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Study of $\Lambda - \bar{\Lambda}$ oscillation in quantum coherent $\Lambda\bar{\Lambda}$ by using $J/\psi \to \Lambda\bar{\Lambda}$ decay

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We discuss the possibility of searching for the $\Lambda - \bar{\Lambda}$ oscillations for coherent $\Lambda\bar{\Lambda}$ production in the $J/\psi \to \Lambda\bar{\Lambda}$ decay process. The sensitivity of measurement of $\Lambda - \bar{\Lambda}$ oscillation in the external field at BES-III experiment is considered. These considerations indicate an alternative way to probe the $\Delta B = 2$ amplitude in addition to neutron oscillation experiments. Both coherent and time-dependent information can be used to extract the $\Lambda - \bar{\Lambda}$ oscillation parameter. With one year's luminosity at BES-III, we can set an upper limit of $\delta m_{\Lambda\bar{\Lambda}} < 10^{-15}$ MeV at 90% confidence level, corresponding to about 10^{-6} s of $\Lambda - \bar{\Lambda}$ oscillation time.

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One of the open questions for fundamental particle physics is whether baryon number violation can be found in nature [1,2], which is key for understanding the observed matter-antimatter asymmetry. There are a few reasons to believe that baryon number symmetry may not be exact symmetry. This is because of the three conditions for generating this asymmetry pointed out originally by Sakharov in 1967 [3]: (a) existence of *CP* violation, (b) baryon number violating interactions, and (c) the presence of out of thermal equilibrium conditions in the early Universe. If indeed such interactions are there, the important question is how one can observe them in experiments. In 1980, it was pointed out by Marshak *et al.* [4] that a crucial test of baryon number violation is neutron-antineutron ($N - \bar{N}$) oscillation. Thus, provided that the new gauge structure occurs beyond the standard model (SM), the mass scale could be the order of 10^2 to 10^3 TeV. After this proposal was made, many experiments had been carried out for searching for $N - \bar{N}$ oscillation [5,6]. The last experiment in the free neutron system at the ILL sets an upper limit of 8.6×10^7 s (90% confidence level) on the oscillation time [7].

Moreover, as discussed in Ref. [8], recent discoveries of neutrino oscillations have made $N - \bar{N}$ oscillation to be quite plausible theoretically if small neutrino masses are to be understood as a consequence of the seesaw mechanism [9], which indicates the existence of $\Delta(B - L) = 2$ interactions. Therefore, it implies the existence of $N - \bar{N}$ oscillation.

It is worth noting that if $N - \bar{N}$ oscillation exists, then $\Lambda - \bar{\Lambda}$ oscillation may also take place as first proposed by K.-B. Luk [10]. In fact one can consider $\Lambda - \bar{\Lambda}$ oscillation independently. However, until now there has not been any direct experimental measurement of $\Lambda - \bar{\Lambda}$ oscillation. In this paper, we would like to consider the phenomenology of $\Lambda - \bar{\Lambda}$ oscillation for free Λ. We also consider the effect of an external field on the Λ baryon, in particular, the effect of an external magnetic field on the opposite magnetic moments of Λ and $\bar{\Lambda}$. Moreover, we first propose to search for $\Lambda - \bar{\Lambda}$ oscillation in the coherent production in $J/\psi \to \Lambda\bar{\Lambda}$ decay. We discuss the observable for both the time-dependent and the time-independent correlated production rate.

The time evolution of the $\Lambda - \bar{\Lambda}$ oscillation is described by the Schrödinger-like equation as

$$i\frac{\partial}{\partial t}\begin{pmatrix} \Lambda(t) \\ \bar{\Lambda}(t) \end{pmatrix} = \mathbf{M}\begin{pmatrix} \Lambda(t) \\ \bar{\Lambda}(t) \end{pmatrix}, \quad (1)$$

where the $\mathbf{M}$ matrix is Hermitian, and is defined as

$$\mathbf{M} = \begin{pmatrix} m_\Lambda - \Delta E_\Lambda & \delta m_{\Lambda\bar{\Lambda}} \\ \delta m_{\Lambda\bar{\Lambda}} & m_{\bar{\Lambda}} - \Delta E_{\bar{\Lambda}} \end{pmatrix}, \quad (2)$$

