19(2): Light Deflection due to Gravitation in m Theory.

In the Newtonian theory the orbital velocity is:

$$v_N^2 = MG\left(\frac{2}{r} - \frac{1}{a}\right) \quad -(1)$$

here M is the mass of the attracting object, G the gravitational constant, r is the distance between a mass m orbiting a mass M and a the semi major axis defined by:

$$a = \frac{\alpha}{1-\epsilon^2} \quad -(2)$$

where α is the half right latitude and ϵ the eccentricity. The orbit is the conic section:

$$r = \frac{\alpha}{1+\epsilon\cos\phi} \quad -(3)$$

in the plane polar coordinate system (r, ϕ). At closest approach:

$$\cos\phi = 1 \quad -(4)$$

Denote closest approach by $r = R_0$ $\quad -(5)$

then

$$R_0 = \frac{\alpha}{1+\epsilon} = a\frac{(1-\epsilon^2)}{1+\epsilon} = a(1-\epsilon) \quad -(6)$$

So at closest approach:

$$\frac{1}{a} = \frac{1-\epsilon}{R_0} \quad -(7)$$

and

$$v_N^2 = \frac{MG}{R_0}(\epsilon+1) \quad -(8)$$

So

$$\epsilon + 1 = \frac{R_0 v_N^2}{MG} \quad -(9)$$

For electromagnetic radiation grazing a large mass:

$$\epsilon \gg 1 \quad -(10)$$

so

$$\epsilon \sim \frac{R_0 v_N^2}{MG} \quad -(11)$$

) The angle of deflection is:

$$\Delta\phi = \frac{2}{\epsilon} = \frac{2MG}{R_0 v_N^2} \quad -(12)$$

in Newtonian theory.

The experimental result is:

$$\Delta\phi = \frac{4MG}{R_0 c^2} \quad -(13)$$

and it is claimed that this is precise. The result (13) can be obtained from the Lorentz transform in Minkowski spacetime:

$$v = \gamma v_N \quad -(14)$$

where the Lorentz factor in Minkowski spacetime is:

$$\gamma = \left(1 - \frac{v_N^2}{c^2}\right)^{-1/2} \quad -(15)$$

In eq. (14), v is the <u>observable</u> relativistic linear velocity.

From eqs. (14) and (15):

$$v_N^2 = \frac{v^2}{\gamma^2} = v^2\left(1 - \frac{v_N^2}{c^2}\right) \quad -(16)$$

from which

$$v_N^2 = \frac{v^2}{1 + \frac{v^2}{c^2}} \quad -(17)$$

From eqs. (12) and (17):

$$\Delta\phi = \frac{2MG}{R_0\left(\frac{v^2}{1 + \frac{v^2}{c^2}}\right)} \quad -(18)$$

The photon travels at:

$$v = c \quad -(19)$$

So for eq. (18):

$$\Delta\phi \xrightarrow[v \to c]{} \frac{4MG}{R_0 c^2} \quad -(20)$$

This is precisely the experimental result, Q.E.D.

The infinitesimal line element of the Minkowski spacetime is:

$$ds^2 = c^2 d\tau^2 = c^2 dt^2 - dr^2 - r^2 d\phi^2 \quad -(21)$$

$$= (c^2 - v_N^2)\, dt^2$$

in plane polar coordinates, so:

$$v_N^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\phi}{dt}\right)^2 \quad -(22)$$

In $m(r)$ theory the infinitesimal line element is:

$$ds^2 = c^2 d\tau^2 = m(r) c^2 dt^2 - \frac{dr^2}{m(r)} - r^2 d\phi^2 \quad -(23)$$

So light deflection due to gravitation can be explained with:

$$m(r) = 1. \quad -(24)$$

This result is preferred to the hugely elaborate and erroneous EGR explanation, which asserts that light deflection due to gravitation needs:

$$m(r) =? \; 1 - \frac{r_0}{r} \quad -(25)$$

This is another refutation of EGR.

