PROFESSOR SUDIPTA DUTTA'S SYMPOSIUM 5TH NOVEMBER 2022

5th November, 2022

List of Speakers

1. Prof T.S.S. R. K. Rao (Shiv Nadar Univ)
2. Prof. P. Shunmugaraj (IIT Kanpur)
3. Prof. Pradipta Bandyopadhya (ISI Kolkata)
4. Prof. Abdullah Bin Abu Baker (IIIT Allahabad)
5. Dr. Aryaman Sensarma (ISI Bangalore)
6. Prof. Divya Khurana (IIM Ranchi)

Title and Abstract

1. Title : **On two results of Sudipta that had profound influence on developments in geometry of Banach spaces in the past decade.**
   Speaker ; T. S. S. R. K. Rao (SNU, Delhi)
   Abstract: In this talk I am going to outline the progress made on two problems that emanate from the joint work of Sudipta, with our colleagues Pradipta and Narayana from his papers from HJM and Colloquium. These problems come from two different areas, one dealing with almost constrained subspaces and the other dealing with strongly proximal subspaces.

2. Title:**Some geometric and proximinality aspects in Banach spaces.**
   Speaker: P. Shunmugaraj (IIT Kanpur)
   Abstract: Characterizations of some geometric properties in terms of some proximinality aspects will be presented.

3. Title: **A modulus inspired by Sudipta**
   Speaker: Pradipta Bandyopadhyay (ISI Kolata)
   Abstract: Taking cue from the modulus of denting points defined by Dutta & Lin, we define a modulus of semidenting points and characterise the Mazur Intersection Property (MIP) and Uniform MIP in terms of this modulus. We expect this will be a step towards the open problem of whether UMIP implies superreflexivity. This is a work in progress.

4. Title : **Numerical Index of Some Classes of Subspaces of Vector-Valued Function Spaces**
   Speaker: Abdullah Bin Abu Baker (IIIT Allahabad)
   Abstract

   The numerical index of a Banach space is a constant relating the norm and the numerical range of operators on the space. This concept was first introduced by G. Lumer in 1968. In this talk, we shall discuss the relationship between the numerical index of a Banach space E and the numerical index of some classes of subspaces of $C(\Omega, E)$, the space of all continuous E-valued functions defined on a compact Hausdorff topological space Ω. The classes considered satisfy an invariance condition and norm attaining condition proposed by Professor James Jamison. As an application, we will prove that the numerical indices of three types of vector-valued function spaces are less than the numerical index of the respective range spaces. This is a joint work with Fernanda Botelho.

5. Title: **A BISHOP-PHELPS-BOLLOBÁS THEOREM FOR BOUNDED ANALYTIC FUNCTIONS**
Speaker: Aryaman Sensarma (ISI Bangalore)
Abstract The Bishop-Phelps-Bollobás property talks about the denseness of norm attaining operators from X into itself in the Banach space of all bounded linear operators from X into itself, that is, $\overline{\mathcal{NA}(X)} = \mathcal{B}(X)$, where X is a Banach space. In general, it is not true. The first counterexample was observed by J. Lindenstrauss (1963). Afterward, this question has been investigated in several Banach Spaces. Let $H^\infty(\mathbb{D})$ be the commutative Banach algebra of all bounded analytic functions on the open unit disc. In this talk, we present that the Bishop-Phelps-Bollobás property holds for $\mathcal{B}(H^\infty(\mathbb{D}))$. As an application, we also discuss about the Bishop-PhelpsBollobás property for operator ideals of $\mathcal{B}(H^\infty(\mathbb{D}))$. This is joint work with Dr. Neeru Bala, Dr. Kousik Dhara, and Prof. Jaydeb Sarkar.

6. **Approximate smoothness in normed linear spaces**
Speaker: Divya Khurana (IIM Ranchi)
Abstract: We introduce the notion of approximate smoothness in a normed linear space. We characterize this property and show the connections between smoothness and approximate smoothness for some spaces. As an application, we consider in particular the Birkhoff-James orthogonality and its right-additivity under the assumption of approximate smoothness. This is a joint work with J. Chmieliński and D. Sain.

