Cosmic Optical Activity in a Randall-Sundrum Braneworld with Bulk Kalb-Ramond Field

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Abstract

Optical activity of electromagnetic waves in a string inspired Kalb-Ramond cosmological background is studied in presence of extra space-time dimension. The Kalb-Ramond-electromagnetic coupling which originates from the gauge anomaly cancelling Chern-Simons term in a string inspired model, is explicitly calculated following Randall-Sundrum braneworld conjecture. It is shown that the Randall-Sundrum scenario leads to an enormous enhancement of the optical rotation of a plane polarized electromagnetic wave propagating on the visible brane. Absence of any experimental support in favour of such a large rotation in astrophysical experiments on distant galactic radio waves indicates an apparent conflict between Randall-Sundrum brane world scenario and the presence of Kalb-Ramond antisymmetric tensor field in the background spacetime.

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1 Introduction

Possibility of observing some experimental signature of String theory in the present low energy world is a subject of interest for a long time. One of the important testing arena is considered to be the Astrophysical/Cosmological observations. Various massless modes of string theory, which are obviously most relevant for the low energy world are expected to have some new observable effects on cosmic phenomena. Among the various massless modes, the low energy field theory action of closed String theory has a second rank antisymmetric tensor field known as Kalb-Ramond (KR) field $B_{\mu\nu}$. The corresponding KR field strength $H_{\mu\nu\lambda} = \partial_{[\mu} B_{\nu\lambda]}$ is modified by Chern-Simons terms which originate from the requirement of quantum consistency namely, the gauge anomaly and gravitational anomaly cancellation in the underlying string theory. The Chern-Simons term for the $U(1)$ gauge anomaly cancellation has been shown to play crucial role in preserving the $U(1)$ gauge symmetry in the resulting action and thereby providing with a gauge invariant coupling between the KR and the electromagnetic field [1]. The resulting gauge invariant coupling of the KR field to the Maxwell field allows us to study the phenomenological effects of string theory on the propagation of electromagnetic field in a KR background[2, 3, 4, 5, 6]. It turns out that this leads to the optical activity of the electromagnetic wave passing through such a space-time. In four dimension, this effect of optical activity has already been explored [4, 5] with different cases of space, time dependence of the pseudoscalar field $H$ (dual of the massless three form $H_{\mu\nu\lambda}$). However experimental bounds on the optical activity implies that the $H$ field must be very weak so that it’s contribution to the observed activity in addition to the usual Faraday rotation must be very low [7, 8].

As a possible explanation to this result it was shown that the effect of extra dimension could be a possible reason for the suppression of the KR field although the pure gravity sector and the KR field has identical coupling in the pre-compactification scale. KR field being the massless mode of a closed string is taken on the bulk alongwith the gravity. It has been explicitly shown [9] that in a higher dimensional framework of Randall-Sundrum [10] scenario the massless mode of KR field in the visible brane is suppressed by a large exponential warp factor. This motivates us to explore whether the phenomenon of optical activity also suffers large suppression in a higher dimensional scenario. For this one needs to study the effective coupling between the electromagnetic field and KR field (arising from Chern-Simons extension) after compactification.

In a string inspired model both the gravity and the KR field are massless modes of closed strings and therefore are assumed to propagate in the bulk while all the standard model fields are confined on the visible 3-brane. In a subsequent section we shall take up a more general case where the $U(1)$ electromagnetic field also propagates in the bulk. Possibility of such a scenario in the context of a large internal dimension was considered earlier to explore
various aspects of supersymmetry breaking [11]. Later it was generalized
for the braneworld model. There are various reasons to consider gauge field
entering into the bulk. To understand the geometric origin of the spectrum of
the fermion masses[12, 13, 14], to identify the Higgs as the extra-dimensional
component of the gauge fields (to protect it’s mass from correction)[15], to
provide a viable candidate for dark matter[16], to achieve high scale gauge
coupling unification[17, 18] and many other important issues led to the model
of a bulk $U(1)$ gauge field in a braneworld scenario.

