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Low energy antineutrino detection using neutrino capture on electron capture decaying nuclei

Alfredo G. Cocco* and Gianpiero Mangano†

Istituto Nazionale di Fisica Nucleare - Sezione di Napoli, Complesso Universitario di Monte S. Angelo, I-80126 Napoli, Italy

Marcello Messina‡

Laboratorium für Hochenergiephysik, Universität Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland

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In this paper we present a study of the interaction of a low energy electron antineutrino on nuclei that undergo electron capture. We show that the two corresponding crossed reactions have a sizable cross section and are both suitable for detection of low energy antineutrino. However, only in the case where very specific conditions on the Q value of the decay are met or significant improvements on the performances of ion storage rings are achieved, these reactions could be exploited in the future to address the long standing problem of a direct detection of cosmological neutrino background.

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I. INTRODUCTION

In a previous paper [1] we have considered $\beta^{\pm}$ unstable nuclei as interesting candidates for very low energy neutrino detection. Indeed, the crossed reaction with an incoming (anti) neutrino has no energy threshold and the product of the corresponding cross section times velocity goes to a finite constant value at low neutrino velocities. Furthermore, the fact that neutrinos have a nonzero mass has important consequences on the kinematics of the capture process and leads to the possibility, at least in principle, to unambiguously detect the very low energy cosmological neutrino background (CνB) [2].

In this paper we address the closely related case of nuclei that decay through the electron capture (EC) process, where the nucleus of a neutral atom A captures one bound electron and produces a daughter atom B and an electron neutrino

$$e^- + A^+ \longrightarrow B^* + \nu_e \longrightarrow B + \nu_e + n\gamma. \tag{1}$$

The atom B, initially in an excited state with a missing electron in an inner atomic shell, decays electromagnetically and releases a total energy E_l. By simple considerations it turns out that E_l is the captured electron binding energy in the field of the daughter nucleus. The nucleus of atom B can be produced in an excited nuclear state as well. As we will see in details in the following, the behavior of reaction (1) depends on the value of the mass difference between the parent and daughter neutral atoms $Q_{\rm EC} = M(A) - M(B)$, the value of E_l, and the value of the neutrino mass.

Electron capture processes are suitable to detect electron antineutrino via the two crossed reactions

$$\bar{\nu}_e + A \longrightarrow B^- + e^+, \tag{2}$$

and

$$\bar{\nu}_e + e^- + A^+ \longrightarrow B. \tag{3}$$

In the following we will analyze in detail both these processes and give an estimate of the antineutrino cross section that in most cases does not require the evaluation of nuclear matrix elements. We will also show under which circumstances the two processes could be used to measure very low energy antineutrinos and estimate the amount of the background due to competing processes.

II. KINEMATICS OF ANTINEUTRINO CAPTURE ON EC DECAYING NUCLEI

The behavior of reaction (2) as a function of the Q value can be divided in three categories. In the case $Q_{\rm EC} > 2m_e - m_\nu$ the neutrino capture process has no energy threshold since the Q value is large enough to allow the creation of a positron in the final state even without the contribution of the electron mass in the initial state of the EC decay. On the other hand, if the Q value satisfies the relation $Q_{\rm EC} > 2m_e + m_\nu$, the β^+ decay becomes energetically allowed. This case is described in detail in [1] and will not be treated here. There is, therefore, a range of values of Q that is $2m_\nu$ wide and that would allow the detection of an antineutrino with an arbitrarily small energy. Transitions falling in this category would have the remarkable property of a unique signature, since the positron in the final state of reaction (2) can be used to tag the antineutrino capture interaction with respect to the spontaneously occurring reaction (1). Finally, in the case of the antineutrino captured on nuclei having $Q_{\rm EC} < 2m_e - m_\nu$, reaction (2) has a threshold on the energy of the incoming antineutrino given by

$$E_\nu^{\rm thr} = 2m_e - Q_{\rm EC}, \tag{4}$$

and the energy of the outgoing positron in this case reads $E_e = E_\nu + Q_{\rm EC} - m_e$. Though this threshold prevents in

*alfredo.cocco@na.infn.it
†mangano@na.infn.it
‡marcello.messina@cern.ch

this case the use of this reaction to detect a low energy antineutrino, nevertheless, atoms undergoing EC decays in which $Q_{\rm EC} \simeq 2m_e$ could still be used for that purpose.