PROFESSOR PRAVIR DUTT'S SYMPOSIUM

6th November 2022

List of Speakers

1. Prof. S C S Rao (IIT Delhi)
2. Prof. Arbaz Khan (IIT Roorkee)
3. Prof. Subhashree Mohapatra (IIIT Delhi)
4. Prof. K.K. Naraparaju (BITS-Pilani Hyderabad Campus)
5. Prof. L. K. Balyan (IIITDM Jabalpur)
6. Prof. Akhalaq Husain (BML Munjal University)
7. Prof. Peeyush Singh (VIT-AP)

Title and Abstract

1. Title: **Parallel computation of block tridiagonal toeplitz-block-toeplitz linear systems**
   Speaker: S C S Rao (IIT Delhi)
   Abstract: Toeplitz-block-toeplitz linear systems arise in many fields of science and engineering, for example, signal and time series analysis, interpolation problems, and in numerical solutions of initial and boundary value problems. We present a direct parallel block W Z algorithm, named DPBWZA, for the solution of block tridiagonal toeplitz?block?toeplitz (TBT) linear system Ax = f. The algorithm is based on the proposed block WZ factorization of the coefficient matrix A. Existence of the block WZ factorization for block tridiagonal TBT block diagonally dominant matrix is proved. Error analysis of the parallel algorithm DPBWZA is presented and numerical stability of the algorithm is established. Numerical experiments are conducted to demonstrate the efficiency, stability, and accuracy of the Direct Parallel Block WZ Algorithm on the GPU platform. Forward and backward errors are computed and DPBWZA is found to be highly accurate, numerically stable, and as efficient as the subroutine csrlsvlu of GPU accelerated cuSolverSP library.

2. Title: **Stochastic Galerkin Mixed FEM for nearly incompressible linear elasticity equations with uncertain inputs.**
   Speaker: Arbaz Khan (IIT Roorkee)
   Abstract: It is the aim of this talk to give an overview of some recent work [1], [2] on the use of stochastic Galerkin mixed finite element methods(SG-MFEMs) for parameter-dependent linear elasticity equations. Starting from a novel three-field PDE model in which the Young's modulus is represented as an affine function of a finite/countable set of parameters, we discuss SG-MFEM approximation and introduce a novel a posteriori error estimation scheme. We examine the error in the natural weighted norm with respect to which the weak formulation is stable. Exploiting the connection between this norm and the underlying PDE operator also leads to an efficient preconditioning strategy for the associated discrete problems. Unlike standard residual-based error estimation schemes, the proposed strategy requires the solution of auxiliary problems on carefully constructed detail spaces on both the spatial and parameter domains. We show that the proposed error estimator is reliable and efficient. The constants in the bounds are independent of the Poisson ratio as well as the SG-MFEM discretisation parameters, meaning that the estimator is robust in the incompressible limit. Finally, we also discuss proxies for the error reduction associated with potential enrichments of the SG-MFEM spaces and suggest how to use these to develop an adaptive algorithm that terminates when the estimated error falls below a user-prescribed tolerance.

3. Title: **Least-squares formulations for Stokes equations with non-standard boundary conditions - A unified approach**

Speaker: Subhashree Mohapatra (IIIT Delhi)
Abstract: Here we propose a unified non-conforming least-squares spectral element approach for solving Stokes equations with various non-standard boundary conditions. Existing least-squares formulations mostly deal with Dirichlet boundary conditions and are formulated using ADN theory-based regularity estimates. However, changing boundary conditions lead to a search for parameters satisfying supplementing and complimenting conditions which are not easy always. Here we have avoided ADN theory-based regularity estimates and proposed a unified approach for dealing with various boundary conditions. Stability estimates and error estimates have been discussed. Numerical results displaying exponential accuracy has been presented for both two and three-dimensional cases with various boundary conditions.

4. Title: **Tensor decompositions and applications**
Speaker: K.K. NARAPARAJU (BITS-Pilani Hyderabad Campus)
Abstract: A tensor is a multidimensional array (for example a matrix is a tensor of order 2). Tensors often arise from the discretizations of multidimensional functions that are involved in the numerical treatment of complex problems in many different areas of natural, financial, or social sciences. The direct numerical treatment of these arrays leads to serious problems like memory requirements and the complexity of basic operations (they grow exponentially in d). In the last decade, the approximation of multidimensional arrays has become a central issue in approximation theory and numerical analysis. The main idea of the approximation of a tensor is decomposing the given tensor as sums of outer products of vectors. In the language of functions, it is an approximation of multivariable functions by sums of products of univariate functions. Tensor decompositions have a lot of applications in image processing, quantum chemistry, data mining, machine learning, stochastic partial differential equations, etc. In the matrix case (i.e tensor of order 2), the singular value decomposition SVD represents a matrix as the sum of the outer product of vectors. SVD algorithm requires arithmetic operations (if the matrix is of size). So it is very expensive when the matrix dimensions are large. Various inexpensive techniques of low-rank approximation based on skeleton/cross approximation are available in the literature. SVD and its applications, other low-rank approximation techniques like RRQR, Interpolative decomposition, randomized algorithms, skeleton/cross approximation techniques will be discussed in the talk. Canonical, Tucker, Tensor Chain and Tensor Train formats for higher-order tensors and their applications will be introduced.

