Certificate of Participation

This certificate is presented to

Dr. Bilal Basti, Ziane Achour University of Djelfa, Algeria

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The title of his talk was A Hybrid Model for a Class of Multidimensional Nonlinear Free Energy Equations

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A hybrid model for a class of multidimensional nonlinear free energy equations

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Abstract

This paper discusses and theoretically studies the existence and uniqueness of radially symmetric solutions for a multidimensional nonlinear time and space-fractional reaction-diffusion/wave equation that enables treating vibration and control, signal and image processing, and modeling earthquakes, among other physical phenomena. Additionally, applying Schauder's and Banach's fixed point theorems facilitates identifying the existence and uniqueness of solutions for the selected equation.

1 Introduction and statement of results

In this work, we shall give an example of a class of fractional-order's PDEs, which helps to describe various complex phenomena; it is a multidimensional nonlinear time and space-fractional reaction-diffusion/wave equation and is written as follows:

$$\partial_t^{\alpha} u - \kappa^2 \Delta u = F\left(t, x, u, \partial_t^{\beta} u, (-\Delta)^s u\right), \text{ for } 0 < s \leq 1 < \beta \leq \alpha \leq 2, \tag{1}$$

where $u = u(t, x)$ is a scalar function of the time $t \geq 0$ and space variables $x \in \mathbb{R}^m$, with $m \in \mathbb{N}^*$. Also $F : [0, \infty) \times \mathbb{R}^m \times \mathbb{C} \times \mathbb{C} \times \mathbb{C} \to \mathbb{C}$ is a nonlinear function, $\kappa \in \mathbb{R}^*$ is a real constant the symbol $(-\Delta)^s$ defines the fractional Laplacian operator [2].

1.1 The significance of the equation

Equation (1) is a representation of a large class of linear and nonlinear equations. Note that, for $F \equiv 0$ and $\alpha = 1$ (resp. $\alpha = 2$), the PDE (1) represents the standard heat equation (resp. the wave equation). In addition to that, it becomes the Klein-Gordon equation when we choose $F = \kappa u$,

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$|\kappa| = 1$ and $\alpha = 2$. All these equations fall under the name of the fractional reaction-diffusion/wave equation (see table 1).

Obviously, the development of accurate mathematical models for the description of complex anomalous systems depends on swapping the fractional Laplacian with integer-order Laplacian, e.g.

Fractional equation	Formula
Reaction-diffusion/wave [3–10]	$\partial_t^\alpha u + \kappa^2 (-\Delta)^s u + c(t,x)\, u = 0$
Quasi-geostrophic [11]	$\partial_t v + \theta . \bigtriangledown v + \kappa (-\Delta)^s v = f$
Cahn-Hilliard [12–14]	$\partial_t w + (-\Delta)^s \left(-\varepsilon^2 \Delta w + f(w)\right) = 0$
Porous medium [12–15]	$\partial_t u + (-\Delta)^s \left(\lvert u\rvert^{m-1} \operatorname{sign} u\right) = 0$
Schrödinger [16]	$i\hbar \partial_t \psi = \partial_t^\alpha \left(-\hbar^2 \Delta\right)^s \psi + c(t,x)\, \psi$
Ultrasound [17, 18]	$\frac{1}{c_0^2} \partial_t^2 \theta = \nabla^2 \theta - \left\{ \tau \partial_t (-\Delta)^s + \eta (-\Delta)^{s+\frac{1}{2}} \right\} \theta$