As far as reaction (3) is concerned, the Q value plays a crucial role as well. For $Q_{\rm EC} - E_l \geq -m_\nu$ reaction (3) has no energy threshold and moreover, the nucleus A is stable since the corresponding EC decay becomes energetically allowed only if $Q_{\rm EC} - E_l \geq m_\nu$. Once again, there is a range of Q values that is $2m_\nu$ wide and in which reaction (3) has no threshold on the energy of the incoming antineutrino. The process is also background free since the EC decay is energetically forbidden. Unfortunately, reaction (3), as it is, is forbidden by the lack of a suitable final state. Using the Fermi golden rule [$w = 2\pi/h|\mathcal{M}|^2\rho_f(E)$] one gets that the cross section depends on the number of available final states per unit energy $\rho_l(E_\nu) = \delta(E_\nu + (Q_{\rm EC} - E_l))$, which in the case of an incoming antineutrino at rest has only one possible solution, $Q_{\rm EC} - E_l = -m_\nu$. Despite this, we can still envisage at least two cases where the process might be allowed:

(i) There exists an excited state B' having energy $M(B) + E_\nu + Q_{\rm EC} - E_l$; in this case the background reaction (EC decay through the same channel) would be forbidden due to energy conservation even in the limit of $E_\nu \to m_\nu > 0$.

(ii) The captured electron is ''off mass shell'' with an effective mass given by $m_{\rm eff} = m_e - Q_{\rm EC} + E_l - E_\nu$; this could happen, for example, in a metal when the nucleus captures an electron in the valence band, being in this case E_l the mean binding energy of valence electrons.

In the case of $Q_{\rm EC} - E_l < -m_\nu$ reaction (3) could still be triggered by antineutrinos with energy greater than $E_\nu^{\rm thr} = -Q_{\rm EC} + E_l$. As an example, we recall the process pointed out in [3], where the high energy reactor antineutrino and the electron are captured by a stable nucleus B and produce a β-unstable nucleus A.

III. ANTINEUTRINO CAPTURE CROSS SECTION

The electron capture process has been studied in detail in [4]. The corresponding rate is given by

$$\lambda_{\rm EC} = \frac{G_\beta^2}{2\pi^3}\sum_x n_x C_x(q_\nu) f_x, \tag{5}$$

where the sum is over all atomic shells from which an electron can be captured, n_x is the relative occupation number of that shell, and $C_x(q_\nu)$ is the nuclear shape factor relative to the given transition. The index x labels the orbital electron wave function via the variable κ_x given by the spherical waves decomposition, as described in [4]. To give an example, nuclear transitions with no change in angular momentum can be coupled only by $\kappa_x = \pm 1$ wave functions, namely, $K, L_1, L_2, M_1, M_2, \ldots$ shells. Finally, the function f_x is the analogous of the integrated Fermi function of the β decay and is given by the following expression:

$$f_x = \frac{\pi}{2} q_x^2 \beta_x^2 B_x, \tag{6}$$

where $q_x = (Q_{\rm EC} - E_l)/m_e$ is the neutrino energy, β_x is the Coulomb amplitude of the bound-state electron radial wave function, and B_x is the associated electron exchange and overlap correction.

In full analogy with the procedure used in [1], the antineutrino capture cross section for reaction (2), $\sigma_{(2)}$ [in the following the cross section index will refer to the corresponding process, as introduced in Eqs. (2) and (3)] can be written as

$$\sigma_{(2)} v = \frac{G_\beta^2}{\pi} p_e E_e F(Z, E_e) C_\nu(p_e, p_\nu), \tag{7}$$

where $C_\nu(p_e, p_\nu)$ is the shape factor of the antineutrino capture interaction and should be evaluated using the prescription given in [5], while $F(Z, E_e)$ is the Fermi function for the outgoing positron. It is worth noticing here that $C_\nu(p_e, p_\nu)$ and $C_x(q_\nu)$ contain the same nuclear form factors. Moreover, $C_\nu(p_e, p_\nu)$ can be expressed as a weighted sum of the $C_x(q_\nu)$ provided the correct superposition of free-particle and bound-state electron wave functions are evaluated for each specific case. We will show that in most of the cases $C_\nu(p_e, p_\nu)$ can be obtained to a very good approximation using leading order $C_x(q_\nu)$ terms.

