1) Paper 105 Notes 1:

A New Approach to Light Bending due to Gravitation

It has been shown in previous work that the Bianchi identity as developed by Cartan is

$$D \wedge T := R \wedge q \qquad -(1)$$

whose tensor expression is:

$$D_\mu \tilde{T}^{\kappa\mu\nu} = \tilde{R}^{\kappa\ \mu\nu}_{\ \mu} \qquad -(2)$$

There also exists the Hodge dual of eq. (1):

$$D \wedge \tilde{T} := \tilde{R} \wedge q \qquad -(3)$$

whose tensor expression is:

$$D_\mu T^{\kappa\mu\nu} = R^{\kappa\ \mu\nu}_{\ \mu} \qquad -(4)$$

Eqns. (1) to (4) are the equations of gravitation in the presence of torsion. In general the metric and connection of these equations are not symmetric. A new approach to the subject of gravitation is needed because the Einstein Hilbert (EH) theory leads to a contradiction in eq. (4). This is because in EH theory:

$$R^{\kappa\ \mu\nu}_{\ \mu} \neq 0, \quad T^{\kappa\mu\nu} = 0 \qquad -(5)$$

2) Also in EH theory:

$$\tilde{R}^{\kappa}{}_{\mu}{}^{\mu\nu} = 0, \quad \tilde{T}^{\kappa\mu\nu} = 0. \quad -(6)$$

This is because in EH theory:

$$\tilde{R}^{\kappa}{}_{\mu}{}^{\mu\nu} = 0 \quad -(7)$$

is the same as the so-called "first Bianchi identity":

$$R^{\kappa}{}_{\mu\nu\rho} + R^{\kappa}{}_{\rho\mu\nu} + R^{\kappa}{}_{\nu\rho\mu} = 0. \quad -(8)$$

Eqs. (7) and (8) are true only if:

$$g_{\mu\nu} = g_{\nu\mu} \quad -(9)$$

and

$$\Gamma^{\kappa}_{\mu\nu} = \Gamma^{\kappa}_{\nu\mu}. \quad -(10)$$

Under the arbitrary assumptions (9) and (10) the Cartan torsion vanishes:

$$T^{\kappa}{}_{\mu\nu} = \Gamma^{\kappa}_{\mu\nu} - \Gamma^{\kappa}_{\nu\mu} = 0. \quad -(11)$$

The fundamental contradiction of eq. (5) was found by computer algebra, which shows that under the conditions (9) and (10) $R^{\kappa}{}_{\mu}{}^{\mu\nu}$ is non-zero in general, while $T^{\kappa\mu\nu}$ is zero.

It has also been shown that the true

3)

second Bianchi identity is:

$$D \wedge (D \wedge T) := D \wedge (R \wedge q) \quad -(12)$$

whereas the so-called "second Bianchi identity" of EH theory is:

$$D \wedge R = 0 \quad -(13)$$

which is

$$D \wedge R^{\kappa}{}_{\mu\nu\rho} = 0 \quad -(14)$$

i.e.:

$$D_\sigma R^{\kappa}{}_{\mu\nu\rho} + D_\rho R^{\kappa}{}_{\mu\sigma\nu} + D_\nu R^{\kappa}{}_{\mu\rho\sigma} = 0 \quad -(15)$$

The EH equation is obtained from eq. (13) and is ~~therefore~~ inconsistent with the Bianchi identity (12).

The usual approach to light bending in the solar system is ~~therefore~~ incorrect. It also suffers from the assumption that the Ricci tensor is zero by construction, and from the assumption that the Schwarzschild parameter α of 1916 is assumed arbitrarily to be the solar mass M. This is also self-inconsistent because in a Ricci flat spacetime there is no M by construction. So the usual method is self-inconsistent fundamentally.

4) Crothers has also shown that the method of solution used is geometrically incorrect even within the flawed context of the theory.

The geometrically correct equations are (2) and (3). In principle, these must be solved without any a priori assumptions about the metric and connection. In general this solution must be a numerical one using a supercomputer. However one can proceed in the weak field limit. The latter can be defined as the approach to Minkowski spacetime. In this limit the connection approaches zero, so eqn (4) approaches:

$$\partial_\mu T^{\kappa\mu\nu} = R^{\kappa\ \ \mu\nu}_{\ \ \mu} \quad - (16)$$

In vector notation it has been shown, following paper 100, that eqn (16) is:

$$\underline{\nabla} \cdot \underline{T}_1 = R_1 \quad - (17)$$

$$\underline{\nabla} \times \underline{T}_2 - \frac{1}{c}\frac{\partial \underline{T}_3}{\partial t} = \underline{R_2} \quad - (18)$$