Table 1: Significant equations involving fractional Laplacian

1.2 Problem statement and main results

Let $0 < s \leq 1$, $1 < \beta \leq \alpha \leq 2$, $\varepsilon, \ell > 0$, and $T_\varepsilon = \ell \varepsilon^{\frac{2}{\alpha}}$ be such that $\Omega = [0, T_\varepsilon] \times [\varepsilon/\sqrt{m}, +\infty)^m$. We consider:

$$\begin{cases} \partial_t^\alpha u - \kappa^2 \Delta u = F\left(t, x, u, \partial_t^\beta u, (-\Delta)^s u\right), & (t,x) \in \Omega,\ \kappa \in \mathbb{R}^*, \\ u(0,x) = \lvert x\rvert^\delta u_0,\ \frac{\partial u}{\partial t}(0,x) = 0, & \delta, u_0 \in \mathbb{C}, \end{cases} \tag{2}$$

where $F : \Omega \times \mathbb{C} \times \mathbb{C} \times \mathbb{C} \to \mathbb{C}$ is a nonlinear function.

This paper's contribution regards determining the existence, uniqueness, and main properties of the general solution of stability problems obtained through replacing classical rules with fractional quadrature rules of the radially symmetric solution (see [3–7, 19–21]),

$$u(t,x) = \lvert x\rvert^\delta f\left(\lvert x\rvert^{-\frac{2}{\alpha}} t\right), \text{ for } \lvert x\rvert = \sqrt{x_1^2 + \cdots + x_m^2}, \text{ and } \delta \in \mathbb{C}, \tag{3}$$

the basic profile f is not known in advance and is to be identified.

For the forthcoming analysis, we impose the following hypotheses:

(*hyp*.1) $F : \Omega \times \mathbb{C} \times \mathbb{C} \times \mathbb{C} \to \mathbb{C}$ is a continuous function that is invariant by the change of scale (3). It gives us:

$$F\left(t, x, u, \partial_t^\beta u, (-\Delta)^s u\right) = \lvert x\rvert^{\delta - 2} \left(J\left(\eta, f(\eta), f'(\eta), {}^C\mathcal{D}_{0^+}^\beta f(\eta)\right) - \frac{4\kappa^2}{\alpha^2} \eta^2 f''(\eta) \right), \tag{4}$$

where $\eta = \lvert x\rvert^{-\frac{2}{\alpha}} t$ and $J : [0, \ell] \times \mathbb{C} \times \mathbb{C} \times \mathbb{C} \to \mathbb{C}$ is a continuous function.

(*hyp*.2) There exist three positive constants $\omega_1, \omega_2, \omega_3 > 0$ so that the continuous function J given by (4) satisfies:

$$\left| J(\eta, f, g, h) - J\left(\eta, \tilde{f}, \tilde{g}, \tilde{h}\right) \right| \leq \omega_1 \left| f - \tilde{f} \right| + \omega_2 \lvert g - \tilde{g}\rvert + \omega_3 \left| h - \tilde{h} \right|,$$

for any $f, g, h, \tilde{f}, \tilde{g}, \tilde{h} \in \mathbb{C}$.

(*hyp*.3) There exist four positive functions $a, b, c, d \in C\left([0,\ell], \mathbb{R}_+\right)$ such that the continuous function J given by (4) satisfies:

$$|J(\eta, f, g, h)| \leq a(\eta) + b(\eta)|f| + c(\eta)|g| + d(\eta)|h|,$$

for any $f, g, h \in \mathbb{C}$ and $\eta \in [0,\ell]$.

λ denotes the positive constant defined by

$$\lambda = \max\left\{\frac{\alpha\ell^{\beta-1}(|q| + c^*) + d^*}{\ell^{\beta-\alpha}\Gamma(\alpha-\beta+1)}, \frac{\alpha\ell^{\beta-1}(|q| + \omega_2) + \omega_3}{\ell^{\beta-\alpha}\Gamma(\alpha-\beta+1)}\right\},$$

where $q = -\frac{2\kappa^2}{\alpha^2}(\alpha(2\delta + m + 2) + 2)$ and

$$a^* = \sup_{\eta\in[0,\ell]} a(\eta),\ b^* = \sup_{\eta\in[0,\ell]} b(\eta),\ c^* = \sup_{\eta\in[0,\ell]} c(\eta) \text{ and } d^* = \sup_{\eta\in[0,\ell]} d(\eta).$$

Now, we give the main theorems of this work.