Using Eq. (5), it is possible to rewrite the cross section (7) in the following way:

$$\sigma_{(2)} v = 2\pi^2 \ln 2 p_e E_e \frac{F(Z, E_e) C_\nu(p_e, p_\nu)}{t_{1/2}^{\rm EC} \sum_x n_x C_x(q_\nu) f_x}. \tag{8}$$

According to the procedure used in [1] we define a shape factor ratio $\mathcal{A}$ as

$$\mathcal{A} = \frac{\sum_x n_x C_x(q_\nu) f_x}{p_e E_e F(Z, E_e) C_\nu(p_e, p_\nu)}, \tag{9}$$

where q_ν is the energy of the outgoing neutrino in the EC decay [reaction (1)] and the subscript (e) refers to the positron in the final state of reaction (2). The antineutrino cross section can then be written as

$$\sigma_{(2)} v = \frac{2\pi^2 \ln 2}{\mathcal{A} \cdot t_{1/2}^{\rm EC}}. \tag{10}$$

In the case of reaction (3) it is easy to show that the antineutrino cross section, $\sigma_{(3)}$ up to a numerical factor which depends upon initial and final angular momentum multiplicity of the considered process, is given by

$$\sigma_{(3)} v = \frac{G_\beta^2}{\pi}\sum_x n_x C_x(p_\nu) g_x \rho_x(E_\nu), \tag{11}$$

where $\rho_x(E_\nu)$ is the number of available final states per unit energy for an electron captured on the shell x and

$$g_x = \frac{\pi}{2}\beta_x^2 B_x, \tag{12}$$

is the analogous of (6). As both energies in the initial and final states are given, $\rho_x(E_\nu)$ is a Dirac delta function $\delta(E_\nu + Q_{\rm EC} - E_{l(x)})$. Therefore, incoming neutrinos are captured only if their energy is compatible with the mass difference between the initial and final states.

For reaction (3) the shape factor ratio is given by

$$\mathcal{A}' = \frac{\sum_x n_x C_x(q_\nu) f_x}{\sum_x n_x C_x(p_\nu) g_x \rho_x(E_\nu)}, \tag{13}$$

where the variable q_ν refers to the neutrino energy in the final state of the EC process while $p_\nu(E_\nu)$ is the momentum (energy) of the incoming neutrino in reaction (3). Also in this case the cross section can be written according to Eq. (10).

We will now show that the shape factor ratios $\mathcal{A}$ and $\mathcal{A}'$ can be evaluated to a very good approximation for allowed decays and in an exact way for superallowed and forbidden unique decays.

A. Superallowed transitions

In the case of superallowed transitions the shape factor involved in the neutrino capture process is given by

$$C_{\rm EC}(p_e, p_\nu) = |{}^A F_{101}^{(0)}|^2.$$

On the other hand, the electron capture proceeds only via capture from $K, L_1, L_2, M_1, M_2, \ldots$ shells, being contributions involving electron orbital momentum forbidden. This means that

$$C_x(q_\nu) = |{}^A F_{101}^{(0)}|^2 \qquad \kappa_x = \pm 1$$

and that the shape factor ratios can be easily written as

$$\mathcal{A} = \frac{\sum_x n_x f_x}{p_e E_e F(Z, E_e)}, \qquad \mathcal{A}' = \frac{\sum_x n_x f_x}{\sum_x n_x g_x \rho_x(E_\nu)}, \tag{14}$$

where neither expression depends anymore on nuclear matrix elements evaluation. We notice here that $\mathcal{A}'$ can be seen as the squared neutrino energy mean weighted with the electron capture probability of each shell. This is of course strictly true only in the limit of an incoming neutrino having an energy greater than the K-capture threshold.

B. Allowed transitions

Using the same arguments of [1] it is easy to show that in the case of allowed transitions and neglecting the (small) contribution of nuclear transitions with a large angular momentum transfer, the electronic capture shape factors reduce to a single term, hereafter denoted by C_0, that describes the lowest order transition and is independent of the outgoing neutrino energy. We have

$$\sum_x C_x n_x f_x \simeq C_0 \sum_x n_x f_x \qquad C_0 \simeq C_{\rm EC}. \tag{15}$$

Up to a very good approximation, the antineutrino capture shape factor ratio is given in this case by (14).