5. Title: **hp-spectral element methods for elliptic boundary layer problems**
Speaker: Akhalaq Husain (BML Munjal University)
Abstract: Elliptic boundary layer problems arise in many applications including fluid dynamics (e.g., the flow of water on the skin of a submarine, oceanic currents), gas dynamics (e.g., the flow of air on the surface of an aircraft wing), plate and shell problems in structural mechanics, modeling of semiconductor devices and many more.
We propose a least-squares hp-spectral element method for elliptic boundary layer problems on smooth domains. The regularity estimates are stated and the main stability theorem is obtained using non-conforming spectral element functions. We use fitted mesh which allows us to resolve the boundary layers completely by using very refined mesh near the boundary and a coarse mesh away from the boundary. A robust preconditioner is constructed using the stability estimates to control the condition number for the normal equations arising from the least-squares formulation. We formulate the numerical scheme and obtain robust error estimates which are independent of the boundary layer parameter and decay exponentially in terms of the degree of the approximating polynomials. Numerical results confirm convergence results with various combinations of the boundary layer thickness, degrees of the approximating polynomials, and layers in the mesh.

6. Title: **High order numerical scheme for reaction diffusion equations and applications in signal processing**
Speaker L. K. Balyan (IIITDM Jabalpur)
Abstract: Someone said there is no satisfaction in formulas unless achieving their numerical magnitude. Therefore, high-order numerical methods for the solution of partial differential equations are attracting researchers over the globe. We know low-order methods are like the chrysalis of a butterfly and inside every low-order program, a high-order algorithm waiting to burst. So, in this talk, the spectral methods, which are known as a global approach method and an alternative of Finite Difference Methods and Finite Element Methods, will be discussed. Its fascinating merit is the high accuracy and convergence of infinite order. The talk

is organized in two parts. Pseudospectral approximation for nonlinear reaction-diffusion equations with suitable initial and boundary conditions will be discussed first. The method is employed in both time and space at Chebyshev collocation points and achieved highly accurate and stable numerical results for very large reaction coefficients. Next, the method is extended for discontinuous functions where high-frequency non-diminishing oscillations occur in the neighbourhood of a discontinuous point, which leads to the deterioration of the convergence rate. To demonstrate the performance, the method is implemented for discontinuous functions, and further, from an application point of view, the technique is implemented for noise-corrupted signals where reconstructed data is interrupted by unwanted interferences in the form of factitious oscillations.

7. Title: **Fully parallelized algorithm for solving elastohydrodynamic lubrication (EHL) problems**
Speaker: Peeyush Singh (VIT-AP)
Abstract: The present talk is focused upon the numerical solution of highly nonlinear integro-differential equations that appear in the area of Elasto-hydrodynamic lubrication (EHL). This work is an extension of previous work which is only partially parallelized due to the nonlocal behaviour of the film-thickness term appearing in the partial differential operator of the Reynolds equation in the EHL model. The main challenge in the EHL problem for dealing with the lm thickness part in terms of computational storage as well as computer complexities. A fully systematic parallel algorithm is developed with help of a projected alternate quadrant interlocking factorization method (PAQIF) for solving band matrix appears during the inner iteration process of the Reynolds equation while the film thickness computation treatment is based on the MPI model, which is able to effectively balance the load as well as bring great reduction on message passing.

PROFESSOR ARVIND LAL'S SYMPOSIUM

7th November 2022

List of Speakers

1. Prof. Sukanta Pati (IIT Guwahati)
2. Prof. Sivaramakrishnan Sivasubramanian (IIT Bombay)
3. Prof. Kamal L. Patra (NISER Bhubaneswar)
4. Prof. Bikas Bhattacharjya (IIT Guwahati)
5. Prof. Sumit Mohanty, (IIM Ranchi)
6. Prof. S. Reddy (Shiv Nadar Univ)

Title and Abstract

1. Title: **Some observations on algebraic connectivity of graphs**
   Speaker: Sukanta Pati (IIT Guwahati)
   Abstract: Let G be a connected simple graph and $L(G)$ be its Laplacian matrix. Let v be a cut vertex and B be a branch at v. Assume that v_1 is the only vertex in B adjacent to v. Let P be a path that starts at v_1 while staying inside B. It is shown that the algebraic connectivity decreases if we do an appropriate sliding operation along the path. Similar results for trees were known decades ago. This general result was believed to be true, but it was never established
   This is a joint work with R.B. Bapat and A.K. Lal

2. Title: **Inequalities among two rowed immanants of the q-Laplacian of Trees and Odd height peaks in generalized Dyck paths**
   Speaker: Sivaramakrishnan Sivasubramanian, IIT Bombay
   Abstract: Let T be a tree on n vertices and let $\mathcal{L}_q^T$ be the q-analogue of its Laplacian. For a partition $\lambda \vdash n$, let the normalized immanant of $\mathcal{L}_q^T$ indexed by λ be denoted as $\overline{\mathrm{Imm}}_\lambda(\mathcal{L}_q^T)$. A string of inequalities among $\overline{\mathrm{Imm}}_\lambda(\mathcal{L}_q^T)$ is known when λ varies over hook partitions of n as the size of the first part of λ decreases. In this work, we show a similar sequence of inequalities when λ varies over two row partitions of n as the size of the first part of λ decreases. Our main lemma is an identity involving binomial coefficients and irreducible character values of $\mathfrak{S}_n$ indexed by two row partitions.