where $\delta m_{\Lambda\bar{\Lambda}}$ is the $\Delta B = 2$ transition mass between Λ and $\bar{\Lambda}$; m_Λ ($m_{\bar{\Lambda}}$) is the mass of the Λ ($\bar{\Lambda}$) baryon; and $\Delta E_\Lambda = -\vec{\mu}_\Lambda \cdot \vec{B}$ and $\Delta E_{\bar{\Lambda}} = -\vec{\mu}_{\bar{\Lambda}} \cdot \vec{B}$ are energy split due to external field $\vec{B}$. Here, $\vec{\mu}_{\Lambda,\bar{\Lambda}}$ is the magnetic moment of Λ, $\mu_\Lambda = -\mu_{\bar{\Lambda}} = -0.613\mu_N$ ($\mu_N = 3.152 \times 10^{-14}$ MeV T^{-1} is the nuclear magneton). For produced unbound Λ propagating in a vacuum without an external field, both ΔE_Λ and $\Delta E_{\bar{\Lambda}}$ are equal to zero. *CPT* invariance imposes $m_\Lambda \equiv m_{\bar{\Lambda}}$ and $\Delta E_\Lambda = -\Delta E_{\bar{\Lambda}}$. The equality of the off-diagonal elements follows from *CP* invariance. The two eigenstates $|\Lambda_{\rm H}\rangle$ and $|\Lambda_{\rm L}\rangle$ of the effective Hamiltonian matrix $\mathbf{M}$ are given by

$$\begin{aligned} |\Lambda_{\rm H}\rangle &= \frac{1}{\sqrt{2}}(\sqrt{1+z}|\Lambda\rangle + \sqrt{1-z}|\bar{\Lambda}\rangle), \\ |\Lambda_{\rm L}\rangle &= \frac{1}{\sqrt{2}}(\sqrt{1-z}|\Lambda\rangle - \sqrt{1+z}|\bar{\Lambda}\rangle), \end{aligned} \quad (3)$$

where $z = \frac{2\Delta E}{\Delta m}$. Here, we define $\Delta E = |\Delta E_\Lambda| = |\Delta E_{\bar{\Lambda}}|$ and $\Delta m \equiv m_{\rm H} - m_{\rm L} = 2\sqrt{(\Delta E)^2 + \delta m^2_{\Lambda\bar{\Lambda}}}$, and $m_{\rm H}$ [$m_{\rm L}$]

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is the mass of the "heavy (H)" $\Lambda_{\rm H}$ ["light (L)" $\Lambda_{\rm L}$] baryon. In the absence of an external field, one has $\Delta E = 0$, thus one gets $z = 0$. While assuming that $\delta m_{\Lambda\bar{\Lambda}} \sim \delta m_{n\bar{n}}$ for the first order, we have $\delta m_{\Lambda\bar{\Lambda}} < 10^{-23}$ eV. It indicates that an external field will make $\Delta m \gg \delta m_{\Lambda\bar{\Lambda}}$, as a result we have $z \to 1$.

From Eq. (3), the corresponding eigenvalues are

$$\lambda_{\Lambda_{\rm H}} = m_\Lambda + \sqrt{(\Delta E)^2 + \delta m^2_{\Lambda\bar{\Lambda}}}, \tag{4}$$

$$\lambda_{\Lambda_{\rm L}} = m_\Lambda - \sqrt{(\Delta E)^2 + \delta m^2_{\Lambda\bar{\Lambda}}}. \tag{5}$$

Thus, starting with a beam of Λ, the probability of generating a $\bar{\Lambda}$ after time t, $\mathcal{P}(\bar{\Lambda}, t)$, is described by the following equation:

$$\mathcal{P}(\bar{\Lambda}, t) = \frac{\delta m^2_{\Lambda\bar{\Lambda}}}{\delta m^2_{\Lambda\bar{\Lambda}} + (\Delta E)^2} \sin^2\Big(\sqrt{\delta m^2_{\Lambda\bar{\Lambda}} + (\Delta E)^2} \cdot t\Big). \tag{6}$$

For free Λ, we have $\Delta E = 0$, and Eq. (6) becomes

$$\mathcal{P}(\bar{\Lambda}, t) = \sin^2(\delta m_{\Lambda\bar{\Lambda}} \cdot t). \tag{7}$$

Hereafter, we consider the possible search of $\Lambda - \bar{\Lambda}$ oscillation in $J/\psi \to \Lambda\bar{\Lambda}$ decay, in which the coherent $\Lambda\bar{\Lambda}$ events are generated with a strong boost. Here we assume that possible strong multiquark effects that involve seaquarks play no role in $J/\psi \to \Lambda\bar{\Lambda}$ decays [11].

