Quantum Hyperspheres

By Peter J Carroll

Hypersphere sizes as given by $\mathbf{L = \frac{\mathit{Gm}}{\mathit{c}^2}}$, and hypersphere vorticitation rates as given by $\mathbf{\frac{c}{L}}$ do not appear to equate with such phenomena as the Compton wavelength $\boldsymbol{\lambda_c}$ of a particle or with its 'Compton' frequency $\mathbf{f_c}$.

Fundamental quanta can appear as either point particles or as wave like phenomena depending on how we choose to measure them. To a simple approximation quanta fly like waves but take off and land like discrete particles. This wave-particle duality lies at the heart of quantum theory and arises because of the quantisation of phenomena down at the Planck scale and the Heisenberg indeterminacy relationships. Plus we conventionally ascribe zero mass to lightspeed particles like photons to avoid conflicts with the Special Relativity model, even though photons hit targets with a measurable momentum.

Now the Heisenberg uncertainty/indeterminacy relationships usually appear as complimentary pairs such as: -

$$\mathbf{\Delta p\ \Delta m_o \sim \hbar}$$

$$\mathbf{\Delta e\ \Delta t \sim \hbar}$$

Where the indeterminacy of position and momentum, or the indeterminacy of energy and time multiply up to about Planck's constant reduced $\mathbf{(\hbar = \frac{\mathit{h}}{2\pi})}$. However in dimensional terms, $\mathbf{h = m\ l^2\ t^{-1}}$ and there seems no reason not to decompose it into complementary trialities of qualities such as: -

$$\mathbf{\Delta m\ \Delta l^2\ \Delta t \sim \hbar}$$

$$\mathbf{\Delta m\ \Delta l\ \Delta v \sim \hbar}$$

Where in the first case we have a triality of indeterminacies of mass, cross sectional area, and time, and in the second case we have a triality of indeterminacies of mass, length, and velocity. There seems little reason to regard mass as somehow more fundamental and inviolate than any of the other characteristics that remain indeterminate within Planck limits.

Now the Compton wavelength gives a measure of the effective apparent 'size' of a quantum wave-particle, and the sort of minimum sized aperture through which it can pass:

$$\boldsymbol{\lambda_c} = \mathbf{\frac{h}{mc}}$$

The corresponding hypersphere length for a quantum of the same mass comes out at: -

$\mathbf{L} = \frac{Gm}{c^2}$ and for most quantum scale objects this comes out at a much smaller length.

However quantisation at the Planck scale, which implies quantisation of spacetime itself, has the effect of giving that mass a larger apparent length: -

$$\frac{Gm}{c^2} \text{ x } \frac{h}{mc} = \frac{Gh}{c^3} = l_p^2$$

Where the Planck length, $\mathbf{l_p} = \sqrt{\frac{\mathbf{Gh}}{\mathbf{c^3}}}$

Similarly the Hypersphere frequencies, masses, and lengths have the following relationships to the Compton characteristics that some choices of measurement make apparent: -

$$\mathbf{f_H \ f_c} = \frac{\mathbf{1}}{\mathbf{t_p^2}}$$

$$\mathbf{m_H \ m_c = m_p^2}$$

$$l_H \ l_c = l_p^2$$

Furthermore, as the information content H, of the entire universe probably corresponds to its surface area in Planck units, as in the Beckenstein-Hawking Conjecture, then: -

$\mathbf{H} \sim \frac{L^2}{l_p^2} \sim \mathbf{10^{120}}$ (Surface area/Planck area)

(or $\mathbf{H} \sim \frac{L^3}{l_p^3} \sim \mathbf{10^{120}}$ (Hypersurface area/Planck volume))

Then those 10^{120} bits of information have to suffice for all the 10^{180} Planck volumes in the universe. Thus the universe has a serious information deficit with only 1 bit per 10^{60} Planck volumes. This number, 10^{60}, corresponds to the 'Ubiquity Constant' U, where $\mathbf{U} = \frac{\mathbf{L}}{\mathbf{l_p}}$ and it means that only one bit of information seems available to specify the state of every 10^{20} Planck units of length, $(\sqrt[3]{\mathbf{U}} = \mathbf{10^{20}})$

or, by similar argument, for every 10^{20} Planck units of time, and that this may well represent the effective quantisation or 'grain size' or 'pixilation' scale of spacetime.

We note that the universe does not appear to actually exhibit any behaviour at scales of less than $\sqrt[3]{\mathbf{U}} \ \mathbf{l_p}$ or $\sqrt[3]{\mathbf{U}} \ \mathbf{t_p}$, twenty orders of magnitude above the Planck length and the Planck time.