146(10): Topological Description of the Sagnac and Tomita Chiao Effects

This is reviewed in the Omnia Opera of www.aias.us in "Advances in Classical Physics", vol. 119 (3) Section X, pp. 93 ff. (2001). After one loop, the light in the Sagnac effect with platform at rest develops an electromagnetic phase shift:

$$\phi_s = \oint \underline{\kappa} \cdot d\underline{r} = \int \kappa^2 \, dA_r \quad -(1)$$

so

$$\psi \rightarrow \exp\left(i \left(\omega t - \underline{\kappa} \cdot \underline{r} + \phi_s \right) \right) \quad -(2)$$

After one loop the plane of plane polarized light is tilted. In the Tomita Chiao effect the plane is tilted after traversing a helical fibre optic cable. The latter is the same as the fibre optic gyro. The quantity κ in eq. (1) is

$$\kappa = \frac{1}{c} \frac{d\phi}{dt} \quad -(3)$$

where $d\phi / dt$ is found from the rotating Minkowski metric as in note 146(2):

$$dt = \pm \left(\frac{r}{c} \right) \left(d\phi + \omega \, dt \right) \quad -(4)$$

i.e.

$$\frac{d\phi}{dt} = \omega_0 \pm \omega \quad -(5)$$

where

$$\omega_0 = \frac{c}{r}. \quad -(6)$$

2) Therefore from eqs. (3) and (6):

$$\kappa = \frac{1}{r} \quad -(7)$$

which is <u>wave</u> particle <u>duality</u>.

From eq. (1), the Sagnac effect is:

$$\Delta\phi_S = \frac{1}{c^2}\oint (\omega_0+\omega)^2 - (\omega_0-\omega)^2 \, dAr \quad -(8)$$

$$= \left(\frac{4\omega A_r}{c^2}\right)\omega_0 \quad -(9)$$

$$:= \Delta t \, \omega_0$$

So

$$\boxed{\Delta t = \frac{4\omega A_r}{c^2}} \quad -(10)$$

<u>as observed</u> to $1 : 10^{25}$

Therefore mechanical rotation at angular frequency ω affects the electromagnetic phase.

The phase:

$$\phi_S = \oint \underline{\kappa} \cdot \underline{dr} = \frac{1}{c^2}\oint \omega_0^2 \, dAr \quad -(11)$$

is <u>electromagnetic</u> through the wave particle duality (6). Therefore it is concluded that the mechanical rotation is a rotation of the

) electromagnetic phase:

$$e^{i\phi} \rightarrow e^{i\phi_s} e^{i\phi} = e^{i(\phi + \phi_s)} \quad -(12)$$

A mechanical angular frequency ω_0 can be added to an electromagnetic angular frequency. This has an effect on absorption spectra.

In the Maxwell Heaviside theory these effects do not occur. They are basically phase effects that all derive from the ECE phase of paper 6. Examples are the Berry phase, the Aharonov Bohm effect, the topological phases, Sagnac effect, and Tomita Chiao effect.

In paper 146, it is shown that they all derive from the Thomas precession, which is rotation of the Minkowski metric.