In order to satisfy both the angular momentum conservation and parity conservation, the relative orbital angular momentum of the $\Lambda\bar{\Lambda}$ pair must be $L = 0$ or 2, and the total spin is $S = 1$ (i.e. $^3S_1$ and $^3D_1$ states), then the $\Lambda\bar{\Lambda}$ pair must be in a state with $C = -1$ [12]. Thus, considering both the spin and orbital part under hypothesis of "factorization," the wave function of the $\Lambda\bar{\Lambda}$ pair system can be defined as

$$|\Lambda\bar{\Lambda}\rangle^{C=-1} = \chi_1 \frac{1}{\sqrt{2}}[|\Lambda\rangle|\bar{\Lambda}\rangle - |\bar{\Lambda}\rangle|\Lambda\rangle], \tag{8}$$

where χ_1 is the symmetric spin triplet for the fermion pair in the $S = 1$ state with S denoting the total spin angular momentum. Then, the amplitude for J/ψ decaying to $\Lambda\bar{\Lambda}$ can be denoted by $\langle\Lambda\bar{\Lambda}|\mathcal{H}|J/\psi\rangle$, where $|\Lambda\bar{\Lambda}\rangle$ is the total wave function for the $\Lambda\bar{\Lambda}$ pair. For simplicity, we may write only the orbital angular part for representing the total wave function since the occurrence of χ_1 would not affect the genuine physical results, which can be easily seen in the following paragraphs.

Now we turn to analyze the time evolution of the $\Lambda\bar{\Lambda}$ system produced in J/ψ decay. Following $J/\psi \to \Lambda\bar{\Lambda}$ decay, the Λ and $\bar{\Lambda}$ will separate and the proper-time evolution of the particle states $|\Lambda_{\rm phys}(t)\rangle$ and $|\bar{\Lambda}_{\rm phys}(t)\rangle$ are given by

$$\begin{aligned} |\Lambda_{\rm phys}(t)\rangle &= (g_+(t) + zg_-(t)|\Lambda\rangle + \sqrt{1-z^2}g_-(t)|\bar{\Lambda}\rangle, \\ |\bar{\Lambda}_{\rm phys}(t)\rangle &= (zg_-(t) - g_+(t))|\bar{\Lambda}\rangle - \sqrt{1-z^2}g_-(t)|\Lambda\rangle, \end{aligned} \tag{9}$$

where

$$g_\pm = \frac{1}{2}(e^{-im_{\rm H}t-(1/2)\Gamma_{\rm H}t} \pm e^{-im_{\rm L}t-(1/2)\Gamma_{\rm L}t}), \tag{10}$$

with definitions

$$\begin{aligned} m &\equiv \frac{m_{\rm L}+m_{\rm H}}{2}, & \Delta m &\equiv m_{\rm H} - m_{\rm L}, \\ \Gamma &\equiv \frac{\Gamma_{\rm L}+\Gamma_{\rm H}}{2}, & \Delta\Gamma &\equiv \Gamma_{\rm H} - \Gamma_{\rm L}. \end{aligned} \tag{11}$$

Note that, here, Δm is positive by definition, while the sign of $\Delta\Gamma$ is to be determined by experiments.

In practice, one defines the following oscillation parameters in a similar fashion as in neutral B and D mixing cases:

$$x_\Lambda \equiv \frac{\Delta m}{\Gamma}, \qquad y_\Lambda \equiv \frac{\Delta\Gamma}{2\Gamma}. \tag{12}$$

Then, we consider a $\Lambda\bar{\Lambda}$ pair in J/ψ decay with a definite charge-conjugation eigenvalue. The time-dependent wave function of the $\Lambda\bar{\Lambda}$ system with $C = -1$ can be written as

$$\begin{aligned} |\Lambda\bar{\Lambda}(t_1, t_2)\rangle = \frac{1}{\sqrt{2}}[&|\Lambda_{\rm phys}(\mathbf{k_1}, t_1)\rangle|\bar{\Lambda}_{\rm phys}(\mathbf{k_2}, t_2)\rangle \\ &- |\bar{\Lambda}_{\rm phys}(\mathbf{k_1}, t_1)\rangle|\Lambda_{\rm phys}(\mathbf{k_2}, t_2)\rangle], \end{aligned} \tag{13}$$

where $\mathbf{k_1}$ and $\mathbf{k_2}$ are the three-momentum vector of the two Λ baryons. We now consider decays of these correlated system into various final states. The amplitude of such joint decays, one Λ decaying to a final state f_1 at proper time t_1, and the other Λ to f_2 at proper time t_2, is given by

