PART V – PLANCK'S CONSTANT, THE QUANTUM OF ACTION

IV.2 – Planck's Constant (h) Derived from Quantum Wavespace Principles

Standard Physics: Significance of Planck's Constant (h)

Planck's constant (h) is fundamental in quantum physics. Planck's constant bridges the gap between particle-like and wave-like behaviors in quantum physics, defining energy quantization through the relationship of the energy of photons (E) to their frequency (ν):

$$E = h\nu$$

QWST provides a fundamental derivation from first principles based on nucleon wave-energy structure at velocity C:

$$\frac{hC}{4r_0} = \frac{m_n C^2}{2}$$

Solving explicitly for h:

$$h = 2m_n r_0 C$$

This concise relationship demonstrates that Planck's constant is fundamentally tied to the nucleon's mass m_n and the wavespace geometry defined by r_0 and C.

Planck's Constant h - Fundamental QWST Derivation

$$h = 2m_n r_0 C$$

This formula reveals Planck's constant as a natural outcome of wave resonance conditions, rather than an arbitrary empirical parameter.

- $m_n = 1.672622 \times 10^{-27}\ kg$ (nucleon mass, anchors mass-energy equivalence at the nucleon core)
- $r_0 = 6.60724060118(10^{-16})\ \mathrm{m}$ (nucleon radius, C-sphere radius, the fundamental length scale that defines wave resonance, from which quantization emerges)
- $C = 2.99792458 \times 10^8\ m/s$ (velocity of light, defining the maximum energy propagation speed in wavespace)

Planck's constant is central to quantum mechanics, linking a photon's energy to its frequency. In QWST, h arises from the wave-energy structure of the nucleon, showing that what mainstream physics treats as a fundamental quantum of action is, in this view, a byproduct of the nucleon's resonant wave energy. This connects mass–energy equivalence $E = m_n C^2$ directly to the wave continuum's boundary conditions and core density.

Planck's Constant h - Relationships to Electromagnetic Constants

QWST also relates Planck's constant directly to electromagnetic phenomena through the fine-structure constant (α) and the electron charge (e):

$$\frac{hC}{2} = e^2 \pi \alpha^{-1}$$

- $h = 6.62607015 \times 10^{-34}\ J \cdot s$ (Planck's constant)
- $e = 1.602176634 \times 10^{-19}\ C$ (electrostatic electron charge)
- $\alpha^{-1} = 137.035999084$ (inverse fine structure constant CODATA 2018)
- $C = 2.99792458 \times 10^{8}\ m/s$ (velocity of light, maximum wave speed)

The fine-structure constant α governs the strength of electromagnetic interactions. According to QWST, it emerges from the interplay of nucleon wave energy and the electron's reaction wave structure, rather than being a purely empirical or unexplained constant. Further derivations later in this section will tie α directly to wave geometry factors. This significant relationship demonstrates how Planck's constant h intimately connects the fine-structure constant (α), fundamental electron charge (e), and nucleon mass-energy relationships, underscoring a deep unity in fundamental physics.

The Josephson constant K_J is central in superconductivity and precise quantum voltage measurements, and thus a clear relationship further strengthens QWST's theoretical predictions. We can derive the following relationship to the Josephson constant:

$$m_n r_0 C = \frac{eC}{K_J}$$

- $K_J = 4.835978484 \times 10^{14}\ Hz/V$ Josephson constant (CODATA2018)

H. W. Schmitz's derivation uses the symbol β_s used CGS units and predates the standardized K_J, so adjustments for modern SI units appear as factors of C. The equation emphasizes that $e = e_s$, measured in electrostatic conditions) is bound within nucleon–electron wave coupling, rather than existing as a separate factor as in SI units.

Planck's Constant h - Summary of Relationships

Fundamental QWST definition:

$$h = 2m_n r_0 C$$

Electromagnetic constants relationship:

$$\frac{hC}{2} = e^2\pi\alpha^{-1} = \frac{eC}{K_J}$$

These equations unify multiple quantum constants within the cohesive wave-based framework of Quantum Wavespace Theory.

