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