$$\begin{aligned} A(J/\psi \to \Lambda_{\rm phys}\bar{\Lambda}_{\rm phys} \to f_1 f_2) \equiv \frac{1}{\sqrt{2}} \times \{&[g_+(t_1)g_-(t_2) \\ &- g_-(t_1)g_+(t_2)]a_2 \\ &- [g_+(t_1)g_+(t_2) \\ &- g_-(t_1)g_-(t_2)]a_1\}, \end{aligned} \tag{14}$$

where

$$\begin{aligned} a_1 &\equiv A_{f_1}\bar{A}_{f_2} - \bar{A}_{f_1}A_{f_2} = A_{f_1}A_{f_2}(\lambda_{f_2} - \lambda_{f_1}), \\ a_2 &\equiv z(A_{f_1}\bar{A}_{f_2} + \bar{A}_{f_1}A_{f_2}) - \sqrt{1-z^2}(A_{f_1}A_{f_2} - \bar{A}_{f_1}\bar{A}_{f_2}) \\ &= A_{f_1}A_{f_2}[z(\lambda_{f_2} + \lambda_{f_1}) - \sqrt{1-z^2}(1 - \lambda_{f_1}\lambda_{f_2})], \end{aligned} \tag{15}$$

with $A_{f_i} \equiv \langle f_i|\mathcal{H}|\Lambda\rangle$, $\bar{A}_{f_i} \equiv \langle f_i|\mathcal{H}|\bar{\Lambda}\rangle$ $(i = 1, 2)$, and we define

$$\lambda_{f_i} \equiv \frac{\langle f_i|\mathcal{H}|\bar{\Lambda}\rangle}{\langle f_i|\mathcal{H}|\Lambda\rangle} = \frac{\bar{A}_{f_i}}{A_{f_i}}, \quad (16)$$

$$\bar{\lambda}_{\bar{f}_i} \equiv \frac{\langle \bar{f}_i|\mathcal{H}|\Lambda\rangle}{\langle \bar{f}_i|\mathcal{H}|\bar{\Lambda}\rangle} = \frac{A_{\bar{f}_i}}{\bar{A}_{\bar{f}_i}}. \quad (17)$$

In the process $e^+e^- \to J/\psi \to \Lambda\bar{\Lambda}$, the $\Lambda\bar{\Lambda}$ pairs are strongly boosted, so that the decay-time difference $[t = \Delta t_- = (t_2 - t_1)]$ between $\Lambda_{\rm phys} \to f_1$ and $\bar{\Lambda}_{\rm phys} \to f_2$ can be measured easily. From Eq. (14), one can derive the general expression for the time-dependent decay rate:

$$\begin{aligned}\frac{d\Gamma(J/\psi \to \Lambda_{\rm phys}\bar{\Lambda}_{\rm phys} \to f_1 f_2)}{dt} &= \mathcal{N} e^{-\Gamma|t|} \times [(|a_1|^2 + |a_2|^2)\cosh(y_\Lambda \Gamma t) + (|a_1|^2 - |a_2|^2) \\ &\times \cos(x_\Lambda \Gamma t) + 2\mathcal{R}e(a_1 a_2^*)\sinh(y_\Lambda \Gamma t) \\ &+ 2\mathcal{I}m(a_1 a_2^*)\sin(x_\Lambda \Gamma t)], \end{aligned} \quad (18)$$

where $\mathcal{N}$ is a common normalization factor. In Eq. (18), terms proportional to $|a_1|^2$ are associated with decays that occur without any net oscillation, while terms proportional to $|a_2|^2$ are associated with decays following a net oscillation. The other terms are associated with the interference between these two cases. In the following discussion, we define

$$R(f_1, f_2; t) \equiv \frac{d\Gamma(J/\psi \to \Lambda_{\rm phys}\bar{\Lambda}_{\rm phys} \to f_1 f_2)}{dt}. \quad (19)$$

For a given state $f_1 f_2 = (p\pi^-)(p\pi^-)$, we have $a_1 = 0$ and $a_2 = 2A_{p\pi^-}\bar{A}_{p\pi^-}$. Thus one can write $R(p\pi^-, p\pi^-; t)$ as

$$R(p\pi^-, p\pi^-; t) = \mathcal{N}\frac{1}{4} e^{-\Gamma|t|}|a_2|^2[\cosh(y_\Lambda \Gamma t) - \cos(x_\Lambda \Gamma t)]. \quad (20)$$

