Corrigendum

Corrigendum to “Comparative Aspects of Spin-Dependent Interaction Potentials for Spin-1/2 and Spin-1 Matter Fields”

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In the article titled “Comparative Aspects of Spin-Dependent Interaction Potentials for Spin-1/2 and Spin-1 Matter Fields” [1], calculations for some interparticle potentials for sources with spin-1/2 and spin-1 in the nonrelativistic (NR) regime contained inadvertent errors which should be corrected as follows. The main conclusions are unaltered.

We note further that we have included contact terms coming from Dirac delta contributions of the following Fourier transforms:

\[
\int \frac{d^3 \bar{q}}{(2\pi)^3} \frac{\delta_{ij} \delta_j}{\bar{q}^2 + m^2} e^{i \bar{q} \cdot \bar{r}} = \frac{1}{3} \delta^{(3)} (\bar{r}) + \frac{e^{-mr}}{4\pi r} (\hat{r} \cdot \hat{r}),
\]

and

\[
\int \frac{d^3 \bar{q}}{(2\pi)^3} \frac{\delta^{ij} \delta_j}{\bar{q}^2 + m^2} e^{i \bar{q} \cdot \bar{r}} = \delta^{(3)} (\bar{r}) - \frac{m^2 e^{-mr}}{4\pi r},
\]

which are the massive generalizations of the “massless” results from [2].

In what follows we list the corrections, indicated by \( \Delta V \), that must be added to some of the potentials given in [1]. The mass of the mediator, \( m \), corresponds to either \( m_\phi \) or \( m_A \), as the case may be. We also highlight that not all the potentials from [1] are affected and in this note we only indicate those which are modified (Moreover, we need to use \( \langle S_i \rangle_{jk} = -i \epsilon_{ijk} \) in all potentials. In [1], we had the opposite sign, so one must make \( \vec{S} \rightarrow -\vec{S} \) throughout.).

2. Correcting the Potentials

2.1. Potentials (Spin-1/2). The \( S - PS \) and \( V - PV \) potentials from [1] are not affected. The other potentials receive partial corrections. For convenience, we define the function:

\[
I(r) \equiv \frac{1}{4} \left( \frac{m_1^2}{m_2} + \frac{1}{m_1} \right) \left( \frac{m_1^2}{m_2} - \frac{1}{m_2^2} \right) e^{-mr} / 4\pi r,
\]

so that the potentials in equations (25), (30) (As mentioned in equation (30) in [1], the \( PS - PS \) potential for \( s = 1/2 \) has the same functional form as the \( PS - PS \) potential for \( s = 1 \)), (44), and (45) in [1] receive the respective corrections:

\[
\Delta V_{S-S}^{s=1/2} = g_{S-S}^1 g_{S-S}^2 \delta_i \delta_2 I (r),
\]

\[
\Delta V_{PS-PS}^{s=1/2} = -g_{PS-PS}^1 g_{PS-PS}^2 \left( \langle \hat{S}_1 \rangle \cdot \langle \hat{S}_2 \rangle \right) \delta^{(3)} (\bar{r}),
\]

\[
\Delta V_{V-V}^{s=1/2} = -e_1 e_2 \left( \delta_i \delta_2 I (r) + \left[ \delta_i \delta_2 \left( \frac{1}{m_1^2} + \frac{1}{m_2^2} \right) + \frac{\langle \hat{S}_1 \rangle \cdot \langle \hat{S}_2 \rangle}{6m_1 m_2} \right] \delta^{(3)} (\bar{r}) \right),
\]
2.2. Potentials (Spin-1)

2.2.1. Vector Representation. The corrections to equations (28), (30), (47), and (48) in [1] are, respectively:

\[
\Delta V^{s=1}_{V,V} = -e_1 e_2 \left\{ 2 \delta_1 \delta_2 I(r) + \left[ \frac{2}{3} \frac{\langle \vec{S}_1 \cdot \vec{S}_2 \rangle}{m_1 m_2} + \frac{\delta_1 \delta_2}{6} \left( \frac{1}{m_1^2} + \frac{1}{m_2^2} \right) \right] \delta(\vec{r}) \right\},
\]

whereby, in (10), \(I(r)\) cancels another term in (47) from [1].

2.2.2. Tensor Representation. The correction to the PS-PS potential in this representation is \(\Delta V^{s=1}_{PS,PS}/4m_1^2 m_2^2\) (cf. (9)). Also, the correction to the PV-PV potential in this representation is the same as in (11).

In [1], equations (65) receive the respective corrections:

\[
\Delta V^{s=1}_{V,V} = -e_1 e_2 \left\{ 2 \delta_1 \delta_2 I(r) + \left[ \frac{2}{3} \frac{\langle \vec{S}_1 \cdot \vec{S}_2 \rangle}{m_1 m_2} + \frac{\delta_1 \delta_2}{6} \left( \frac{1}{m_1^2} + \frac{1}{m_2^2} \right) \right] \delta(\vec{r}) \right\}.
\]
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