339(2). The Vacuum Hamiltonian and Velocity of the Vacuum Particle

The ECE2 theory is special relativity with finite torsion and curvature in material matter such as an electron. Its hamiltonian is:

$$H = (c^2 p^2 + m^2 c^4)^{1/2} + U \quad -(1)$$
$$= \gamma m c^2 + U$$
$$= \text{constant of motion.}$$

Therefore the Lorentz factor is defined by:

$$\gamma^2 = \frac{p^2}{m^2 c^2} + 1. \quad -(2)$$

Here $\underline{p}$ is the relativistic momentum:

$$\underline{p} = \gamma \underline{p}_0 = \gamma m \underline{v}_0 \quad -(3)$$

U is the potential energy, m the particle mass and c the speed of light in vacuo.

The de Broglie / Einstein equations are:

$$E = \gamma m c^2 = \hbar \omega \quad -(4)$$

and

$$\underline{p} = \hbar \underline{\kappa} = \gamma \underline{p}_0 \quad -(5)$$

and are true under all conditions.

So from eqs. (2) and (4):

$$\left(\frac{\hbar \omega}{m c^2}\right)^2 = 1 + \frac{p^2}{m^2 c^2} \quad -(6)$$

2)

$$= 1 + \left(\frac{\hbar \kappa}{mc}\right)^2$$

So
$$\omega^2 = c^2 \kappa^2 + \frac{mc^2}{\hbar} \quad -(7)$$

for any relativistic matter wave.

In UFT338 it was shown that the interaction of a matter wave with a vacuum wave is given by:

$$\kappa^\mu(\text{matter}) \rightarrow \kappa^\mu(\text{matter}) + \kappa^\mu(\text{vacuum}) \quad -(8)$$

where the wave four-vector of the vacuum is:

$$\kappa^\mu(\text{vacuum}) = \hbar\left(\frac{\omega(\text{vacuum})}{c}, \underline{\kappa}(\text{vacuum})\right) \quad -(9)$$

The relativistic hamiltonian of the vacuum is:

$$H(\text{vac}) = \left(c^2 p^2(\text{vac}) + m^2(\text{vac})\, c^4\right)^{1/2} + U(\text{vac}) \quad -(10)$$

Therefore for a relativistic particle in contact with the vacuum:

$$E \rightarrow E + E(\text{vac}) \quad -(11)$$

$$\underline{p} \rightarrow \underline{p} + \underline{p}(\text{vac}) \quad -(12)$$

where

$$E(\text{vac}) = \hbar\omega(\text{vac}) \quad -(13)$$

$$\underline{p}(\text{vac}) = \hbar\underline{\kappa}(\text{vac}) \quad -(14)$$

) As in notes for UFT 358 the g. factor of the electron is

$$g = 1 + \gamma \quad -(15)$$

$$= 1 + \frac{\hbar \omega}{mc^2}$$

When the electron is at rest:

$$\hbar \omega_0 = mc^2 \quad -(16)$$

so

$$g = 2 \quad -(17)$$

For an electron in contact with the vacuum:

$$g = 1 + \frac{\hbar(\omega + \omega(vac))}{(m + m(vac))c^2} \quad -(18)$$

so the observed mass of the electron is always:

$$M = m + m(vac) \quad -(19)$$

So in general:

$$\gamma = \frac{\hbar(\omega + \omega(vac))}{(m + m(vac))c^2} \quad -(20)$$

From experiment:

$$g = 2.00231931 4 \quad -(21)$$

therefore

$$\gamma = 1.00231931 4 \quad -(22)$$

$$= \left(1 - \frac{v_0^2}{c^2}\right)^{-1/2}$$

) so

$$V_0 = 0.068c \quad -(23)$$

which is the velocity of the vacuum particle if the electron is at rest.

Eq. (15) is derived from the hamiltonian (1) by expressing it as:

$$(H-U)^2 = c^2p^2 + m^2c^4 \quad -(24)$$

So

$$(H-U)^2 - m^2c^4 = c^2p^2$$

$$= (H-U-mc^2)(H-U+mc^2) \quad -(25)$$

So

$$H-U-mc^2 = \frac{c^2p^2}{H-U+mc^2}$$

$$= \frac{c^2p^2}{E+mc^2} \quad -(26)$$

$$= \frac{c^2p^2}{(1+\gamma)mc^2 - U}$$

In this procedure it is assumed in the Dirac theory that

$$E \to E - U = E - e\phi_W \quad -(27)$$

but that m does not change.

