THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF APPLIED MATHEMATICS
應 用 數 學 系

Department of Applied Mathematics Seminar

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Topic

Bridging Algebra and Nature: Toward a Deformable 3D Hyper-complex Framework for Modeling Dynamic Systems

Date| Time

8 September 2025 (Monday) | 11:00am – 12:00nn (HK Time)

Venue

TU817

Abstract:

In this paper, we present a new hyper-complex number system, Trinition, that has an unusual structure of commutativity, non-commutativity, non-associativity, and deformability. Challenging traditional algebra, it is generative and degenerative, so it is able to form a dynamic construction that can self-regulate. We are able to extend basic mathematical primitives, such as a norm and distance metric, to a reversible and deformable definition, ultimately creating an entirely new geometry. This then leads to new 3D geometrical figures, such as a deformable sphere and isosurface representations, yielding a new family of 3D fractal systems described using recursive Trinition transformations. We then prove a new collection of inequalities which also generalize classical results to this hyper-complex scenario. Along with geometric configurations, we derive new velocity, acceleration, and energy functions and respective Laplace and Fourier transforms for a wider range of physics and engineering applications. Using the process of extending classical mechanics into Trinition space, we find the new Hamiltonian and Lagrangian formalism associated with Trinition mechanics, which produces a generalized equation of motion that incorporates hyper-complex interactions. To relate these new evolution stages, we now introduce Archiometry, a new form of hyper-complex trigonometry in which the angles, called Archiotwists, define the rotational transformations in Trinition space. The culmination of these results outlines a novel mathematical background that integrates algebra, geometry, physics, and analysis all within the same frame, which may pave the way toward future quantum mechanics developments, complex systems modeling, and room-temperature higher-dimension physics applications. We have reformulated the spacetime equation, which led to a formula that could open doors for further investigation and deeper understanding of nature. We have presented a new norm that deforms the geometry by injecting deformation parameters directly into the inner product, resulting in a deformation Laplace–Beltrami operator. This operator, in turn, yields generalized partial differential equations from which anisotropic and non-Euclidean entities may be appropriately extracted. We prove the existence, uniqueness, and stability of the solutions in the corresponding inequalities with deformation effects. In particular, numerical simulations in MATLAB clearly show how a simple modification of the deformation parameters can lead to significant changes in wave propagation, illustrating the power of this approach to model complex systems where classical convex Euclidean metrics fail to reproduce the system dynamics. Our results pave the way for future studies in anisotropic media, higher-order PDE models, and new probabilistic structures.

ALL ARE WELCOME