3.11(1) : Precession and Light Deflection due to Gravitation

The experimentally observed light deflection due to gravitation is:

$$\Delta\phi = \frac{4MG}{R_0 c^2} \quad -(1)$$

where M is the mass of the attracting object and R_0 is the distance of closest approach. This must be calculated from the ECE 2 hamiltonian:

$$H = \gamma m c^2 - \frac{mMG}{r} \quad -(2)$$

and lagrangian:

$$\mathcal{L} = -\frac{mc^2}{\gamma} + \frac{mMG}{r} \quad -(3)$$

In the Newtonian limit:

$$H \rightarrow \frac{1}{2} m v_N^2 - \frac{mMG}{r} \quad -(4)$$

$$\mathcal{L} \rightarrow \frac{1}{2} m v_N^2 + \frac{mMG}{r} \quad -(5)$$

The Newtonian orbital velocity is:

$$v_N^2 = MG\left(\frac{2}{r} - \frac{1}{a}\right) - (6)$$

and the orbit is

$$r = \frac{\alpha}{1+\epsilon\cos\phi}, \quad -(7)$$

in plane polar coordinates. The semi major axis is:

$$a = \frac{\alpha}{1-\epsilon^2} \quad -(8)$$

and the distance of closest approach is:

$$R_0 = \frac{\alpha}{1+\epsilon} \quad -(9)$$

Here α is the semi major axis and ϵ is the eccentricity. It follows that:

a)
$$v_N^2 = \frac{mG}{R_0}\left(2 + \frac{\epsilon^2 - 1}{\epsilon + 1}\right) = \frac{mG}{R_0}(1+\epsilon) \quad -(10)$$

Light grazing the sun is a hyperbola with:
$$\epsilon \gg 1 \quad -(11)$$

so
$$v_N^2 \sim \frac{mG\epsilon}{R_0} \quad -(12)$$

The angle of deflection is
$$\Delta\zeta = \frac{2}{\epsilon} = \frac{2mG}{R_0 v_N^2} \quad -(13)$$

and this is not the experimental result (1).

The Lorentz factor is defined by:
$$\gamma = \left(1 - \frac{v_N^2}{c^2}\right)^{-1/2} \quad -(14)$$

and the observable relativistic velocity is
$$v = \gamma v_N \quad -(15)$$

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

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

If the observable v approaches c the speed of light then:
$$v \rightarrow c \quad -(18)$$

and

$$v_N^2 \rightarrow \frac{c^2}{1+\frac{c^2}{c^2}} = \frac{c^2}{2} \quad - (19)$$

So eq. (13) becomes:

$$\Delta \psi = \frac{2}{\epsilon} = \frac{4MG}{R_0 c^2} \quad - (20)$$

which is the experimental result (1), Q.E.D.

Light deflection by gravitation is explained very easily by ECE2 physics, using the definition (15) of the observed relativistic velocity v. There is no need at all for the Einstein theory. Eq. (19) means that the Lorentz factor (19) approaches:

$$\gamma \rightarrow \left(1 - \frac{1}{2}\right)^{-1/2} \quad - (21)$$

This theory must now be extended to demonstrate conservation of antisymmetry.