From table 1 of paper 100:

5)

$$\underline{T}_1 = T^{010}\,\underline{i} + T^{020}\,\underline{j} + T^{030}\,\underline{k} \quad -(19)$$

$$R_1 = R^{0}{}_{1}{}^{10} + R^{0}{}_{2}{}^{20} + R^{0}{}_{3}{}^{30} \quad -(20)$$

$$\underline{T}_2 = T^{332}\,\underline{i} + T^{113}\,\underline{j} + T^{221}\,\underline{k} \quad -(21)$$

$$\underline{T}_3 = T^{110}\,\underline{i} + T^{220}\,\underline{j} + T^{330}\,\underline{k} \quad -(22)$$

and $\underline{R}_2$ is defined by eqs. (21) and (22).

As shown in paper 103, the Newton law is obtained from eq. (16), and is:

$$\underline{\nabla} \cdot \underline{g} = c^2 R \quad -(23)$$

The structures of eqs. (17) and (23) are the same. So:

$$\underline{g} = c^2\,\underline{T}_1 \quad -(24)$$

$$R = R_1 \quad -(25)$$

The acceleration due to gravity in the weak field limit is therefore:

$$\boxed{\underline{g} = c^2\left(T^{010}\,\underline{i} + T^{020}\,\underline{j} + T^{030}\,\underline{k}\right)}$$

$$-(26)$$

6) and the mass density is defined by:

$$\boxed{\rho_m = \frac{1}{k}\left(R^{0}{}_{1}{}^{10} + R^{0}{}_{2}{}^{20} + R^{0}{}_{3}{}^{30} \right)} \quad -(27)$$

where k is Einstein's constant.

<u>Discussion</u>

1) In a Ricci flat spacetime it is found by computer algebra that:

$$\rho_m \left(\text{Ricci flat} \right) = 0 \quad -(28).$$

In such a spacetime:

$$\underline{g} = \underline{0} \quad -(29)$$

because T^{010}, T^{020} and T^{030} are proportional to elements of the angular energy-momentum tensor. In other words if <u>there is no source</u> ($\rho_m = 0$) <u>there is no field</u> ($\underline{g} = \underline{0}$).

2) Light bending due to gravitation is governed by eq. (23), and by six components, T^{010}, T^{020}, T^{030}, $R^{0}{}_{1}{}^{10}$, $R^{0}{}_{2}{}^{20}$ and $R^{0}{}_{3}{}^{30}$, in general. If $\underline{g}$ is

7) restricted to one axis, e.g. $\underline{k}$, then the problem reduces to two components, T^{030} and $R^{0}{}_{3}{}^{30}$,

i.e.

$$\underline{g} = c^2 T^{030} \underline{k} \quad -(30)$$

$$\rho_m = \frac{1}{k} R^{0}{}_{3}{}^{30} \quad -(31)$$

From this point onwards it becomes necessary to refer to experimental data, notably:

a) the Earth's $\underline{g}$ is known experimentally, and is given by $c^2 T^{030}$ (Earth);

b) when light is deflected by the sun it is known that two components must be used in eq. (26), because the light is defined by X and Y in a given orbital plane around the sun. So:

$$\underline{g}\,(\text{bent by sun}) = c^2 \left(T^{010} \underline{i} + T^{020} \underline{j} \right) \quad -(32)$$

whereas:

$$\underline{g}\,(\text{Earth}) = c^2 T^{030} \underline{k} \quad -(33)$$

If we assume isotropy:

$$T^{010} = T^{020} = T^{030} \quad -(34)$$

then it is seen that the effective $\underline{g}$ in light bending around the sun is twice the $\underline{g}$ at the surface of the earth.

This is the experimental result to an accuracy of 1 : 100,000.

So a torsion based explanation, even a very simple one such as this, is plausible and consistent with Cartan geometry. As we have seen the EH explanation is incorrect and self-inconsistent.

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c) Alternatively it may be assumed that the $\underline{g}$ governing the deflection of light by the sun is in general:

$$\underline{g} = c^2 \left(T^{010}\, \underline{i} + T^{020}\, \underline{j} + T^{030}\, \underline{k} \right) \quad -(35)$$

9) and experimentally:

$$\underline{g}\,(\text{deflection}) = 2\underline{g}\,(\text{Earth}) \quad -(36)$$

This could also be true if:

$$\underset{(\text{light bending})}{T^{010}\,\underline{i} + T^{020}\,\underline{j} + T^{030}\,\underline{k}} = \underset{(\text{Earth})}{2\,T^{030}\,\underline{k}}$$