# Pi is Fundamental Cosmic Frequency in Expanding Universe

Leong Ying[*]

*Thermo Fisher Scientific, 303C College Road East, Princeton, NJ, 08540, USA*

**Abstract.** Our physical existence is interpreted using the fundamental real base positive unit of *1*. With the addition of an orthogonal imaginary component with base unit of *i*, the oscillatory nature between both phases results in *π* becoming a fundamental time constant of the universe. By extending this dual orthogonal existence to the Big Bang beginning of our cosmos the oscillatory mixing between the Real and Imaginary expansion components can produce a numerical answer for the current observed matter to antimatter discrepancy in our universe.

**Keywords:** Pi, Time, Oscillating, Twin, Universe, Antimatter, Entropy, Conservation.

## 1. UNIVERSAL BASE UNITS

In electricity the impedance of a complex circuit is $Z = R + iX$, where $R$ is the resistance and $X$ is the orthogonal reactance which can either be of capacitive or inductive components or combination of both. The base unit of the real resistive component is $+1$ and $+i$ is the imaginary reactive component base unit. The magnitude of the total impedance squared is the sum squared of the two orthogonal vector components represented by $Z^2 = R^2 + X^2$.

By using the electrical analogy that our cosmos exists both with a real $Y$ and orthogonal imaginary $X$ axial components we can define any equivalent vector quantity $Z$ by the following summation:

$$Z = Y + iX \qquad (1)$$

The observable measured value in our Real-World axis is given by $Y$. The fundamental base unit of the total combined cosmos is derived by the sum squared of its orthogonal components base units $+1$ and $+i$:

$$z^2 = 1^2 + i^2 = 0 \qquad (2)$$

Table **1** below lists all the fundamental base units as defined by the existence of orthogonal twin universes.

The Total-World base unit of zero is equivalent to a fully conserved cosmos existing as Twin Universes that obeys Universal Laws of Thermodynamics whereby energy and entropy are conserved for all matter and processes in the combined Total-World referenced system [1].

## 2. OSCILLATING PARTICLE STATES

The phenomenon whereby a neutrino can change lepton flavor as it propagates was predicted by Bruno Pontecorvo [2]. Neutrino oscillations arise from mixing of the flavors and mass eigenstates. As a neutrino propagates through space, the quantum phases of the three mass states advance

at different rates due to the neutrino mass differences, resulting in different mixture of flavor states as the neutrino travels.

**Table 1. Fundamental Base Units for Orthogonal Universal System**

| World Existence | Base Unit |
|---|---|
| Real-World | +1 |
| Imaginary-World | +i |
| Total-World | 0 |

The state of a neutrino with flavor α is the superposition of the mass eigenstates $\nu_j$.

$$\left| \nu_\alpha \right\rangle = \sum U_{\alpha j}^* \left| \nu_j \right\rangle \qquad (3)$$

For a two neutrino flavor state (α = e,μ) the unitary mixing matrix can be expressed as:

$$U_{e \to \mu} = \begin{array}{c c} & \begin{array}{c c} \nu_1 & \nu_2 \end{array} \\ \begin{array}{c} \nu_e \\ \nu_\mu \end{array} & \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \end{array} \qquad (4)$$

The evolution over time $t_j$ of an oscillating neutrino of mass $m_j$ can be obtained by applying Schrödinger's equation to $\nu_j$ component of $\nu_\alpha$.

$$\left| \nu_\alpha(t_j) \right\rangle = e^{-i m_j t_j} \left| \nu_j(0) \right\rangle \qquad (5)$$

In the two neutrino case $\nu_e \to \nu_\mu$ the probability of a neutrino of energy E propagating over a length L changing its flavor is given by:

$$P_{e \to \mu} = \sin^2(2\theta)\sin^2\left( \frac{\Delta m_{e \to \mu}^2 L}{4E} \right) \qquad (6)$$

While there are currently only three known lepton flavors of neutrinos, experiments suggest the possibility of more