Relationship of h to the Fundamental Constants of QWST

In PART II.3 we derived a critical relationship defining m_n, shown to emerge from the mass energy density of wavespace M_E and the characteristic length scale r_0:

$$m_n = Ar_0^3\, M_E$$

This relationship can be substituted in our equation for Planck's Constant as follows:

$$h = 2Ar_0^4\, M_E C$$

alternatively, since $M_E = P_0/C^2$

$$h = 2Ar_0^4\, P_0/C$$

This demonstrates that Planck's constant emerges from the fundamental constants of QWST, the limiting energy density and velocity P_0/C, and wave geometry $2Ar_0^4$ including the C-sphere radius r_0 which relates to the quantization imposed by the resonant frequency. This fundamental QWST derivation directly links Planck's constant to the nucleon's intrinsic energy density and wave structure. It reveals that Planck's constant is not merely an empirical constant, but arises from deeper resonant wave relationships.

Constants:

- $m_n = 1.67492749804 \times 10^{-27} kg$ = mass of a nucleon
- $r_0 = 6.60724 \times 10^{-16}$ m = nucleon radius, 1/4 wavelength of the basic frequency
- $M_E =$ 2.25488815780(10^{-10}) J = the mass energy density of quantum wavespace and the nucleon
- $P_0 =\ 5.15851475432(10^{35})\ Pa$ = the maximum energy density of quantum wavespace as well as the nucleon C-sphere
- $A = 1.010296164593 = \frac{16(\pi^2-8)}{3\pi^2}$ = a wave geometry constant, used as a simplifying placeholder

Physical Meaning and Interpretations:
While mainstream physics accepts h empirically, QWST logically derives it from the nucleon's stable wave energy distribution. This demonstrates that quantum phenomena traditionally associated with h are intrinsically tied to wavespace energy conditions.

This unified approach strongly suggests that Planck's constant is not arbitrary but fundamentally related to nucleon wave structures. We encourage the scientific community to leverage modern computational tools—such as AI-driven PDE solvers and high-performance computing—to rigorously test, refine, and potentially confirm these groundbreaking derivations.

Following is the original chapter and appendix from *The Physical and Philosophical Nature of the Universe (PPNU)* deriving the Planck's constant relationships.

Planck's Constant of Action (PPNU Chapter 10)

The energy, $h \times f$, where f is the wave frequency, may be equated to the kinetic energy of motion, stored in the field energy of the involved nucleon.

If the relationship between the field energy and velocity is omitted, then an equality may be written for the limiting velocity C and the limiting frequency $\frac{C}{4r_0}$ or f_0.

$$f_0 = \frac{C}{4r_0}$$

At this velocity, the total axial component of the nucleon energy would be converted into the kinetic energy of velocity.

$$\frac{hC}{4r_0} = \frac{m_n C^2}{2} \quad \text{or} \quad \frac{hC}{2} = m_n r_0 C^2$$

When this value is equated to the relationships already established among the Planck constant of action h the Josephson junction voltage-frequency ratio β_s the fine structure constant α^{-1} and the electron charge e_s then for the electrostatic case:

$$\frac{hC}{2} = e_s^2 \, \pi\alpha^{-1} = \frac{e_s}{\beta_s} = m_n r_0 C^2$$

Additionally:

$$e_m = \frac{10e_s}{C}$$

Plank's Constant Derivations (PPNU Appendix 10)

Planck's constant of action may be regarded as equating the kinetic energy of velocity of the nucleon to the resonant frequency of the photons created by these nucleons, as covered in the analysis of the Rydberg constant.