2 Optical Activity in a KR background

In the proposed string inspired model adopted by us, the higher dimensional
extension of the low energy effective action for the gravity and electromagnetic
sectors in 5-dimension is given by,

$$ S = \int d^5x \sqrt{-g} \left[ R(g) - \frac{1}{4} F_{MN} F^{MN} + \frac{1}{2} \tilde{H}_{MNL} \tilde{H}^{MNL} \right] \quad (1) $$

where $\tilde{H}_{MNL} = \partial_M B_{NL} + \frac{1}{3M_p^2} \delta^{\mu\nu} \delta^L_{\lambda\mu} A_{[\mu F_{\nu \lambda}] }$ with each Latin index
running from 0 to 4 and Greek index running from 0 to 3. The second term
on the righthand side of this equation is the $U(1)$ Chern-Simons term.
Assuming that the gauge field is confined on the visible 3-brane the above
low energy effective action for the gravity and KR field coupled to the $U(1)$
electromagnetic field reduces to

$$ S = \int d^5x \sqrt{-g} \left[ R(G) + \frac{1}{2} H_{MNL} H^{MNL} \right] - \frac{1}{4} \int d^4x \sqrt{-g_{\text{vis}}} F_{\mu\nu} F^{\mu\nu} \\
+ \frac{1}{3M_p^4} \int d^5x \sqrt{-g} H_{MNL} \delta^M_{\mu} \delta^N_{\nu} \delta^L_{\lambda} A^{[\mu F^{\nu\lambda}\delta(\phi - \pi)} \quad (2) $$

We have ignored the higher order Chern-Simons term because of extra Planck
mass suppression. It has been shown that in the case of four dimensional
scenario the KR-electromagnetic field coupling leads to the phenomena of
optical activity.

In a flat four dimensional background this rotation of the plane of polarization
[4] in terms of the comoving time $\eta$ is given as,

$$ (\Delta \phi)_{\text{mag}} = -h\eta / M_p \quad (3) $$

$h$ comes from the dual pseudoscalar field $H$ defined through the duality
relation

$$ H_{\mu\nu\lambda} = \epsilon_{\mu\nu\lambda\sigma} \partial^\sigma H \quad (4) $$

where the solution for $H$ is given as $H = h\eta + h_0$. We shall like to empha-
size here that equ.(2) and equ.(4) together imply an axion-electromagnetic
coupling which has emerged naturally from the requirement of the gauge

3
anomaly cancellation in the underlying string theory. Thus such an axion induced effects on electromagnetic field is a direct consequence of the requirement of quantum consistency of the full string theory.

The generalization of this optical activity with inhomogeneous Kalb-Ramond field in a non-flat background has also been done in ref [5]. While this axion induced optical rotation may be viewed as a possible explanation of the additional small wavelength independent rotation of the plane of polarization of the electromagnetic wave from distant galaxies over the usual Faraday rotation [7], a comparison with experimental data immediately implies that the pseudoscalar field (dual to the 3 form KR field strength) $H$ must couple very weakly to the electromagnetic field.

In another work [9] it has been shown that although in a higher dimensional scenario the KR field and gravity have similar coupling at the Planck scale, a compactification in Randall-Sundrum scenario suppresses the KR field enormously on the visible 3-brane. In that scenario it was assumed that like gravity KR field also resides in the bulk whereas the standard model fields are confined on the visible 3-brane.

In this paper we explore whether a RS type of extra dimensional brane world picture may lead to the suppression of KR field induced optical rotation in the brane to a near invisibility. To start with we take the electromagnetic and the other standard model fields to be confined in the visible 3-brane whereas the gravity and KR field propagates in the bulk. Later we shall consider the scenario where the $U(1)$ gauge field also propagates in the bulk.

**Optical activity in Randall-Sundrum scenario**

In RS scenario in a five dimensional ADS spacetime, the fifth coordinate $\phi$ is compactified on a $S_1/Z_2$ orbifold. Two branes namely the hidden brane and the visible brane are located at the two orbifold fixed points 0 and $\pi$ respectively. It was shown that the corresponding background metric is given as,

$$ds^2 = e^{-2\sigma} \eta_{\alpha\beta} dx^\alpha dx^\beta + r_c^2 d\phi^2$$  \hspace{1cm} (5)

where $\sigma = k r_c |\phi|$. Now consider the free electromagnetic part of the action in eqn.(2),

$$S_{electro} = -\frac{1}{4} \int d^4x \sqrt{-g_{\text{vis}}} g^{\mu\alpha} g^{\nu\beta} F_{\mu\nu} F_{\alpha\beta}$$  \hspace{1cm} (6)