*Address correspondence to this author at Thermo Fisher Scientific, 303C College Road East, Princeton, NJ 08540, USA; Tel: 609 924 7310; Fax: 609 924 1729; E-mail: leong.ying@thermofisher.com

N

$$N(t) = N_0 e^{t/\Upsilon}$$

Present Cosmos
13.7B Years

Star Formation
150M Years

Super-particle
t=0

t
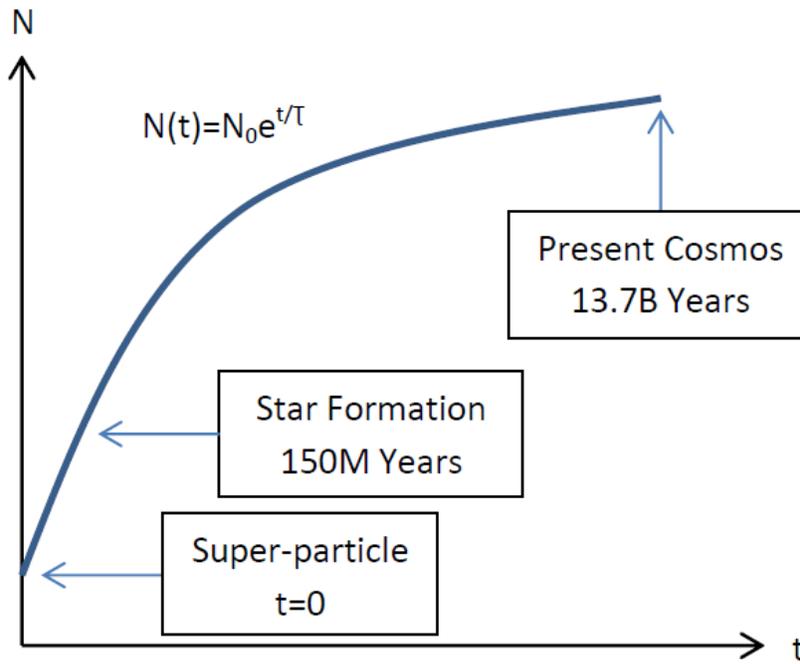
**Fig. (1).** Cosmic particle evolution after Big Bang.

**Table 2.   Unitary Time Sequence of Oscillating Big Bang Expansion**

| Time Unit (t) | Real-World (y) | Imaginary-World (x) | Total-World (z) |
|:---:|:---:|:---:|:---:|
| 0 | +1 | 0 | $+1=e^0$ |
| 1 | 0 | +i | $-1=e^{i/\Upsilon}$ |
| 2 | $N_y(2)$ | $N_x(2)$ | $N_z(2)^2=N_y(2)^2+N_x(2)^2$ |

than three associated mass eigenstates. These additional neutrinos since they are not coupled by the weak boson force particles *W, Z* in a standard 4-dimensional Real-World space-time are termed sterile neutrinos [3]. This observational evidence of sterile neutrinos indicates the presence of an additional Imaginary-World space-time.

Neutral particle oscillation is the phenomenon whereby two mesons interchange identities through the Weak interaction causing them to decay. The evolution of the oscillating mixed states can be written in matrix notation as:

$$\Psi(t) = e^{iHt}\begin{pmatrix} y \\ x \end{pmatrix}; \ H = \begin{pmatrix} M & \Delta \\ \Delta & M \end{pmatrix} \tag{7}$$

The diagonal elements of the Hamiltonian must be equal since the particle and antiparticle have identical masses. Charge-Parity (CP) Symmetry requires the components to be real, and any imaginary components will lead to CP-violation. Experiments with neutral kaons decaying into two and three pions have verified CP-violation [4]. This is equivalent to stating that identical particle-antiparticle states oscillate between orthogonal Real-World and Imaginary-World referenced phases.

There are further supporting theories in the technical publications proposing such dual Imaginary-World existence of time-reversed particles [5] and virtual-particles [6].