C. Unique Kth forbidden transitions

In the case of Kth unique forbidden transitions and taking again only dominant terms

$$C_x = |{}^A F_{LL-11}^{(0)}|^2 \mathcal{B}_L^{k_x}(p_x R)^{2(k_x-1)}(q_x R)^{2(L-k_x)}, \tag{16}$$

where $L > k_x$ and numerical coefficients, here and in the following, can be evaluated using prescriptions given in [4]. In the case of capture from s shells ($k_x = \pm 1$) we obtain the simple form

$$C_x = |{}^A F_{LL-11}^{(0)}|^2 \frac{(q_x R)^{2(L-1)}}{(2L-1)!!}, \tag{17}$$

and the shape factor ratio can be written as

$$\frac{C_x}{C_\nu} = \frac{((2L-1)!!)^{-1}(q_x R)^{2(L-1)}}{\sum_{n=1}^{L} \mathcal{B}_L^n \lambda_n (p_e R)^{2(n-1)}(p_\nu R)^{2(L-n)}}, \tag{18}$$

again with no dependence on the nuclear form factors. The ratio $\mathcal{A}'$ is again given by (14). In Fig. 1 we show the value

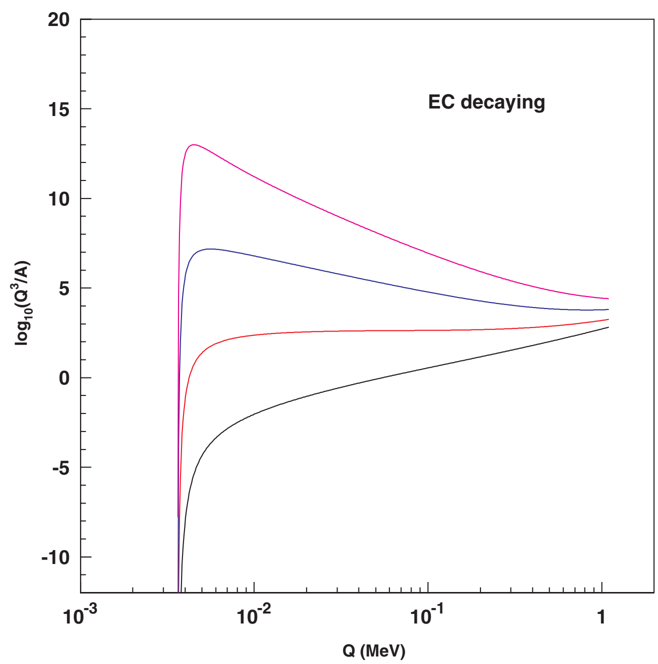

FIG. 1 (color online). Values of $Q_{\rm EC}^3/\mathcal{A}$ for EC decaying nuclei at $E_\nu = 2m_e$. The four curves represent from bottom to top superallowed, first unique forbidden, second unique forbidden, and third unique forbidden transitions, respectively. Curves are shown for $Z = 20$ and the sharp cutoff at 3.6 keV is due to the electron binding energy E_l of the K shell electron capture.

TABLE I. Pure EC decaying nuclei with the largest $\sigma(2) \cdot t_{1/2}^{\mathrm{EC}}$ value for neutrino capture processes of Eq. (2). Cross section is evaluated for incoming antineutrino energy of 1 MeV above reaction threshold and in the case of K shell capture. Allowed (top) and forbidden unique (bottom) transitions are shown.