Theorem 1. *Assume the hypotheses* (*hyp*.1)–(*hyp*.3) *hold. If we put* $\lambda \in (0,1)$ *and*

$$\frac{T_\varepsilon^\alpha\left(\left|\delta\kappa^2(\delta + m - 2)\right| + b^*\right)}{\Gamma(\alpha+1)(1-\lambda)} < \varepsilon^2, \tag{5}$$

then, there is at least one solution to the problem (2) on Ω *in the radially symmetric form (3).*

Theorem 2. *Assume the hypotheses* (*hyp*.1), (*hyp*.2) *hold. We give* $\lambda \in (0,1)$ *and*

$$\mathcal{K} = \left(\frac{\Gamma(\alpha+1)(1-\lambda)}{|\delta\kappa^2(\delta + m - 2)| + \omega_1}\right)^{\frac{1}{\alpha}}.$$

If we put

$$T_\varepsilon < \varepsilon^{\frac{2}{\alpha}}\mathcal{K}, \tag{6}$$

then the problem (2) admits a unique solution in the radially symmetric form (3) on Ω.

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Programme-23rd IPMC 2023

Kar Peng Shum Day

Professor Kar Peng Shum (02.01.1940 – 08.06.2023)
He was Honorary Director of the Institute of Mathematics at Yunnan University Kunming, PRC. He will be remembered not only for his remarkable achievements and dedication to the field of mathematics but also for his genuine passion for promoting education around the world. He has collaborated in research with leading experts in his field, in particular, Yonghua Xu, Leonid A. Bokut, B.H. Neumann, Cong Xin Wu, Liang Zhang, Ann Chi Kim and Qaiser Mushtaq. He visited Pakistan three times for the IPMC on the invitation of Professor Qaiser Mushtaq.

Saturday 26th August 2023, Face-to-Face

09:00 – 09:10	**Recitation**
09:10 – 09:30	**Inaugural Speech** **Emeritus Professor Dr. Qaiser Mushtaq, Quaid-i-Azam University, Islamabad** **Convener 23rd IPMC 2023**
09:30 – 09:50	**Introduction to the IPMC Series** **Dr. Muhammad Sarwar Saeed, Secretary Organizing Committee, IPMC**
09:50 – 10:10	**Chief Guest Speech** **Professor Dr. Niaz Ahmad Akhtar (Sitara-i-Imtiaz)** **Vice Chancellor, Quaid-i-Azam University, Islamabad**
	Short Break
10:20 – 10:40	**Dr. Tahir Mahmood, International Islamic University, Islamabad** Fuzzy Sets and Their Applications in Group Theory
10:50 – 11:10	**Dr. Shahida Bashir, University of Gujrat, Gujrat** An Efficient Model for the Approximation of Intuitionistic Fuzzy Sets in terms of Soft Relations with Applications in Decision Making
11:20 – 11:40	**Dr. Muhammad Javaid, University of Management and Technology, Lahore** On Fractional Metric Dimensions of Connected Graphs
11:50 – 12:10	**Dr. Khizar Hayat, University of Kotli, AJ&K** Type-2 Soft Graphs
12:20 – 12:40	**Dr. Amna Kalsoom, International Islamic University, Islamabad** Fixed Point Property for Semitopological Semigroups
12:50 – 13:50	**Lunch Break**
14:00 – 14:40	**Keynote Lecture** **Emeritus Professor Dr. Qaiser Mushtaq, Quaid-i-Azam University, Islamabad** Coset Diagrams for the Modular Group
14:50 – 15:10	**Dr. Muhammad Naseer Khan, Govt. Postgraduate College Rawalakot AJ & K** The Structures of Path Coalgebra of a Weak Hopf Quiver
15:20 – 15:40	**Dr. Usman Ali, University of Management and Technology, Lahore** Computing Zagreb Connection Indices of the Cartesian Product for Molecular Networks
15:50 – 16:10	**Mr. Syed Sikander Shirazi, Muhammad Ali Jinnah University, Karachi** Jensen-Steffensen, Jensen-Mercer and Niezgoda's Inequalities for Convexifiable Functions with Applications
16:20 – 16:40	**Dr. Kifayat Ullah, Riphah International University, Lahore Campus** Spherical and T-Spherical Fuzzy Sets for Decision Making Problems
	Tea