## 3. BIG BANG EVOLUTION

At the beginning of the cosmos a Super-seed particle comes into existence. To conserve the Total-World scenario *z=0* (which obeys the conservation of matter-energy and entropy) this unitary particle oscillates as a Super-particle in the Real-World (y) and Super-antiparticle in an orthogonal Imaginary-World (x). As these twin universes expands space-time there is oscillatory mixing of the Super-particle and Super-antiparticle that decays into other sub-atomic particles. Almost 14 billion years into our expansion we reach our current accelerating state of the cosmos with a full complement of elemental particles.

Interpreting the Big Bang evolutionary expansion and particle generation by $N(t) = N_0 e^{t/\Upsilon}$, where $\Upsilon$ is the equivalent cosmic time constants of the oscillatory decaying Super-particle and Super-antiparticle. Fig. (**1**) gives a graphical illustration of the evolution of our expanding universe from the original Big Bang event at t=0 to our current Real-World observable conditions.

Table **2** lists the initial primeval sequence of events for each unitary segmented expansion of time from the origin of the Big Bang with the condition that the Total-World is conserved (z=0).

Mathematically equivalent $e^{i\pi}=-1$, so the first arbitrary unit of time that comes into existence can be defined as

$1/T=\pi$, or the Fundamental Cosmic Frequency. In our current Real-World state the smallest indivisible unit of time reference is the Planck time $t_p \sim 10^{-44}$ seconds.

During the second fundamental oscillatory frequency period ($2\pi$) there is a mixing of the original unitary Super-particle (+1) and Super-antiparticle (+i). The difference in matter and antimatter at this initial mixing phase is given by:

$$\Delta = N_y(2) - N_x(2) = N_y(0)e^{2\pi.\pi} - N_x(0)e^{2\pi.\pi} = +1.e^{2\pi.\pi} \qquad (8)$$

So the approximate numerical value of surplus matter to antimatter is $\sim e^{20}$ or $\sim 10^9$ due to this mixing of the original Super-particle and Super-antiparticle between the two orthogonal worlds. This is consistent with present-day matter surplus observed in our referenced Real-World existence.

## 4. CONCLUSION

Treating the total cosmos as expanding twin universes can provide an explanation for the oscillatory mixing observed in neutral particle-antiparticle states that requires an imaginary orthogonal component. By interpreting the existence of unitary Super-particle and Super-antiparticle at the origin of the Big Bang event and obeying a universal conservation laws for the total system, the numeric value of $\pi$ becomes the Fundamental Cosmic Frequency. The initial mixing of these Super-states provides a numeric surplus of matter over antimatter that is consistent with observed measurements. This Twin Universe interpretation has further support from computation based on a reverse stellar nuclear fusion process occurring in the Imaginary-World scenario that is consistent with Hubble's present-day expansion rate of the universe and provides a plausible explanation for Dark Energy [7].

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

## ACKNOWLEDGEMENTS

## REFERENCES

[1]    Ying L. Nuclear fusion drives present-day accelerated cosmic expansion. Hadronic J 2009; 32: 573-88.

[2]    Pontecorvo B. Mesonium and Anti-mesonium. Zh Eksp Teor Fiz 1957; 33: 549-51.

[3]    Nakamura K. Particle data group. J Phys G 2010; 37: 075021.

[4]    Christenson JH, Cronin JW, Fitch VL, Turlay R. Evidence for the $2\pi$ Decay of the $K_2^0$ Meson. Phys Rev Lett 1964; 13: 138-40.

[5]    Santilli RM. Isodual theory of antimatter. Springer: Dordrecht, The Netherlands 2006; pp. 85-136.

[6]    Rowlands P. Zero to infinity. Singapore: World Scientific Publishing 2007; pp. 39-62.

[7]    Ying L. Dark Energy is stellar nuclear fusion replicated in a mirrored universe. Open Astron J 2011; 4: 54-6.