Isotope	Decay ($J_i \to J_f$)	E_ν^{thr} (keV)	Half-life (s)	$\sigma_{(2)}$ (10^{-41} cm^2)
^{7}Be	$\frac{3}{2}^- \to \frac{1}{2}^-$	637.80	4.40×10^7	6.80×10^{-3}
^{7}Be	$\frac{3}{2}^- \to \frac{3}{2}^-$	160.18	5.13×10^6	1.16×10^{-2}
^{55}Fe	$\frac{3}{2}^- \to \frac{5}{2}^-$	790.62	8.64×10^7	1.55×10^{-5}
^{68}Ge	$0^+ \to 1^+$	916.00	2.34×10^7	1.39×10^{-4}
^{178}W	$0^+ \to 1^+$	930.70	1.87×10^6	5.14×10^{-4}
^{41}Ca	$\frac{7}{2}^- \to \frac{3}{2}^+$	600.61	3.22×10^{12}	8.35×10^{-9}
^{81}Kr	$\frac{7}{2}^+ \to \frac{3}{2}^-$	741.30	7.23×10^{12}	2.40×10^{-9}
^{100}Pd	$0^+ \to 2^-$	693.68	3.14×10^5	4.17×10^{-4}
^{123}Te	$\frac{1}{2}^+ \to \frac{7}{2}^+$	970.70	1.89×10^{22}	5.40×10^{-15}

of the ratio $Q_{\mathrm{EC}}^3/\mathcal{A}$ in the case of superallowed and unique forbidden EC transitions for a specific case.

IV. ESTIMATING ANTINEUTRINO CAPTURE CROSS SECTION

The cross section for reaction (2) can be evaluated using (10) and following the procedure illustrated in Sec. II. Numerical values for the constants appearing in Eqs. (6)

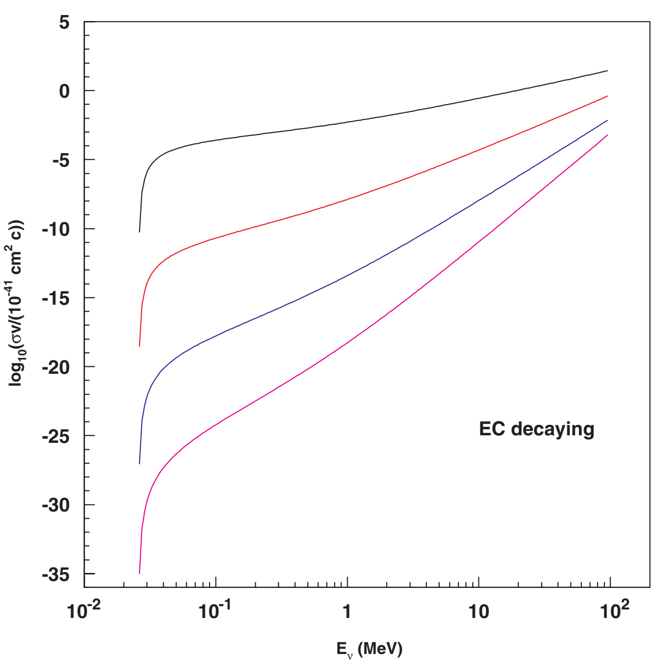

FIG. 2 (color online). The product σv_ν for EC decaying nuclei versus neutrino energy for reaction (2). Typical values for $\log(ft)$ values have been assumed [15] from top to bottom as follows: allowed (5.5), first unique forbidden (9.5), second unique forbidden (15.6), and third unique forbidden (21.1). The curves refer to $Q_{\mathrm{EC}} = 1$ MeV, $Z = 20$ and nuclear radius given by $R = 1.2A^{1/3}$ fm, where $A = 2.5Z$.

and (18) can be found in [4], while a description of the algorithm used to compute the Fermi function is given in [1]. We report in Table I the value of $\sigma_{(2)}$ for nuclei having the largest product of cross section times lifetime for a specific value of the incoming neutrino energy.

Antineutrino capture cross section behavior as a function of the incoming antineutrino energy is shown in Fig. 2 for a specific case. As an example, we consider the case of ^{7}Be, which decays with a half-life of $t_{1/2}^{\mathrm{EC}} = 53.22$ days [6] with $Q_{\mathrm{EC}} = 861.815 \pm 0.018$ keV [6]. The difference in the electron binding energy between ^{7}Be and its daughter ^{7}Li is of $E_l = 54.8$ eV [7], and can be neglected with respect to the decay Q value. The energy threshold, according to (4), is of 160.24 keV. Assuming an incoming antineutrino with energy of 100 eV above the energy threshold we have that

$$\sigma_{(2)} = 2.0 \times 10^{-48}\ \mathrm{cm}^2, \tag{19}$$

in the case of the $3/2^- \to 3/2^-$ transition.

