Cai and Papini Reply: In the preceding Comment [1] Anandan claims that our recent derivation of the gravity-spin coupling [2] violates the principle of equivalence and that our use of line integrals to describe the effect of gravity in particle interferometry is incorrect. These claims are based on a misinterpretation of our results and are unfounded. We welcome the opportunity to clarify the matter. In Ref. [2] we presented solutions of the general relativistic Dirac and Maxwell-Proca equations, which are exact to first order in the metric deviation. For spin-$\frac{1}{2}$ particles in particular, the solution is given by Eq. (3) of Ref. [2]. The first term of the equation contains the spin-gravity coupling and does not depend on the strength of the gravitational field. The second term also contains an integral, is exact to first order only, and exists even in the absence of spin. Both integrals depend on the spacetime paths followed by the particles. Were these to be closed, then the integrals could be transformed as in Eq. (5) of Ref. [2]. It is also explicitly stated in Ref. [2] (p. 1261) that "no such closed-spacetime paths exist physically..." and that, therefore, "Eq. (5) is of scarce practical use." In the actual applications to interferometry [3,4], all line integrals were performed by dividing the particle world lines into segments joining a mirror to the next, a procedure which takes into account the effects of the mirrors automatically. The results agree remarkably well with those of similar calculations and with available experimental results. They also confirm the existence of the spin-rotation effect derived by Mashhoon [5] and Helh and Ni [6] following different approaches. This is represented by a term $\propto \mathbf{\Omega}\cdot\boldsymbol{\sigma}$ which is obviously observer dependent, mixes the helicity states of massive particles, and leads to helicity oscillations. For neutrinos with energies $E \gg m_\nu$ the oscillation equation follows from the Dirac equation and is of the type

$$i\frac{d}{dz}\begin{pmatrix}\nu_R\\ \nu_L\end{pmatrix} = \tfrac{1}{2}\{-P_+(\mathbf{\Omega}\cdot\boldsymbol{\sigma})P_- - P_-(\mathbf{\Omega}\cdot\boldsymbol{\sigma})P_+\}\begin{pmatrix}\nu_R\\ \nu_L\end{pmatrix}, \qquad (1)$$

where $P_\pm$ are helicity projection operators, and the neutrino motion and spin quantization axis are in the z direction. In Eq. (1), terms proportional to $m_\nu^2/2E$, $P_\pm\Gamma_i P_\mp$ and terms representing the coherent interaction of ν_L with the media have been neglected for simplicity. A corotating observer would, in particular, use Eq. (1) to describe the helicity precession of neutrinos also corotating with a neutron star. A similar equation (Refs. [14-18] of Ref. [2]) describes the magnetic spin flip of neutrinos. The relative magnitude of the effects is also discussed in Ref. [2]. Since the helicity of a massive particle is not a relativistically invariant quantity, its dynamics is in general dictated by the relative motion of particle and observer. Anandan's statement that the principle of equivalence prevents the helicity from changing applies only to zero-mass neutrinos which are completely out of context with the content and intent of our paper.

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