Unity Root Matrix Theory
Mathematical and Physical Advances
Volume I

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$$\mathbf{A}_5 = \begin{pmatrix} 0 & M & (\tau/2)\mathbf{X}^{3-} \\ -M & 0 & (t/2)\mathbf{X}^{3-} \\ -(\tau/2)\mathbf{X}_{3+} & -(t/2)\mathbf{X}_{3+} & \mathbf{A}_3 \end{pmatrix}$$

$$\mathbf{A}_5\mathbf{X}_{5+} = C\mathbf{X}_{5+}$$

$$E_0 = mMC$$

About the Front Cover

The front cover shows the five-dimensional, Unity Root Matrix Theory (URMT), relativistic mass solution; see Section (7) for full details. The symbols are as follows, in approximate order of appearance:-

$\mathbf{A}_5$: The 5x5 (URM5) unity root matrix (7.124)

M : Reduced velocity, $0 \le M \le c$, Section (6-7)

τ : Relativistic proper time

t : Laboratory (wall clock) time

$\mathbf{X}_{3+}$: Three-element, invariant, acceleration eigenvector (A33a)

$\mathbf{X}^{3-}$: Conjugate (or reciprocal) of $\mathbf{X}_{3+}$ (A35c), $\mathbf{X}^{3-}\mathbf{X}_{3+} = 0$ (F1)

$\mathbf{X}_{5+}$: The five-element, zero-padded form of $\mathbf{X}_{3+}$ (7.3a)

C : The invariant eigenvalue, equated with the speed of light c

$\mathbf{A}_5\mathbf{X}_{5+} = C\mathbf{X}_{5+}$: The invariant eigenvector equation (7.3a)

$\mathbf{E}_0$: Rest mass energy

m : Relativistic mass

$\mathbf{E}_0 = mMC$: URMT's rest mass energy equation, (7.41).

Mathematical and Physical Advances

The Mathematical Advances

- Incorporation of completely arbitrary vectors.

A new method, termed 'Arbitrary Vector Embedding', is developed to incorporate an arbitrary, n-dimensional vector as the invariant eigenvector, which is no longer constrained to be a Pythagorean n-tuple. In parallel, a more flexible class of 'A matrices' is developed to replicate unity root matrices.

- Inclusion of real and complex numbers

The constraint to integers is relaxed to include real and complex numbers, albeit they still only play an intermediary role. The relaxation widens URMT's scope, eases some algebraic aspects and, most importantly, serves to assuage any doubts about an all-integer formulation. Details on converting back to integers, as the observables, are also provided with numeric examples.

The Physical Advances

- Non-zero, invariant and non-invariant scalar potentials

URMT's favoured 4D and 5D solutions (URM4 and URM5) are expanded from a kinetic-only term to include both a constant and varying, non-zero potential energy term. Amongst other things, this leads to a formulation of the classical harmonic oscillator and the relativistic energy-momentum equation.

- A formulation of the classical harmonic oscillator

Using the new method of arbitrary vector embedding in URM4, a quadratic potential emerges providing a URMT formulation of the harmonic oscillator. Although with classical origins, its quantisation in integers, with a non-zero, zero-point energy, gives it a distinctly non-classical feel. A numeric example is provided.

- A relativistic Doppler solution with cosmological implications

A solution is given for a relativistic, non-zero interval event, i.e. the time evolution of the position of an object with a non-zero rest mass. This solution is parameterised in terms of the dimensionless Doppler shift, and shows intriguing cosmological implications such as a huge initial acceleration, decaying thereafter as time progresses in accordance with the Hubble expansion law. Numeric examples are provided.

- A relativistic solution with mass

A solution is developed incorporating the relativistic energy-momentum equation for a non-zero potential, and linked to the appearance of mass via the addition of a sub-luminal velocity to the 5D unity root matrix.

- Lorentz Transformations in URMT

The behaviour of the unity root matrix and its eigenvectors is studied under a Lorentz transformation, which leads to an interpretation of the unity root matrix as a relativistic event and its Lorentz transform.