Similarly, the antineutrino cross section for reaction (3) can be easily written using (14). For an electron captured from the K shell we can write (we recall that q_ν is the outgoing neutrino in the EC process)

$$\sigma_{(3)} v = \frac{2\pi^2 \ln 2}{q_\nu^2 t_{1/2}^{\mathrm{EC}}} \rho_K(E_\nu), \tag{20}$$

with $t_{1/2}^{\mathrm{EC}}$ the half-life of the nucleus EC decay.

V. ANTINEUTRINO CAPTURE VERSUS EC DECAY RATE

Using Eqs. (9) and (13), the ratio between antineutrino capture (2) and (3) and EC decay rates can be written as

$$\frac{\lambda_\nu}{\lambda_{\mathrm{EC}}} = \frac{2\pi^2}{\mathcal{A}^{(\prime)}} n_{\bar{\nu}}, \tag{21}$$

where $n_{\bar{\nu}}$ is the antineutrino density at the nucleus. As an example, in case of reaction (2) and superallowed transitions we have that

$$\frac{\lambda_\nu}{\lambda_{\rm EC}} = 4\pi \frac{n_{\bar\nu}}{\sum n_x \beta_x^2 B_x} \frac{p_e E_e F(Z, E_e)}{q_\nu^2}, \tag{22}$$

while for (3) and considering only K-shell capture in superallowed and Kth unique transitions

$$\frac{\lambda_\nu}{\lambda_{\rm EC}} = 2\pi^2 \frac{n_{\bar\nu}\rho_K(E_\nu)}{q_\nu^2}. \tag{23}$$

It is possible to get an order of magnitude estimate for the rate ratio using a simple argument. For reaction (2), the corresponding EC decay rate is related to the electron density at the nucleus and to the electron neutrino phase space

$$\frac{\lambda_\nu}{\lambda_{\rm EC}} \simeq \frac{n_{\bar\nu}}{|\psi_e(0)|^2} \frac{p_e E_e F(Z, E_e)}{q_\nu^2}, \tag{24}$$

where $\psi_e(\vec{x})$ is the captured electron wave function and $E_e = (E_{\bar\nu} + Q_{\rm EC}) - m_e$ is the outgoing positron energy in the antineutrino capture process. The expected antineutrino capture cross section is, therefore, given by

$$\sigma_{(2)} \simeq \frac{\lambda_{\rm EC}}{|\psi_e(0)|^2} \frac{p_e E_e F(Z, E_e)}{q_\nu^2}, \tag{25}$$

which depends only upon the experimental decay rate $\lambda_{\rm EC}$ and on the electron wave function at the nucleus. To test this result, we reevaluate the antineutrino capture cross section on ^{7}Be and compare the result with what we found in the previous section. Assuming the antineutrino having an energy of 100 eV above threshold for the $3/2^- \to 3/2^-$ reaction and using expression (25) we obtain $\sigma_{(2)} = 2.88 \times 10^{-48}$ cm^2 [compare with Eq. (19)] where a plain single particle hydrogenlike wave function has been used to describe K-shell electrons in the ^{7}Be atom.

VI. COSMOLOGICAL ANTINEUTRINO BACKGROUND DETECTION

Recently, the possibility to detect the CνB using beta unstable nuclei has received great interest [1,8,9]. In particular, this is strictly related to the now well-established experimental evidence for the neutrino mass from oscillation experiments. Though a direct measure of the neutrino mass scale is still missing, results from the large scale structure power spectrum and cosmic microwave background suggest an upper limit for the sum of the three eigenstate masses at the 0.5–1 eV level (a lower value is obtained if data from Lyman-α clouds are included in the analysis), see, e.g., [10] for a review. In case neutrino masses saturate this bound, the cosmological neutrino background could be really within the experimental reach in the near future. For an overview on perspectives for direct measurements of the CνB, see, e.g., [11].