M. M. Deza Day

Professor Michel Marie Deza (27.04.1939 – 23.11.2016)
He was an eminent Professor of mathematics specializing in combinatorics, discrete geometry and graph theory. He retired as a Director of the famous French National Centre for Scientific Research (CNRS). Professor Deza visited Pakistan for IPMC twice on the invitation of Professor Qaiser Mushtaq.

Sunday, 27th August 2023-Online

08:50 – 09:00	**Welcome address by the Convener of the 23rd IPMC 2023** **Emeritus Professor Dr. Qaiser Mushtaq, Quaid-i-Azam University, Islamabad**		
09:00 – 09:40	**Keynote Lecture** **Professor Khalik Guseinov, Eskisehir Technical University, Turkiye** Continuity of L_p Balls and an Application to Input-Output System Described by the Urysohn Type Integral Operator		
09:50 – 10:30	**Keynote Lecture** **Dr. Loredana Simcic, University of Rijeka, Croatia** Uniqueness of a Generalized Solution for a Micropolar Real Gas Flow with Spherical Symmetry		
	Channel A	**Channel B**	**Channel C**
10:40 – 11:00	**Dr. Maram Alossaimi** The Poisson spectrum of a class of Poisson algebras	**Miss Sabah Baibeche** Numerical analysis for nonlinear wave equations with micro temperatures	**Dr. Rebiha Benterki** Phase portraits of of Piecewise differential Systems with a Pseudo equilibria
11:05 – 11:25	**Dr. Milica Kolundžija** The generalization of Sherman-Morrison-Woodbury formula for the generalized Drazin inverse	**Miss Abibssi Imane** Existence of mild solutions for second order partial functional perturbed pseudo integro-differential with finite state dependent delay	**Mrs. Nardjis Lachachi** Mild Solutions For Perturbed Partial Evolution Equations with Finite State-Dependent Delay involving Caputo's Fractional order Derivative
11:30 – 11:50	**Dr. Saima Mustafa** Subclasses of Analytic functions based on Hpergeometric and Cho-Kwon-Srivastava Operators	**Dr. Rebiha Saffidine** Necessary and Sufficient condition for observability of a class of hybrid control systems	**Mr. Babar Sultan** Boundedness of fractional integrals on grand weighted Herz spaces with variable exponent
11:55 – 12:15	**Mrs. MA Mateos Camacho** Some results of the Total Triple Roman Domination in Graphs	**Dr. Lila Ihaddadene** On the stabilization of an Navier's elastic model for thin plates	**Mr. Ibrahim Merabet** Open Problem in the Calculus Of Variations
12:20 – 12:40	**Dr. Ammara Nosheen** Interval valued Jensen's inequalities for h-convex functions on time scales	**Dr. Kheireddine Biroud** Nonlocal Elliptic Systems with Gradient Source Terms	**Miss Hayat Bensella** On diophantine equation related to linear reccurent sequences and Baker's method
12:45 – 13:00	**Dr. Mehamdia Abd elhamid** Extension of modified Hestenes-Stiefel conjugate gradient method to non para-metric estimation	**Ms Nour Elhouda Allaoui** Existence and regularity of Pseudo-monotone operator with irregular data	**Miss INES GARTI** Well-posedness of solutions for the generalized Boussinesq equations
13:00 – 14:00	**Break**		

