

# Rhythm Based Time and the conventional time

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*Abstract:* I explain how Riemann surface splits Rhythm Based Time into conventional time.

It is known that the exponential function  $e^z = \exp(z)$  of a complex number  $z \in \mathbb{C}$  has the form, when we write  $z = x + iy$  with  $x, y \in \mathbb{R}$ ,

$$(1) \quad \exp(z) = e^x e^{iy} = e^x (\cos y + i \sin y).$$

Therefore  $e^z$  is cyclic or periodic with respect to the imaginary part  $y$  of  $z$ , and takes the same values on each strip

$$(2) \quad (k-1)(2\pi) < y < k(2\pi) \quad (k = \dots, -2, -1, 0, 1, 2, \dots).$$

$\exp(z)$  maps each strip onto the whole complex plane. These strips can be connected through the positive real axis of  $e^z$  to form a Riemann surface of  $e^z$ . On this Riemann surface  $w = e^z$  is invertible and the inverse function is the logarithm function  $z = \ln w$ .

The local clock  $\exp(-itH)$  is expressed as we have seen before as

$$(3) \quad \exp(-itH) = \int_{-\infty}^{\infty} e^{-it\lambda} dE(\lambda).$$

This means that, on an abstract space  $\frac{dE}{d\lambda}(\lambda)\mathbb{H}$  (where  $\mathbb{H}$  is the base Hilbert space), the local clock is represented by a periodic function  $e^{-it\lambda}$  of  $t$ . This periodicity is exactly that of the Rhythm Based Time of Dr. Beamish.

In so far as we consider the value  $e^{-it\lambda}$ , it is periodic and takes the same value infinitely many times when  $t$  varies. The Riemann surface of  $e^z$  splits this periodic function, into a one-to-one function  $e^{-it\lambda}$  from the set of real numbers into the Riemann surface of  $e^z$ . (Note that  $-t\lambda \in \mathbb{R}$  is the imaginary part of the exponent of  $e^{-it\lambda}$ .)

This Riemann surface is a spiral surface, as expected by Dr. Beamish.

This is the relation between the cyclicity of Rhythm Based Time  $T = \exp(-itH)$  and the linearity of conventional time  $t$ .

## REFERENCES

- [1] P. Beamish and Ceta-Research, *Rhythm Based Communication in the year 2000*, Proceedings of Biennial Meeting of the Society for Marine Mammalogy, Maui, Hawaii, U.S., November 1999.
- [2] P. Beamish and Ceta-Research, *"TIME" beyond "conventional time"*, ISBN 0-9689955-0-0, 2001.
- [3] H. Kitada, *Theory of local times*, Il Nuovo Cimento **109 B, N. 3** (1994), 281-302 (<http://xxx.lanl.gov/abs/astro-ph/9309051>).
- [4] H. Kitada, *Quantum Mechanics and Relativity — Their Unification by Local Time*, in "Spectral and Scattering Theory," Edited by A. G. Ramm, Plenum Publishers, New York, pp. 39-66, 1998 (<http://xxx.lanl.gov/abs/gr-qc/9612043>).
- [5] H. Kitada and L. Fletcher, *Local time and the unification of physics, Part I: Local time*, Apeiron **3** (1996), 38-45.
- [6] H. Kitada, *Local time and the unification of physics, Part II: Local System*, (2001) (<http://xxx.lanl.gov/abs/gr-qc/0110066>)
- [7] H. Kitada, *Quantum Mechanical Clock and Classical Relativistic Clock*, (2001) (<http://xxx.lanl.gov/abs/gr-qc/0102057>).