203(1): Estimates of the Orbital Energy and Angular Momentum for the Photon.

In UFT155 an expression was used for the orbital angular momentum derived from:

$$b = R_0 = \frac{cL}{E} \quad -(1)$$

but this is the Einsteinian result, which is based on the incorrect Schwarzschild metric.

In UFT202 a Newtonian theory was used, so

$$E = \frac{1}{2} m v^2 - \frac{mMG}{r} \quad -(2)$$

$$L = m r^2 \omega. \quad -(3)$$

Here:

m = photon mass $\sim 10^{-57}$ kg.

M = sun's mass = 1.9891×10^{30} kg

G = 6.67428×10^{-11} $m^3 kg^{-1} s^{-2}$.

Assume

$$r = R_0 \quad -(4)$$

at closest approach and that:

$$v = \left(\left(\frac{dr}{dt} \right)^2 + r^2 \left(\frac{d\theta}{dt} \right)^2 \right)^{1/2} \sim c \quad -(5)$$

Then

$$T = \frac{1}{2} m v^2 \sim 4.5 \times 10^{-41} J \quad -(6)$$

$$V = -\frac{mMG}{r} \sim -1.909 \times 10^{-25} J \quad -(7)$$

with

$$R_0 = 6.955 \times 10^{8} m \quad -(8)$$

2) However:

$$E = \hbar\omega = 1.05459 \times 10^{-34} \times 10^{16} \text{ J} \quad -(9)$$

assuming:

$$\omega = 10^{16} \text{ rad s}^{-1} \quad -(10)$$

Denote this as:

$$E(\text{quantum}) = 1.05 \times 10^{-18} \text{ J} \quad -(11)$$

The maximum value of the classical potential energy is

$$V = -1.91 \times 10^{-25} \text{ J} \quad -(12)$$

at the distance of closest approach, and the classical kinetic energy is:

$$T = 4.5 \times 10^{-41} \text{ J} \quad -(13)$$

at most.

So as assumed in UFT 202 the total energy of the photon is dominated entirely by $\hbar\omega$.

The classical orbital angular momentum of the photon is:

$$L(\text{orbital}) = m r^2 \omega = m r^2 \frac{d\theta}{dt} \quad -(14)$$

$$= m r^2 \frac{d\theta}{dr}\frac{dr}{dt} \quad -(15)$$

Assume that

$$\frac{dr}{dt} \sim c \quad -(16)$$

then

$$L = m c r^2 \frac{d\theta}{dr} \quad -(17)$$

3)

Consider:

$$\Delta\theta = 2\int_{R_0}^{R_1} \frac{d\theta}{dr}\,dr$$

$$= \frac{2}{x}\left(\sin^{-1}\left(\frac{1}{\epsilon} - \frac{\alpha}{R_1}\right) - \sin^{-1}\left(\frac{1}{\epsilon} - \frac{\alpha}{R_0}\right)\right)$$

$$\sim \frac{2\alpha}{x}\left(\frac{1}{R_0} - \frac{1}{R_1}\right) \quad - (18)$$

So $$\Delta\theta = \frac{2\alpha(R_1 - R_0)}{x R_0 R_1} \sim \frac{2\alpha\Delta R}{R_0^2} \quad - (19)$$

where

$$R_1 \sim R_0 \quad - (20)$$

So $$\boxed{\frac{\Delta\theta}{\Delta R} \sim \frac{2\alpha}{R_0^2}} \quad - (21)$$

i.e. $$\frac{d\theta}{dr} \sim \frac{2\alpha}{R_0^2} \quad - (22)$$

From UFT 202: $$\left.\begin{aligned}\frac{\alpha}{R_0} &= 4.242\times10^{-6}\\ R_0 &= 6.955\times10^{8}\end{aligned}\right] - (23)$$

so $$\boxed{\frac{d\theta}{dr} \sim 6\times10^{-15}\ \mathrm{rad\ m^{-1}}} - (24)$$

This makes sense because the deflection is very small, 1.75 seconds of arc. Eq. (24) represents the maximum deflection at the distance of closest approach.

4)

So the maximum orbital angular momentum is:

$$L(\text{max}) = m R_0^2 \omega$$

$$= m R_0^2 \frac{d\theta}{dt} = m R_0^2 \frac{d\theta}{dr} \frac{dr}{dt} \quad -(25)$$

Assume that

$$\frac{dr}{dt} \sim c \quad -(26)$$

because for all practical purposes the photon travels at the speed of light.

So:

$$L(\text{max}) = m R_0^2 c \frac{d\theta}{dr}$$

$$= 10^{-57} \times 6.955^2 \times 10^{16} \times 3 \times 10^{8} \times 6 \times 10^{-15}$$

$$\boxed{L(\text{max}) = 9 \times 10^{-46} \ Js}$$

This is twelve orders of magnitude smaller than the spin angular momentum:

$$\boxed{\hbar = 1.05 \times 10^{-34} \ Js}$$

So the assumptions of UFT 202 are correct, the dominant energy is $E = \hbar\omega$, and the dominant angular momentum is $\hbar = L(\text{spin})$.