14:00 – 14:40	**Keynote Lecture** **Professor Anita Tomar, Sri Dev Suman Uttarakhand University, India** Some Recent Applications of Fixed Points and Fixed Figures		
14:50 – 15:30	**Keynote Lecture** **Dr. Ozen Ozer, Kırklareli University, Turkiye** On the Benefits of Diophantine Equations and Some Particular Types with New Perspections' Solutions		
	Channel A	**Channel B**	**Channel C**
15:40 – 16:00	**Dr. Abid Ali** Integral subgroups of Kac-Moody groups	**Dr. Zaamoune Faiza** Extended Maximum Attractor Range to Multispirals Chaotic Attractors in Chua's system	**Miss Zahra Ameur** Some results concerning the Diophantine equation $(x^n - 1)(y^m - 1) = z^2$
16:05 – 16:25	**Dr. Irfan Younas** Presentations and Graphs of Inverse LA-semigroups	**Dr. Mebarki Maroua** Study of reaction diffusion system with diagonal matrix	**Dr. Benseghir Aissa** Study of the asymptotic behavior of a frictionless contact problem
16:30 – 16:50	**Dr. Muhammad Nazam** On Orthogonal Interpolative Iterative Mappings with Applications in Multiplicative Calculus	**Dr. Raouf Ziadi** A covering method combined with the Hook-Jeeves algorithm for continuous global optimization problems	**Miss Bouacida Ichrak** Approximate Controllability of Sobolev Type (k, ψ)-Hilfer Fractional Integro-Differential Equations In Hilbert Space
16:55 – 17:15	**Dr. Tabchouche Nesrine** Primal-Dual Interior Point Methods for SDLCP Based on a New Type of Kernel Functions	**Dr. Helal Mohamed** Perturbed Hadamard Fractional Integral Equations in Fréchet Spaces	**Miss Besma Laouadi** A Proposed Coincidence Point Theorem Using C-Class Function
17:20 – 17:30	**Dr. Mehsin Jabel Atteya** Notes on Multiplicative Generalized (σ, τ)-Reverse Derivations with Lie Ideals of Semiprime ⋆-Rings	**Dr. Zakia Tebba** Result of global existence and finite time blow-up in a new class of non-linear viscoelastic wave equation	**Miss Samiha Djemai** Pattern formation in reaction-diffusion system

I.B.S. Passi Day

Professor I.B.S. Passi (20.08.1939 – 02.10.2021)
He was an eminent mathematician who specialized in group theory. He was a doctoral student of David Rees. After retiring as a Dean, he was appointed as an Emeritus Professor at Punjab University, India. His results on the dimension subgroups, augmentation powers in group rings received wide recognition. He visited Pakistan for IPMC on the invitation of Professor Qaiser Mushtaq.