The rigorous theory of light deflection in m theory requires the orbital linear velocity in m space, calculated in Note 317(7). As in that note the

(t) calculation starts from the hamiltonian of m theory:

$$H = m(r)\gamma mc^2 - m(r)^{1/2}\frac{mMG}{r} \quad -(26)$$

where

$$\gamma = \left(m(r) - \frac{v_N^2}{m(r)c^2}\right)^{-1/2} \quad -(27)$$

A smooth transition to classical theory is obtained by using

$$H_0 = T + U \quad -(28)$$

where:

$$T = m(r)\gamma mc^2 - m(r)^{1/2} mc^2 \quad -(29)$$

is the relativistic kinetic energy of m theory derived in UFT 18 from the work integral of m(r) theory. In eq. (28), the potential energy of m theory is:

$$U = -m(r)^{1/2}\frac{mMG}{r} \quad -(30)$$

As in Note 417(7), in the approximation:

$$v << c, \quad -(31)$$

$$H_0 \rightarrow \frac{1}{2}\frac{mv_N^2}{m(r)^{3/2}} - m(r)^{1/2}\frac{mMG}{r}. \quad -(32)$$

Using

$$v_N^2 = \dot{r}^2 + r^2\dot{\phi}^2 \quad -(33)$$

and the conserved angular momentum of m theory:

$$L = \frac{\gamma m r^2}{m(r)}\dot{\phi} \quad -(34)$$

it follows that:

$$H_0 = \frac{1}{2}\frac{m\dot{r}^2}{m(r)^{3/2}} + \frac{1}{2}m(r)^{1/2}\frac{L^2}{\gamma^2 m r^2} - m(r)^{1/2}\frac{mMG}{r} \quad -(35)$$

Now use the approximation:

$$\frac{1}{r^2} = m(r) - \frac{v_N^2}{c^2 m(r)} \quad -(36)$$

$$\xrightarrow[v_N \ll c]{} m(r)$$

$$-(37)$$

and it follows that:

$$v_N^2 = m(r)^{3/2} MG \left(\frac{2m(r)^{1/2}}{r} - \frac{1}{a} \right)$$

in the given approximation of Note 417(7).

So eq. (1) is modified to eq. (37) in m theory.

Now assume that eq. (7) holds approximately at closest approach, so:

$$v_N^2 = m(r)^{3/2} \frac{MG}{R_0} \left(\epsilon + 2m(r)^{1/2} - 1 \right)$$

$$-(38)$$

and assume that:

$$\epsilon - 1 + 2m(r)^{1/2} \sim \epsilon + 1 \quad -(39)$$

In the approximation: $\epsilon \gg 1 \quad -(40)$

it follows that:

$$\epsilon = \frac{R_0 v_N^2}{m(r)^{3/2} MG} \quad -(41)$$

and

$$\Delta\phi = m(r)^{3/2} \left(\frac{2MG}{R_0 v_N^2} \right) \quad -(42)$$

Now use:

$$p_1 = \gamma m v_1 \quad -(43)$$

i.e

$$v = \gamma v_N \quad -(44)$$

6) So:
$$v_N^2 = \frac{v^2}{r^2} = v^2 n(r)\left(1 - \frac{v_N^2}{n(r)^2c^2}\right) \quad -(45)$$

It follows that:
$$v_N^2 = n(r)\frac{v^2}{1+\frac{v^2}{n(r)c^2}} \quad -(46)$$

So eq. (17) in n space becomes eq. (46).

From eq.s. (42) and (46):
$$\Delta\phi = n(r)^{3/2}\left(\frac{2MG}{R_0 n(r)\frac{v^2}{1+\frac{v^2}{n(r)c^2}}}\right)$$

$$\xrightarrow[v\to c]{} \left(\frac{1+n(r)}{n(r)^{1/2}}\right)\left(\frac{2MG}{R_0c^2}\right) \quad -(47)$$

In the limit:
$$n(r)\to 1 \quad -(48)$$

it follows that:
$$\boxed{\Delta\phi = \frac{4MG}{R_0c^2}} \quad -(49)$$

Q.E.D

Any observed deviation from eq. (49) can be explained with eq. (47).