1)

70(1): Optical Rotation in a Vacuum, Zavattini et al., Phys. Rev. Lett., 96, 110406 (2006)

The explanation for this experiment in ECE theory is based on the concept of vacuum magnetization, more accurately spacetime magnetization, defined by the fourth paper of volume two of M.W. Evans, "Generally Covariant Unified Field Theory" (Abramis Academic, 2006):

$$M^a = \frac{1}{\mu_0} B^a = \frac{1}{\mu_0} \omega^a{}_b \wedge A^b. \quad -(1)$$

Here, B^a is the ECE spin field, μ_0 is the vacuum permeability, $\omega^a{}_b$ is the spin connection, and A^b is the electromagnetic potential. For a plane wave, and using vector notation and the complex circular basis:

$$\underline{B}^{(3)*} = -i g \underline{A}^{(1)} \times \underline{A}^{(2)}, \quad -(2)$$

$$\underline{M}^{(3)*} = \frac{1}{\mu_0} \underline{B}^{(3)*}. \quad -(3)$$

This was first defined in M.W. Evans, "The Enigmatic Photon" (Kluwer, 1999, reprinted 2002), volume 5.

In the presence of a transverse, static magnetic field $\underline{B}_\perp$, the magnetization in eq. (3) is changed to:

$$\underline{M}^{(3)*} = \underline{M}_{\parallel} \longrightarrow \underline{M}_{\parallel} + \underline{M}_{\perp}.$$

2)

In the notation of eq. (4), $\underline{M}_{\parallel}$ is parallel to the Z axis and $\underline{B}_{\perp}$ is applied in the X or Y axis perpendicular to Z. The X and Y axis is the transverse axis defined by Zavattini et al., who observe circular dichroism. From eq. (4), the spin field is changed by:

$$\underline{B}^{(3)} \rightarrow \frac{1}{\mu_0} \left(\underline{M}_{\parallel} + \underline{M}_{\perp} \right). \quad -(5)$$

From eq. (2) it is seen that the conjugate product $\underline{A}^{(1)} \times \underline{A}^{(2)}$ is changed. This is:

$$\underline{A}^{(1)} \times \underline{A}^{(2)} = \underline{A} \times \underline{A}^{*} \quad -(6)$$

where $\underline{A}$ is the electromagnetic potential, and where $\underline{A}^{*}$ is its complex conjugate. <u>Before</u> application of $\underline{B}_{\perp}$:

$$\underline{A} = \frac{A^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j} \right) e^{i(\omega t - \kappa z)} \quad -(7)$$

$$\underline{A}^{*} = \frac{A^{(0)}}{\sqrt{2}} \left(\underline{i} + i\underline{j} \right) e^{-i(\omega t - \kappa z)} \quad -(8)$$

where

$$\phi = \omega t - \kappa Z \quad -(9)$$

is the electromagnetic phase.

<u>After</u> application of $\underline{B}_{\perp}$:

$$\underline{A} = \frac{A^{(0)}}{\sqrt{2}}\left(a\underline{i} - ib\underline{j}\right) e^{i(\omega t - \kappa Z)} \quad \text{— (10)}$$

$$\underline{A}^* = \frac{A^{(0)}}{\sqrt{2}}\left(a\underline{i} + ib\underline{j}\right) e^{-i(\omega t - \kappa Z)} \quad \text{— (11)}$$

Thus:

$$\underline{M}_{\parallel} = \frac{g}{\mu_0} A^{(0)2}\underline{k} \quad \text{— (12)}$$

$$\underline{M}_{\perp} = \frac{g}{\mu_0} A^{(0)2}\left(a^2 + b^2\right)\underline{k} \quad \text{— (13)}$$

and from eq. (4):

$$\underline{M}^{(3)} \rightarrow \frac{g}{\mu_0} A^{(0)2}\left(1 + a^2 + b^2\right)\underline{k} \quad \text{— (14)}$$

This change of magnetization manifests itself as a change from circular polarization (eqns. (7) and (8)) to elliptical polarization (eqns. (10) and (11)). This results in circular dichroism. The experimental observation of the latter implies the existence of spacetime magnetization and the ECE Spin field.