Erratum: What can we learn from the global spin alignment of ϕ mesons in heavy-ion collisions? [Phys. Rev. D 101, 096005 (2020)]

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We correct a sign error in the polarization formula for the antifermion. This may change some results and related discussions. The main conclusion is not changed.

In the abstract, the third sentence is changed to "The contribution may be from the polarization of the strange quark and antiquark through the ϕ field, an effective mode of the gluon field in the strong interaction."

In Sec. III, in the second line below Eq. (4), there is a sign error in the definition of p^μ for the antifermion, which should be $p^\mu = (E_p, \mathbf{p})$. Such a sign in the polarization of the antifermion is very subtle and may lead to an inconsistency in the relativistic spin transport theory. On the rhs of Eq. (5), the sign for $\bar{s}$ in the second and fourth terms should be $+$ and $-$, respectively. On the rhs of Eq. (8), the sign in the third and fourth terms should be $+$ and $-$, respectively. In line 7 after Eq. (8), "9.18 m_π^2" is changed to "9.45 m_π^2." In the last paragraph in the left column on page 3, the third to sixth sentences should be changed to: "The c_Λ term has two contributions: the vorticity contribution is negative and the magnetic field contribution is positive, and they are all of the order 10^{-3} to 10^{-4} according to the simulations using transport models [21,22] and hydrodynamic models [57,58], respectively. The c_ε term provides a positive contribution to ρ_{00}^{ϕ} but is not constrained by the data of Λ polarization."

In Sec. IV, in the left column on page 4 we make the following changes:

(a) The mathematical expression at the beginning of line 7 should have a minus sign for the antiquark, i.e., it should be changed to $\pm g_\phi \hat{\mathbf{y}} \cdot (\mathbf{E}_\phi \times \mathbf{p}_{s/\bar{s}})/(2m_s^2 T)$.

(b) The sentence in line 7 starting with "Correspondingly, $P^y_{\Lambda/\bar{\Lambda}}(t, \mathbf{x})\ldots$" is changed to "Correspondingly, $P^y_{\Lambda/\bar{\Lambda}}(t, \mathbf{x})$ in Eq. (6) has an additional term $\pm g_\phi B^y_\phi/(2m_s T)$ which is constrained by the data."

(c) The sentence before Eq. (13) is changed to: "where c_ϕ is from the ϕ field," and Eq. (13) is changed to

$$c_\phi \equiv \frac{g_\phi^2}{27 m_s^2 T_{\text{eff}}^2}\left[3\langle B_{\phi,y}^2\rangle - \frac{\langle \mathbf{p}^2\rangle_\phi}{m_s^2}\langle E_{\phi,z}^2 + E_{\phi,x}^2\rangle\right].$$

(d) The fourth sentence after Eq. (13) should be changed to: "The important feature in Eq. (13) is that c_ϕ has a positive contribution from $\mathbf{B}_\phi$ and a negative contribution from $\mathbf{E}_\phi$ in the form of field squares which are not constrained by $P^y_{\Lambda/\bar{\Lambda}}(t, \mathbf{x})$."

(e) The second sentence in the second-to-last paragraph in the left column is changed to: "If the data show that ρ_{00}^{ϕ} is larger than $1/3$ by at least a few percent, according to our model, the deviation may possibly be from c_ϕ involving the magnetic part of the ϕ field under the condition that the quark polarization is only along the y direction."

In the right column of page 4, we make the following changes: (a) The expression "$\partial j_s^{z,x}/\partial t$" in line 8 is changed to "$\partial j_s^{z,x}/\partial t$ and $(\nabla \times \mathbf{J}_s)_y$." (b) The expression "$C_s^{(y)} = 400, 600, 1000\ \text{fm}^{-8}$" and the formula "$C_s^{(y)} \equiv g_\phi^4\langle \tilde{E}_{\phi,z}^2 + \tilde{E}_{\phi,x}^2\rangle$" in line 10 are changed to "$G_s^{(y)} = (2.05, 3.08, 5.13)\ m_\pi^4$" and "

$$G_s^{(y)} \equiv g_\phi^2\left[3\langle B_{\phi,y}^2\rangle - \frac{\langle \mathbf{p}^2\rangle_\phi}{m_s^2}\langle E_{\phi,z}^2 + E_{\phi,x}^2\rangle\right]$$

for the case that the quark polarization is only along the y direction, and

$$G_s^{(y)} \equiv g_\phi^2\left[3\langle B_{\phi,y}^2\rangle + \frac{\langle \mathbf{p}^2\rangle_\phi}{m_s^2}\langle E_{\phi,y}^2\rangle - \frac{3}{2}\langle B_{\phi,x}^2 + B_{\phi,z}^2\rangle - \frac{\langle \mathbf{p}^2\rangle_\phi}{2m_s^2}\langle E_{\phi,x}^2 + E_{\phi,z}^2\rangle\right]$$

for the case that the quark polarization can be along any direction.", respectively. (c) We add a sentence right after the sentence containing the expression of "$C_s^{(y)}$": "We note that $G_s^{(y)}$ comes from a quadratic form of field strength tensors of the ϕ field, $\langle F_\phi^{\mu\nu} F_\phi^{\alpha\beta}\rangle I_{\alpha\beta\mu\nu}$, where $I_{\alpha\beta\mu\nu}$ is a tensor involving an integral of the ϕ meson's momentum."

In Fig. 1, "$C_s^{(y)} = 400$ fm^{-8}," "$C_s^{(y)} = 600$ fm^{-8}," and "$C_s^{(y)} = 1000$ fm^{-8}" are changed to "$G_s^{(y)} = 2.05\ m_\pi^4$," "$G_s^{(y)} = 3.08\ m_\pi^4$," and "$G_s^{(y)} = 5.13\ m_\pi^4$", respectively. In the figure caption, "$C_s^{(y)}$" is changed to "$G_s^{(y)}$." Here we use a better and different parameter $G_s^{(y)}$ in units of m_π^4 to replace the original one $C_s^{(y)}$ in units of fm^{-8}.

In the summary section, the sixth to ninth sentences are changed to: "Note that $\mathbf{E}_\phi$ can also polarize s and $\bar{s}$ through the spin-orbit force, the same force that is responsible for the nuclear shell structure at the nucleon level. Both $\mathbf{B}_\phi^2$ and $\mathbf{E}_\phi^2$ are not constrained by the polarization data of Λ and $\bar{\Lambda}$. We then propose that a significant deviation of ρ_{00}^ϕ from $1/3$ could indicate the presence of the ϕ field in heavy-ion collisions, which polarizes s and $\bar{s}$ in the same way as the electromagnetic field. The contributions are significant even for fluctuating fields."

The corrected version of the paper with an integration of this erratum can be found in Ref. [1].

[1] X.-L. Sheng, L. Oliva, Q. Wang, arXiv:1910.13684.