Assuming that the electromagnetic field to be confined on the flat visible brane and noting that the $\sqrt{-g_{\text{vis}}} = e^{-4k r_c \pi}$ and $g^{\mu\nu} = e^{2k r_c \pi}$ the above action reduces to

$$S_{electro} = - \int d^4x \eta^{\mu\alpha} \eta^{\nu\beta} F_{\alpha\beta} F_{\mu\nu}$$  \hspace{1cm} (7)

Similarly the 5-dimensional action corresponding to the Kalb-Ramond field is given by

$$S_H = \frac{1}{2} \int d^5x \sqrt{-g} H_{MNL} H^{MNL}$$  \hspace{1cm} (8)
where $\sqrt{-g} = e^{-4\sigma} r_c$. This action has KR gauge invariance $\delta B_{MN} = \partial_{[M}A_{N]}$.

We use the KR gauge fixing condition to set $B_{4\mu} = 0$. Therefore the only non vanishing KR field components are $B_{\mu\nu}$ where $\mu, \nu$ runs from 0 to 3. These components are functions of both compact and non-compact coordinates. One thus gets

$$S_H = \frac{1}{2} \int d^4x \int d\phi r_c e^{2\sigma(\phi)} \left[ \eta^{\mu\alpha} \eta^{\nu\beta} \eta^{\lambda\gamma} H_{\mu\nu\lambda} H_{\alpha\beta\gamma} - \frac{3}{r_c^2} e^{-2\sigma(\phi)} \eta^{\mu\alpha} \eta^{\nu\beta} B_{\mu\nu} \partial_\phi^2 B_{\alpha\beta} \right]$$

Applying the Kaluza-Klein decomposition for the Kalb-Ramond field:

$$B_{\mu\nu}(x, \phi) = \sum_{n=0}^{\infty} B^n_{\mu\nu}(x) \chi^n(\phi) \frac{1}{\sqrt{r_c}}$$

and demanding that in four dimension an effective action for $B_{\mu\nu}$ should be of the form

$$S_H = \int d^4x \sum_{n=0}^{\infty} \left[ \eta^{\mu\alpha} \eta^{\nu\beta} \eta^{\lambda\gamma} H^n_{\mu\nu\lambda} H^n_{\alpha\beta\gamma} + 3m_n^2 \eta^{\mu\alpha} \eta^{\nu\beta} B^n_{\mu\nu} B^n_{\alpha\beta} \right]$$

where $H^n_{\mu\nu\lambda} = \partial_{[\mu} B^n_{\nu\lambda]}$ and $\sqrt{3} m_n$ gives the mass of the nth KR mode, one obtains

$$-\frac{1}{r_c^2} \frac{\partial^2 \chi^n}{\partial \phi^2} = m_n^2 \chi^n e^{2\sigma}$$

The $\chi^n(\phi)$ field satisfies the orthogonality condition

$$\int e^{2\sigma(\phi)} \chi^m(\phi) \chi^n(\phi) d\phi = \delta_{mn}$$

Defining $z_n = e^{\sigma(\phi)} m_n / k$ the above equation reduces to

$$\left[ z_n^2 \frac{d^2}{dz_n^2} + z_n \frac{d}{dz_n} + z_n^2 \right] \chi^n = 0$$

This has the solution

$$\chi^n = \frac{1}{N_n} \left[ J_0(z_n) + \alpha_n Y_0(z_n) \right]$$

The zero mode solution [9] of $\chi$ therefore turns out to be

$$\chi^0(\phi) = C_1 |\phi| + C_2$$

However the condition of self-adjointness leads to $C_1 = 0$ and leaves the scope of only a constant solution for $\chi^0(\phi)$. Using the normalization condition, one finally obtains

$$\chi^0 = \sqrt{kr_c} e^{-kr_c \pi}$$
This result clearly indicates that the massless mode of the KR field is suppressed by a large warp factor on the visible 3-brane. In a similar way we now take the KR-EM interaction term

$$S_{int} = \frac{1}{3M_p^2} \int d^5x \sqrt{-g} H_{MNL} \delta^M_{\mu} \delta^N_{\nu} \delta^L_{\lambda} A^{[\mu} F^{\nu \lambda]} \delta(\phi - \pi) \tag{18}$$