The detection of a very low energy antineutrino using reaction (2) is of course problematic due to the presence of the energy threshold in expression (4). A possible solution could be using the CνB as a target for accelerated nuclei. In this case the threshold energy is provided by the energy of the accelerated nucleus in the CνB comoving frame. From simple kinematical considerations, the minimal value of the γ factor (for a nonrelativistic CνB electron neutrino) reads

$$\gamma_{\rm min} = \frac{E_\nu^{\rm thr}}{m_\nu}. \tag{26}$$

It is worthwhile noticing here that EC decaying atoms show the remarkable property of having a Q value that depends on the ionization degree of the parent atom. This is simply due to the fact that the difference between the electron binding energies of the parent and the daughter atoms depends on the total number of electrons in the atom before and after the decay. This result is well known and has been used, for example, to evaluate the age of the Universe using the Os-Re transition in the case of fully ionized atoms [12]. In order to evaluate the change of the Q value as a function of the decaying nucleus we recall here that nuclear masses are related to the atomic ones by the relation

$$M_N(A, Z) = M_A(A, Z) - Z \times m_e + B_e(Z), \tag{27}$$

where $B_e(Z)$ is the total binding energy of all removed electrons. Values of this quantity can be found in [13], while a useful parametrization is reported in [14]

$$B_e(Z) = 14.4381 Z^{2.39} + 1.554\,68 \times 10^{-6} \times Z^{5.35}\ \text{eV}. \tag{28}$$

In the case of fully ionized atoms the effective Q value is given by

$$Q_{\rm eff} = Q_{\rm EC} - m_e + [B_e(Z) - B_e(Z-1)]. \tag{29}$$

A completely ionized EC decaying atom whose Q value is smaller than $2m_e$ represents the best low energy antineutrino detector one could achieve, since there are no competing backgrounds. The process of Eq. (2) only occurs in the presence of an electron antineutrino having an energy greater than $E_\nu^{\rm thr}$.

As the relic antineutrino capture rate per nucleus can be expressed as (we notice that $t_{1/2}^{\rm EC}$ is the half-life in the nucleus rest frame)

$$\lambda_\nu = \frac{n_{\bar\nu} 2\pi^2 \ln 2}{\mathcal{A} \cdot t_{1/2}^{\rm EC}}, \tag{30}$$

the total rate is obtained by multiplying this expression by the total number of accelerated nuclei $\mathcal{N}$, where realistic values for the present storage rings are $\mathcal{N} = 10^{13}$ and $\gamma = 100$. Assuming a transition having a value of $Q_{\rm eff}$ of the order of the electronvolt this would lead to an interaction rate in the case of allowed transitions of the order of $\lambda_\nu \simeq 10^{-18}\ \mathrm{s}^{-1}$, too slow to be effectively detected even in the absence of background due to the EC decay of the nucleus (in the case of a fully ionized beam).

The CνB detection using reaction (3) appears even more difficult since for neutrinos having very small energy the number of final states per unit energy $\rho_x(E_\nu)$ is basically unknown. The atom in the final state has to have an excess energy $Q_{\mathrm{EC}} - E_l + m_\nu$ and this can only happen if this energy can be radiated out via electromagnetic or phonon emission, if the decaying atom is bounded in a solid. Photon emission can be due either to atomic electrons or to nuclear level transition; in the first case the typical energy lies in the eV-keV region and, being E_l in the same energy range, this implies that only nuclei with a very small Q value could be suitable for this detection. In the second case, a nuclear level should exist that matches the energy difference. Furthermore, to avoid the possibility that spontaneous EC decay is also allowed, these levels must be m_ν above the transition Q value by the fine-tuned value m_ν. Notice that in this latter case (EC decay forbidden) there is *a priori* no easy way to evaluate the cross section for reaction (3).

VII. CONCLUSIONS

In this paper we have considered the interaction of a low energy electron antineutrino on nuclei that undergo electron capture spontaneously. Depending on the Q value, crossed processes where a neutrino is in the initial state could be in principle exploited to measure low energy incoming neutrino fluxes from astrophysical or cosmological sources. Using a method already applied to neutrino captures on beta decaying nuclei in [1] to relate the nuclear shape factors of crossed reaction, we have computed the expected neutrino-nucleus cross section versus neutrino energy. The results show that these processes seem quite difficult to be used as a way to measure the CνB, whose detection might be more promisingly pursued in the future using beta decaying nuclei for sufficiently massive neutrinos. Nevertheless, EC decaying nuclei could be an interesting perspective for higher energy neutrino fluxes, if very specific conditions on the Q value of the decay are met or significant improvements on the performances of ion storage rings are achieved.

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