Monday, 28th August 2023-Online

09:00 – 09:40	**Keynote Lecture** **Dr. Taras Goy, Vasyl Stefanyk Precarpathian National University, Ukraine** Lucas Identities Using the Generalized Trudi Formula		
09:50 – 10:30	**Keynote Lecture** **Dr. Ferit Gurbuz, Kırklareli University, Turkiye** Variable Exponent Vanishing Morrey Type Spaces on Unbounded Domains		
	Channel A	**Channel B**	**Channel C**
10:40 – 10:55	**Dr. Ashar Ghulam** Constructing an example of a Fractal	**Miss Mehvish Sultan** Grand weighted Herz spaces	**Mr. Mbekezeli Nxumalo** On open maps over the Salbany compactification
11:00 – 11:15	**Dr. Harrouche Nesrine** Hilbert solution of fuzzy fractional boundary value problems	**Dr. Khalil Ahmad** New Exact Solutions of Burgers' Equation Using Power Index Method	**Ms Imane Ouakil** Solvability of frictional contact problem for viscoelastic materials
11:20 – 11:35	**Dr. Farheen Ibraheem** Supervised Computing Algorithm for Predicting Data Patterns	**Mr. Jabbar Ahmad** T-bipolar soft rings and their algebraic properties	**Mr. Muhammad Bilal** Some inequalities related to Csiszár divergence via diamond integral on time scales
11:40 – 11:55	**Dr. Djamel Abid** Existence Result For A Fractional Elliptic Problem Involving Critical Exponent Via Nehari Manifold	**Ms Marwa Khemis** Existence and uniqueness results of a neutral iterative differential equation via Krasnoselskii's fixed point theorem	**Mr. Youssouf Mezzar** Converting linear systems into matrix equations and vice versa using Kronecker sum decomposition
12:00 – 12:15	**Dr. Tehreem** Multigranulation Roughness in Semihypergroups	**Ms Asma Hammou** Duality in Spaces of p-Nuclear Operators	**Ms Meriem Chabekh** Discrete Energy Behavior of a Bresse-Timoshenko System
12:20 – 12:35	**Miss Roufaida Ketfi** Asymptotic analysis of solutions to the problem $\varepsilon^2\Delta u + \lambda u = F(u)$ on a ring in R^n	**Mr. Hassan Messaoudi** Long-time behavior of the solution of the nolinear piezoelectric beam system	**Miss Ikram Hamed** Risk-Neutral for System Driven by Fractional Brownian Motion
12:40 – 12:55	**Dr. Radhouane Aounallah** Global Existence and Energy Decay Analysis of a Timoshenko Beam System with Internal Fractional Feedback: A Lyapunov-based Approach	**Dr. Semmar Billel** Dynamical Analysis of a New Three-Dimensional Lotka-Volterra Mode with Incommensurate Conformable Fractional Order	**Mr. Sami Loucif** Exponential stability of some evolution problems with thermal effect and distributed delay
13:00 – 14:00	**Break**		

14:00 – 14:40	**Keynote Lecture** **Prof. Shi Yin, Hebei Agricultural University, China** Artificial intelligence-driven bioenergy system: Digital green innovation partner selection of bioenergy enterprises based on interval fuzzy multi-criteria decision making		
14:50 – 15:30	**Keynote Lecture** **Professor Vijay Kumar, Manav Rachna International Institute of Research & Studies, Faridabad, India** Generalized Theorem for 0-Cauchy Completion in Partial Fuzzy Metric Space		
	Channel A	**Channel B**	**Channel C**
15:40 – 15:55	**Dr. Bilal Basti** A hybrid model for a class of multidimensional nonlinear free energy equations	**Miss Nawal Bettayeb** On Caputo Tempered Fractional Differential Equations	**Mr. Mohammed Amine Benmelouka** An abstract approach for the study of an elliptic problem
15:55 – 16:10	**Mr. Ubaid ur Rehman** Bipolar Complex Fuzzy Linguistic set	**Prof. Mohamed Dalah** An implicit scheme for the fractional advection equation : Codes Matlab	**Dr. Djamila Benterki** The existence of solutions of nonlinear Mindlin-Timoshenko with thermodifusion effects
16:10 – 16:25	**Mrs. Lina Chetioui** Numerical solution of general fractional Riccati differential equation	**Ms Chaima Saadi** Existence results for non-linear fractional problem involving a distributional Riesz gradient	**Dr. Selmani Wissame** Attractors and Strange Attractors
16:25 – 16:40	**Miss Lynda Mezghiche** New results for a housefly model with iterative source term	**Dr. Nazeran Idrees** Distance Two Labeling of Olive tree, W-graph and H-graph	**Dr. Kaid Mohammed** Existence of solution for nonlinear FDEs
16:40 – 16:55	**Dr. Munir Ahmed** Weak Hopf Algebra and Kaplansky's Sixth Conjecture	**Kainat Naeem** Advancing Convex Optimization: Modern and Current Evolution and Future Directions	
Conclusion			

NOTE: There are three parallel channels of talks.

Talks including keynote lectures listed in the column colored blue will be held in Channel A

Talks listed in the column colored red will be held in Channel B

Talks listed in the column colored green will be held in Channel C