Following the same arguments as were given in the previous case, the interaction term reduces to

$$S_{int} = \frac{r_c}{M_p} \int d^4x \int d\phi e^{2\sigma} \delta(\phi - \pi) \eta^{\mu \alpha} \eta^{\nu \beta} \eta^{\lambda \gamma} H_{\mu \nu \lambda}(x, \phi) A_{[\alpha} F_{\beta \gamma]} \tag{19}$$

Integrating over the bulk coordinate $\phi$, retaining only the massless modes and using eq.(18) one obtains

$$S_{int} = \sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} \int d^4x H_{\mu \nu \lambda}(x) A^{[\mu} F^{\nu \lambda]} \tag{20}$$

With these the KR-electromagnetic part of the action becomes

$$S = -\frac{1}{4} \int d^4xF_{\mu \nu} F^{\mu \nu} + \frac{1}{2} \int d^4x H_{\mu \nu \lambda} H^{\mu \nu \lambda} + \frac{1}{3} \sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} \int d^4x H_{\mu \nu \lambda} A^{[\mu} F^{\nu \lambda]} \tag{21}$$

It may be noted here that in the string inspired RS model our calculation completely determines the KR-Maxwell coupling as is evident from the above action.

Now varying with respect to $B_{\mu \nu}$ and $A_\mu$ we obtain the following equations

$$\partial_\alpha \left[ H^{\alpha \beta \gamma} + \sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} A^{[\alpha} F^{\beta \gamma]} \right] = 0 \tag{22}$$

$$\partial_\alpha \left[ F^{\alpha \beta} - 2 \sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} H^{\alpha \beta \gamma} A_\gamma \right] = -\sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} H^{\alpha \beta \gamma} F_{\gamma \alpha} \tag{23}$$

Replacing the massless three form $H^{\alpha \beta \gamma}$ by using the duality relation

$$H^{\alpha \beta \gamma} = \epsilon^{\alpha \beta \gamma \mu} \partial_\mu H \tag{24}$$

where $H$ is the dual pseudo scalar axion, we find the modified Maxwell’s equations as

$$\nabla \cdot E = 4 \sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} \nabla H \cdot B \tag{25}$$

$$\partial_0 E - \nabla \times B = 4 \sqrt{k} \frac{r_c e^{k r_c \pi}}{M_p} \left[ \partial_0 \left( H B \right) + \nabla \times E \right]$$

$$\nabla \cdot B = 0$$

$$\partial_0 B + \nabla \times E = 0$$

(25)
Now we consider the Bianchi identity of the KR field strength

$$\varepsilon^{\mu\nu\lambda\sigma} \partial_{\sigma} H_{\mu\nu\lambda} = 0$$

(26)

This along with equ.(24) immediately implies that the pseudoscalar $H$ satisfies the massless Klein-Gordon equation $\Box H = 0$. In a flat four dimensional spacetime $H$ is only a function of comoving time coordinate $\eta$. As a result the Klein-Gordon equation simply reduces to the $d^2 H / d\eta^2 = 0$ which has the solution $H = h\eta + h_0$, where $h$ and $h_0$ are constants. Proceeding along the lines of [4, 21], we arrive at the equation

$$\frac{d^2 b_\pm}{d\eta^2} + (p^2 \pm 4p \sqrt{\frac{k}{M_p}} r_c e^{kr_c \pi} h) b_\pm = 0$$

(27)

Where we have decomposed $\mathbf{B} = \mathbf{b}(\eta)e^{ip\cdot x}$ and have chosen the z-direction as the propagation direction of the electromagnetic wave, $p$ being the wave vector. The circular polarization states are defined by $b_\pm = b_x \pm ib_y$. So from equ.(27) the optical activity due to the KR field is given by,

$$(\Delta \phi)_{mag} \equiv \frac{1}{2}(\phi_+ - \phi_-) = -2 \sqrt{\frac{k}{M_p}} r_c e^{kr_c \pi} h\eta.$$  

(28)

Comparing with our previous result of the optical rotation in four dimensional spacetime we find that Randall-Sundrum scenario causes an enormous enhancement of the optical rotation in the visible brane although the field $H$ itself gets suppressed by the warp factor.