The maximum possible velocity is C, and the energy associated with this velocity is:

$$\frac{m_n C}{2}$$

The maximum possible frequency is the basic frequency f_0.

$$f_0 = \frac{C}{4r_0}$$

If we equate $hC/4r_0$ to $m_nC/2$ then

$$\frac{hC}{2} = m_n r_0 C$$

and the existing relationships for h become:

$$\frac{hC}{2} = e_s^2 \pi \alpha^{-1} = e_s/\beta_s = m_n r_0 C^2$$

where:
e_s = the electrostatic electron charge and
β_s = the Josephson voltage frequency ratio for the electrostatic case.

Historical Context of the Josephson Constant:

When the author originally introduced β_s, the Josephson constant K_J, was not yet standardized. The Josephson effect was experimentally verified in the 1960s, but the internationally recognized value for K_J, was not officially adopted until 1972 (CODATA).

This explains why the author worked with β_s instead of using K_J directly. Our reformulation shows that his concept of β_s aligns with K_J, but is scaled by C.

The original derivations by H. W. Schmitz used CGS electrostatic units common in the 1970s. Conversion to SI units involves the Coulomb electrostatic constant (k_e):

$$k_e = \frac{1}{4\pi\varepsilon_0} = C^2 \times 10^{-7} = 8.987551787 \times 10^9 \ \frac{N \cdot m^2}{C^2}$$

Electron charge conversion from CGS to SI units is then:

$$e_{SI} = e_{CGS}\sqrt{k_e} \quad \text{and} \quad e_{SI}^2 = e_{CGS}^2\, k_e$$

This ensures consistency between CGS and SI units. Therefore, we would modify H. W. Schmitz equations to adapt to SI units as follows:

$$\frac{hC}{2} = e_s^2 \pi \alpha^{-1}(C^2 \times 10^{-7}) = e_s(C)/K_J = m_n r_0 C^2$$

Selected Investigations – CGS and SI units, and the Coulomb constant k_e

It is helpful to examine the difference between CGS and SI units, since in addition to the basic conversion of g and cm, they each employ a different interpretation of the Coulomb Constant. To calculate values using SI units, we must account for an additional factor (k_e) which is excluded from the CGS system. In its original form, Quantum Wavespace Theory (QWST) equations are expressed using CGS *electrostatic* units (also called esu or Gaussian). In CGS equations, the Coulomb electrostatic constant is implicitly unity:

$$(k_e)_{CGS} = 1$$

When converting to SI units, the Coulomb constant instead becomes:

$$(k_e)_{SI} = \frac{1}{4\pi\epsilon_0} = C^2 \times 10^{-7} = 8.987551787 \times 10^9 \ \frac{\mathrm{N\,m^2}}{\mathrm{C^2}}$$

where ϵ_0 is the permittivity constant. Therefore, when using SI units the equations become:

$$\frac{hC}{2} = m_n r_0 C^2 = e_s^2 \pi \alpha^{-1} (k_e)_{SI}$$

$$\frac{hC}{2} = e_s/\beta_s(CGS) = eC/K_j(\mathrm{SI})$$

Thus, any QWST formula originally containing (e^2) in CGS (esu) must incorporate this factor when converted to SI units:

$$(e^2)_{\mathrm{SI}} = (e^2)_{\mathrm{CGS}} \times (k_e)_{SI}$$

This conversion step is critical for accurately matching numerical results from QWST-derived equations to known physical constants in SI units, particularly when validating constants such as Planck's constant (h).

$$\alpha = \frac{e^2}{4\pi\epsilon_0 \hbar C}, \quad \text{where} \quad \hbar = \frac{h}{2\pi}$$

$$\frac{h}{2\pi} = \frac{e^2}{4\pi\epsilon_0 \alpha C} = \frac{e^2 (k_e)_{SI}}{\alpha C}$$

$$\frac{hC}{2} = \frac{\pi e^2 (k_e)_{SI}}{\alpha} = m_n r_0 C^2$$

$$m_n r_0 C^2 = hC/2 = A P_0 r_0^4$$