At BES-III experiment, the external magnetic field is about 1.0 T, in which case, $\Delta E \sim 2 \times 10^{-11}$ MeV, thus $z \sim 1$. Taking into account that $|\lambda|, |\bar{\lambda}| \ll 1$ and $x_\Lambda, y_\Lambda \ll 1$ and $z \to 1.0$, keeping terms up to order x_Λ^2, and y_Λ^2 in the expressions, neglecting CP violation, expanding the time-dependent decay rate for xt, yt, we can write Eq. (20) as

$$R(p\pi^-, p\pi^-; t) = \mathcal{N} e^{-\Gamma|t|}|A_{p\pi^-}|^2|\bar{A}_{p\pi^-}|^2 \times \frac{x_\Lambda^2 + y_\Lambda^2}{2}(\Gamma t)^2. \quad (21)$$

For $f_1 f_2 = (p\pi^-)(\bar{p}\pi^+)$, we have $a_1 = A_{p\pi^-}\bar{A}_{\bar{p}\pi^+}(1 - \lambda_{p\pi^-}\bar{\lambda}_{\bar{p}\pi^+})$ and $a_2 = A_{p\pi^-}\bar{A}_{\bar{p}\pi^+}(1 + \lambda_{p\pi^-}\bar{\lambda}_{\bar{p}\pi^+})$. Thus the time-dependent decay rate can be expressed as

$$\begin{aligned} R(p\pi^-, \bar{p}\pi^+; t) &= \mathcal{N}\frac{1}{2} e^{-\Gamma|t|}|A_{p\pi^-}|^2|\bar{A}_{p\pi^-}|^2(1 + y_\Lambda \Gamma t) \\ &\approx \mathcal{N}\frac{1}{2} e^{-\Gamma|t|}|A_{p\pi^-}|^2|\bar{A}_{p\pi^-}|^2. \end{aligned} \quad (22)$$

We define the following observable:

$$\mathcal{R}(t) \equiv \frac{R(p\pi^-, p\pi^-; t) + R(\bar{p}\pi^+, \bar{p}\pi^+; t)}{R(p\pi^-, \bar{p}\pi^+; t) + R(\bar{p}\pi^+, p\pi^-; t)}. \quad (23)$$

Combining Eqs. (21) and (22), one obtains

$$\mathcal{R}(t) = 2|\lambda_{p\pi^-}|^2 \frac{x_\Lambda^2 + y_\Lambda^2}{2}(\Gamma t)^2. \quad (24)$$

For completeness, we derive general expressions for time-integrated decay rates into a pair of final states f_1 and f_2:

$$R(f_1, f_2) = \frac{1}{4}\mathcal{N}\left[(|a_1|^2 + |a_2|^2)\frac{1}{1 - y_\Lambda^2} + (|a_1|^2 - |a_2|^2)\frac{1}{1 + x_\Lambda^2}\right]. \quad (25)$$

At last, the ratio of two probabilities mentioned above can be rewritten as

$$\begin{aligned}\mathcal{R} &\equiv \frac{R(p\pi^-, p\pi^-) + R(\bar{p}\pi^+, \bar{p}\pi^+)}{R(p\pi^-, \bar{p}\pi^+) + R(\bar{p}\pi^+, p\pi^-)} \\ &= 2|\lambda_{p\pi^-}|^2(x_\Lambda^2 + y_\Lambda^2). \end{aligned} \quad (26)$$

If there is no external field and the Λ is free, we have $z = 0$, Eq. (24) becomes

$$\mathcal{R}(t) = \frac{1}{2}\frac{x_\Lambda^2 + y_\Lambda^2}{2}(\Gamma t)^2, \quad (27)$$

and the time-independent ratio in Eq. (26) becomes

$$\mathcal{R} = \frac{x_\Lambda^2 + y_\Lambda^2}{2}. \quad (28)$$

Assuming $y_\Lambda = 0$, one estimation value of $\delta m_{\Lambda\bar{\Lambda}}$ in the presence of an external field reads, from Eq. (26),

$$\delta m_{\Lambda\bar{\Lambda}} = \sqrt{\left(\frac{\mathcal{R}\Gamma}{4|\lambda_{p\pi^-}|^2}\right)^2 - (\Delta E)^2}. \quad (29)$$

Correspondingly, Eq. (28) is rewritten as

$$\delta m_{\Lambda\bar{\Lambda}} = \frac{1}{\sqrt{2}}\sqrt{\mathcal{R}}\Gamma. \quad (30)$$

With a huge data sample, one can measure $\mathcal{R}$ and $|\lambda_{p\pi^-}|^2$ simultaneously, and from Eq. (29), the oscillation mass $\delta m_{\Lambda\bar{\Lambda}}$ will be determined.