### 3 Coupling between the bulk U(1) gauge field and the Kalb-Ramond field in RS Scenario

Let us now focus our attention to the RS scenario with the electromagnetic gauge field in the bulk. In this case the action for a bulk electromagnetic gauge field is given as [22]

$$S_{gauge} = -\frac{1}{4} \int d^5 x \sqrt{-g} F_{MN} F^{MN}$$

(29)

where $\sqrt{-g} = r_c e^{-4\sigma(\phi)}$. After RS compactification,

$$S_{gauge} = -\frac{1}{4} \int d^4 x \int d\phi \left[ r_c \eta^{\mu\alpha} \eta^{\nu\beta} F_{\alpha\beta} F_{\mu\nu} - \frac{2}{r_c} \eta^{\mu\alpha} A_\alpha \partial_\phi (e^{-2\sigma} A_\mu) \right]$$

(30)

Next, we consider Kaluza-Klein decomposition for the U(1) gauge field $A_\mu$ which is function of both $x$ and $\phi$:

$$A_\mu(x, \phi) = \sum_{n=0}^{\infty} A_\mu(x) \frac{\chi_n(\phi)}{\sqrt{r_c}}$$

(31)
In terms of four dimensional field $A_\mu(x)$, an effective action of the form

$$S_{\text{gauge}} = -\frac{1}{4} \int d^4x \sum_{n=0}^{\infty} \left[ \eta^{\mu\alpha} \eta^{\nu\beta} F_{\alpha\beta}^{m} F_{\mu\nu}^{n} + 2m^2 n \eta^{\mu\nu} A_\mu^n A_\nu^n \right]$$

(32)

can be obtained provided

$$-\frac{1}{r_c^2} \partial^2 (e^{-2\sigma} \chi^m) \partial\phi^2 = m_n^2 \chi^m$$

(33)

along with the orthogonality condition

$$\int d\phi \chi^n(\phi) \chi^m(\phi) = \delta_{nm}$$

(34)

where $\sqrt{2m_n}$ gives mass of the nth mode of the gauge field. In this case we have assumed that $A_4$ is a $Z_2$ odd function of the extra dimension and have used the gauge degree of freedom to choose $A_4 = 0$. The gauge invariant equation $\int d^4x A_4 = 0$ follows automatically from $Z_2$ odd condition. We have also used the Lorentz gauge condition $\eta^{\mu\nu} \partial_\mu A_\nu^n = 0$.

Now in terms of $z_n = \frac{m_n}{k} e^{\sigma}$ and $y_n = e^{-\sigma} \chi^n$, one may recast the above equation in the form

$$\left[ z_n^2 \frac{d^2}{dz_n^2} + z_n \frac{d}{dz_n} + (z_n^2 - 1) \right] y_n = 0$$

(35)

The above equation admits of the solution:

$$\chi^n = \frac{e^{\sigma}}{N_n} \left[ J_1(z_n) + \alpha_n Y_1(z_n) \right]$$

(36)

This yields the zero mode solution

$$\chi^0 = \frac{1}{\sqrt{2\pi}}$$

(37)

Earlier we got the zero mode solution for the KR field

$$\xi^0 = \sqrt{k r_c} e^{-k r_c}$$

(38)

Now in this scenario we again consider the interaction term

$$S_{\text{int}} = \frac{1}{3M_p^2} \int d^5x \sqrt{-g} H_{MNL} A^{[M} F_{N]}^{NL}$$

(39)

Choosing the gauge condition $B_{4\mu} = 0$ and using the explicit form of the RS metric, we find

$$S_{\text{int}} = \frac{1}{3M_p^2} \int d^4x \int d\phi \left[ e^{2\sigma} r_c \eta^{\mu\alpha} \eta^{\nu\beta} \eta^{\rho\gamma} H_{\mu\nu\rho\gamma} A_{[\alpha} F_{\beta\gamma]} + \frac{6}{r_c} \eta^{\mu\alpha} \eta^{\nu\beta} (\partial_\mu B_{\nu\alpha}) A_\beta (\partial_\beta A_\alpha) \right]$$

(40)
Now using the Kaluza-Klein decomposition for both the fields as mentioned earlier, one obtains

\[
S_{\text{int}} = \frac{1}{3M_p^2} \int d^4x \int d\phi \left[ e^{2\sigma} \frac{1}{\sqrt{r_c}} \sum_{n,m,l=0}^{\infty} \xi^n \chi^m \lambda^{l} \eta^{\mu\alpha} \eta^{\nu\beta} \eta^{\lambda\gamma} H_{\mu\nu\lambda} A_{\alpha}^{m} F_{\beta\gamma}^{l} \right] \\
+ \frac{6}{r_c^2} \sum_{n,m,l=0}^{\infty} (\partial_{\phi} \xi^n) \chi^m (\partial_{\phi} \lambda^{l}) \eta^{\mu\alpha} \eta^{\nu\beta} B_{\mu\nu} A_{\alpha}^{m} A_{\beta}^{l} 
\]