) As in note 338(2), for a free particle:

$$H = E \quad -(28)$$

so eq. (27) is equivalent to:

$$E \rightarrow H - U, \quad -(29)$$

i.e.

$$H = E + U \quad -(30)$$

Q.E.D.

However:

$$E = \hbar\omega = \gamma m c^2 \quad -(31)$$

and

$$e\phi_W = U = \hbar\omega(\text{vac}) \quad -(32)$$
$$= \gamma(\text{vac}) m(\text{vac}) c^2$$

So

$$\boxed{H = \gamma m c^2 + \gamma(\text{vac}) m(\text{vac}) c^2} \quad -(33)$$

Eq. (33) can be expressed as:

$$\boxed{H = \hbar(\omega + \omega(\text{vac}))} \quad -(34)$$

The concept:

$$U = \hbar\omega(\text{vac}) \quad -(35)$$

is introduced by ECE2 theory.

There are two ways of interpreting eq. (34):

1) It can be assumed that the mass m of the

) electron does not change. In this case:

$$H = \hbar(\omega + \omega(vac)) = (\gamma + \gamma(vac))mc^2 \quad -(36)$$

However this assumes that the vacuum mass $m(vac)$ is the same as m.

2) It can be assumed that γ does not change, so:

$$H = \hbar(\omega + \omega(vac)) = \gamma(m + m(vac))c^2 \quad -(37)$$

3) Eq. (33) can be assumed.

Eq. (37) is the simplest assumption. It needs that for an electron at rest:

$$\boxed{\hbar(\omega_0 + \omega(vac)) = (m + m(vac))c^2} \quad -(38)$$

because for an electron at rest:

$$\gamma \rightarrow 1 \quad -(39)$$

So the traditional eq. (26) is an approximation which assumes:

$$m + m(vac) \sim m \quad -(40)$$

From eq. (26) the γ factor can be understood if it is assumed that:

$$U \ll (1+\gamma)mc^2, \quad -(41)$$

then

$$H - U - mc^2 = \frac{c^2p^2}{(1+\gamma)mc^2 - U}$$

$$) = \frac{p^2}{m(1+\gamma) - \frac{U}{c^2}} = \frac{p^2}{m\left((1+\gamma) - \frac{U}{mc^2}\right)} \quad -(42)$$

$$= \frac{p^2}{m(1+\gamma)\left(1 - \frac{U}{mc^2(1+\gamma)}\right)}$$

$$\sim \frac{p^2}{m(1+\gamma)}\left(1 + \frac{U}{mc^2(1+\gamma)}\right)$$

$$= \frac{p^2}{m(1+\gamma)} + \cdots$$

The classical kinetic energy in the non-relativistic limit is

$$T = \frac{p^2}{2m} \quad -(43)$$

The g factor is obtained traditionally by writing this as:

$$T = \frac{1}{2m}(\underline{p} - e\underline{A})\cdot(\underline{p} - e\underline{A}) \quad -(43)$$

in the presence of a magnetic field, so:

$$T = -\frac{2e}{m}\,\underline{p}\cdot\underline{A} + \cdots$$

$$= -\frac{e}{m}\,\underline{L}\cdot\underline{B} + \cdots \quad -(44)$$

) This is the Zeeman effect, where:

$$\underline{L} = \underline{r} \times \underline{p} \quad -(45)$$

The g factor of $\quad g = 2 \quad -(46)$

is introduced by writing eq. (44) as:

$$T = -g \frac{e}{2m} \underline{L} \cdot \underline{B} \quad -(47)$$

From eq. (42), eq. (44) is changed to:

$$T = \frac{-e}{m(1+\gamma)} \underline{L} \cdot \underline{B} + \cdots \quad -(48)$$

so g is changed by:

$$\boxed{2 \rightarrow 1+\gamma} \quad -(49)$$

so

$$\boxed{g = 1+\gamma} \quad -(50)$$

QED