Currently, we can get an estimated value for $\delta m_{\Lambda\bar{\Lambda}}$ in the absence of an external field from Eq. (30). In the experiment at BES-III, about 10×10^9 J/ψ and 3×10^9 $\psi(2S)$ data samples can be collected per year's running according to the designed luminosity of BEPCII in Beijing [13,14].

Assuming that no signal events of $J/\psi \to \Lambda_H \Lambda_L \to (p\pi^-)(p\pi^-)$ or $(\bar{p}\pi^+)(\bar{p}\pi^+)$ are observed, we can set an upper limit of $\mathcal{R} < 3.5 \times 10^{-7}$ and further $\delta m_{\Lambda\bar{\Lambda}} < 10^{-15}$ MeV at 90% confidence level. This will be the first search for $\Lambda - \bar{\Lambda}$ oscillation experimentally. In the future, at the next generation of a τ-charm factory with luminosity of 10^{35} cm^{-2} s^{-1} [15,16], the expected sensitivity of measurement of $\Lambda - \bar{\Lambda}$ oscillation will be more stringent, $\delta m_{\Lambda\bar{\Lambda}} < 10^{-17}$ MeV at 90% confidence level.

It is known that one has to fit the proper-time distribution as described in Eq. (24) in experiments to extract the Λ oscillation parameters. At a symmetric ψ factory, namely, the J/ψ is at rest in the central-mass (CM) frame. Then, the proper-time interval between the two Λ baryons is calculated as

$$\Delta t = (r_\Lambda - r_{\bar{\Lambda}}) \frac{m_\Lambda}{c|\mathbf{P}|}, \tag{31}$$

where r_Λ and $r_{\bar{\Lambda}}$ are the Λ and the $\bar{\Lambda}$ decay lengths, respectively, and $\mathbf{P}$ is the three-momentum vector of Λ. Since the momentum can be calculated with J/ψ decay in the CM frame, all the joint $\Lambda\bar{\Lambda}$ decays in this paper can be used to study $\Lambda - \bar{\Lambda}$ oscillation in the symmetric J/ψ factory.

The average decay length of the Λ baryon in the rest frame of J/ψ is $c\tau_\Lambda \times (\beta\gamma)_\Lambda \approx 7.6$ cm. At BES-III, the impact parameter resolution of the main draft chamber, which is directly related to the decay vertex resolution of Λ, is described in Ref. [13], from which we can get that the resolution for the reconstructed Λ decay length should be less than 200 μm within the coverage of the detector. This means that the BES-III detector is good enough to separate the two Λ decay vertices, so that the oscillation parameters can be measured by using time information.

In conclusion, if $N - \bar{N}$ oscillation exists, then it would be possible to induce $\Lambda - \bar{\Lambda}$ oscillation. We suggest that the coherent $\Lambda\bar{\Lambda}$ events from the decay of $J/\psi \to \Lambda\bar{\Lambda}$ can be used to search for possible $\Lambda - \bar{\Lambda}$ oscillation. The Λ baryons from J/ψ decay are strongly boosted, so that it will offer the possibility to measure the proper-time interval Δt between the fully reconstructed Λ and $\bar{\Lambda}$. Both coherent and time-dependent information can be used to extract the $\Lambda - \bar{\Lambda}$ oscillation parameter. With one year's luminosity at BES-III, we can set an upper limit of $\delta m_{\Lambda\bar{\Lambda}} < 10^{-15}$ MeV at 90% confidence level, corresponding to about 10^{-6} s of $\Lambda - \bar{\Lambda}$ oscillation time. It will be the first search of $\Lambda - \bar{\Lambda}$ oscillation experimentally. At the BES-III experiment, the $\Lambda\bar{\Lambda}$ pair can be fully reconstructed, and backgrounds will be highly suppressed with particle identification and reconstruction of the second vertex of the Λ decay. The BES-III experiment is collecting data at the J/ψ peak now, and we expect to see the first result of $\Lambda - \bar{\Lambda}$ oscillation soon. Here we want to point out that the shorter mean life of Λ can significantly hamper a sensitive search for the $\Lambda - \bar{\Lambda}$ oscillation as stated in Ref. [10]. Finally, we have to address that the future super τ-charm factory will be important to search for this kind of new physics. Precisely measuring the baryon number violating process is encouraged.

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