(41)

Using eqn.(38) and (39), the part of the above action containing the massless modes only is given as

\[
S_{\text{int}} = \frac{1}{3M_p^2} \int d^4x \int d\phi \frac{e^{2\sigma}}{\sqrt{r_c}} \xi^0 (\chi^0)^2 H_{\mu\nu\lambda} A_{\mu}^{\mu} F_{\nu\lambda}^{\nu} 
\]

(42)

Where \(\xi^0 = \sqrt{kr_c} e^{-kr_c^2} \), \(\chi^0 = \frac{1}{2\pi} \) and \(A^\mu = \eta^{\mu\nu} A_{\nu} \).

So the KR-EM part of the 4d effective action (without the curvature term) becomes

\[
S_{\text{eff}} = \int d^4x \left[ -\frac{1}{4} F_{\mu\nu} F_{\mu\nu} + \frac{1}{2} H_{\mu\nu\lambda} H_{\mu\nu\lambda} + \frac{C}{3} H_{\mu\nu\lambda} A_{\mu} A_{\nu\lambda} \right] 
\]

(43)

where \(C = \sqrt{\frac{k}{M_p^2}} e^{kr_c^2} \).

We have thus explicitly determined the KR-Maxwell coupling in the proposed string inspired RS scenario.

By varying the \(B_{\mu\nu} \) and \(A_{\mu} \) as done in the previous section, we get the corresponding field equation for \(B_{\mu\nu} \) and the set of modified Maxwell’s equations. From these equations the angle of optical rotation in this case turns out to be

\[
(\Delta\phi)_{\text{mag}} = -\frac{2k}{M_p^2} e^{kr_c^2} h \eta 
\]

(44)

Once again we find that there is an enormous enhancement in the optical rotation by a large exponential warp factor. We therefore find that for both the cases of bulk gauge field as well as the gauge field confined in the visible brane, a plane polarized electromagnetic wave will suffer an enormous optical rotation if our four dimensional world is an effective picture of a five dimensional Randall-Sundrum brane world. Interestingly quite in contrary to our expectation, this enhancement takes place inspite of the fact that the massless mode of the KR field suffers large suppression on the visible brane as shown in ref.[9]. No such large rotation has ever been reported in any astrophysical experiments. To make this result consistent with experiment one needs to finetune the value of h to an extremely small value which would render the theory unnatural. This in a sense will bring back the old naturalness problem that we already have in connection with the stabilization of the Higg’s mass and as a remedy of which the Randall-Sundrum scenario
was originally proposed. We thus conclude that if one believes in a string inspired cosmological model where the second rank antisymmetric tensor field is essentially present in the background then the $U(1)$ gauge anomaly cancelling Chern-Simons term results into a coupling between the KR and the electromagnetic field leading to optical rotation of plane of polarization of the distant galactic radiation. However if one simultaneously considers a Randall-Sundrum type of brane world model to compactify one extra dimension then it is hard to explain the apparent anomaly between the theoretically predicted large value of the wavelength independent optical rotation and the corresponding small experimental value of this rotation measured in the context of distant galactic radio waves [7]. The implications of the results reported in this work may also be studied in the context of observed CMB anisotropy.

One may try to explore the effect of the radion field on the KR field induced optical rotation for a possible suppression in it’s value. It is also well known that the breakdown of supersymmetry may result into generation of mass for the scalar axion which in turn may make their experimental signature unobservable. However among large class of possible vacua of string theory we still have not been able to resolve that how and why a particular vacuum is chosen and the supersymmetry is broken. Nature of the scalar axion potential does depend on the geometry of the compact manifold as well as on the exact mechanism of supersymmetry breaking. Generation of the axion mass is therefore still not well understood. The result reported in this work may however serve as an indirect clue to this problem by constraining the compactification scheme as well as supersymmetry breaking so that it may result into a significant axion mass and thereby making the resulting optical rotation practically invisible from such a large value to make it consistent with observation. So far there is no proper understanding in this direction in the domain of string theory. However in this work we find an undeniable conflict between the RS braneworld picture and the presence of antisymmetric tensor field in the background spacetime.

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