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Torsion electrodynamics and the axial vector spin–torsion coupling effects in the framework of the Poincaré gauge theory of gravity

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Based on the Poincare gauge theory of gravity with the most general Lagrangian quadratic in curvature and torsion, we investigate the axial vector torsion-spin coupling. The dynamical equations for the so-called "electric"$\mathcal{E}_a$ and "magnetic"$\mathcal{B}^a$ components of the torsion variable are obtained in the general form, where the helicity density and spin density of the electromagnetic with scalar and vector potentials $\phi, \vec{A}$ are the sources of these fields
\begin{align}
\vec{\nabla}\cdot\vec{\mathcal E} - \mu^2\varphi - \lambda\partial_t(\partial\alpha) &=
-\,{\frac{\chi}{\mu_0}}\,\vec{A}\cdot\vec{B},\\
\vec{\nabla}\times\vec{\mathcal B} -{\frac 1{c^2}}\partial_t\vec{\mathcal E} + \mu^2\vec{\alpha}
+ \lambda\vec{\nabla}(\partial\alpha) &= -\,\chi\varepsilon_0\left(\phi\vec{B}
+ \vec{E}\times\vec{A}\right).
\end{align}The modified Maxwell's equations for the electromagnetic field are derived, where the sources are dependent on the torsion field potentials $\varphi, \vec{\alpha}$
\begin{align}
\vec{\nabla}\cdot\vec{E} &= 2\chi c\,\vec{\alpha}\cdot\vec{B}
- \chi c\,\vec{A}\cdot\vec{\mathcal B},\\
\vec{\nabla}\times\vec{B} - {\frac 1{c^2}}\partial_t\vec{E} &=
{\frac{2\chi}{c}}\left(\varphi\vec{B} + \vec{E}\times\vec{\alpha}\right) -
{\frac{\chi}{c}}\left(\phi\vec{\mathcal B} + \vec{\mathcal E}\times\vec{A}\right).
\end{align}It has been shown that the source of the "electric" component of the torsion variable is the helicity density of the electromagnetic field $\sim \vec{A}\cdot\vec{B}$. Such a configuration can be implemented in electromagnetic systems with a non-trivial topology. The source of the vortex "magnetic" component of the torsion variable generated by the spin density of the electromagnetic field $\sim \phi\vec{B} + \vec{E}\times\vec{A}$. The rotation of the polarization plane of the electromagnetic wave, in the uniform torsion field $(\varphi, \vec{\alpha}) = const$, is predicted. When a wave passes through the axial vector torsion field region, an orthogonal component of the electric field strength occurs. The polarization plane of the electomagnetic wave rotates, and the angle of rotation is proportional to the coupling constant and value of the potential φ of the axial vector torsion field $|\gamma| = \frac{\chi\varphi h}{c}$. The physical meaning of the polarization plane rotation may specify the process of photons generation during their interaction with axial vector bosons.

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