   Our proof can be interpreted using the combinatorics of Riordan paths and our main lemma admits a nice probabilisitic interpretation involving peaks at odd heights in generalized Dyck paths or equivalently involving special descents in Standard Young Tableaux with two rows. As a corollary, we also get inequalities between $\overline{\mathrm{Imm}}_{\lambda_1}(\mathcal{L}_q^{T_1})$ and $\overline{\mathrm{Imm}}_{\lambda_2}(\mathcal{L}_q^{T_2})$ when T_1 and T_2 are comparable trees in the GTS_n poset and when λ_1 and λ_2 are both two rowed partitions of n, with λ_1 having a larger first part than λ_2.

   This is joint work with Arbind K Lal and Mukesh K Nagar.

3. Title **H-integral and Gaussian integral normal mixed Cayley graphs**
   Speaker: Bikash Bhattacharjya, IIT Guwahati
   (A Joint work with Monu Kadyan)
   Abstract: If all the eigenvalues of the Hermitian-adjacency matrix of a mixed graph are integers, then the mixed graph is called *H-integral*. If all the eigenvalues of the (0,1)-adjacency matrix of a mixed graph are *Gaussian integers*, then the mixed graph is called *Gaussian integral*. In this talk, we characterize the set S for which the normal mixed Cayley graph $\mathrm{Cay}(\Gamma, S)$ is H-integral, where Γ is a finite group. We further prove that a normal mixed Cayley graph is H-integral if and only if the mixed graph is Gaussian integral.

4. Title: **On the super graphs and reduced super graphs of some finite groups**
Speaker: Kamal L. Patra(NISER Bhubaneswar)
Abstract: For a finite group G, let B be an equivalence (equality, conjugacy or order) relation on G and let A be a (power, enhanced power or commuting) graph with vertex set G. The B super A graph is a simple graph with vertex set G and two vertices are adjacent if either they are in the same B-equivalence class or there are elements in their B-equivalence classes that are adjacent in the original A graph. The graph obtained by deleting the dominant vertices (adjacent to all other vertices) from a B super A graph is called the reduced B super A graph.

   In this talk, we discuss about the characterization of finite groups for which a pair of B super A graphs are equal. We also discuss the dominant vertices for the order super commuting graph of G and study the same for some for the groups S_n and A_n. The connectedness and diameter for the reduced order super commuting graphs of S_n and A_n will also be discussed.

5. Title: **On Squared Distance Matrix of Complete Multipartite Graphs**
Speaker: Sumit Mohanty (IIM Ranchi)

   Abstract:. Let $G = K_{n_1,n_2,\cdots,n_t}$ be a complete t-partite graph on $n = \sum_{i=1}^{t} n_i$ vertices. The distance between vertices i and j in G, denoted by d_{ij} is defined to be the length of the shortest path between i and j. The squared distance matrix $\Delta(G)$ of G is the $n \times n$ matrix with $(i,j)^{th}$ entry equal to 0 if $i = j$ and equal to d_{ij}^2 if $i \neq j$. We define the squared distance energy $E_\Delta(G)$ of G to be the sum of the absolute values of its eigenvalues. We determine the inertia of $\Delta(G)$ and compute the squared distance energy $E_\Delta(G)$. More precisely, we prove that if $n_i \geq 2$ for $1 \leq i \leq t$, then $E_\Delta(G) = 8(n-t)$ and if $h = |\{i : n_i = 1\}| \geq 1$, then

$$8(n-t) + 2(h-1) \leq E_\Delta(G) < 8(n-t) + 2h.$$

   Furthermore, we show that for a fixed value of n and t, both the spectral radius of the squared distance matrix and the squared distance energy of complete t-partite graphs on n vertices are maximal for complete split graph $S_{n,t}$ and minimal for Turán graph $T_{n,t}$.
   Joint work with Joyentanuj Das

6. Title: **Cyclotomic factors of Borwein polynomials**
Speaker: A. Satyanarayana Reddy (Shiv Nadar University)
Abstract: We call $f(x) \in \mathbb{Z}[x]$ a Borwein polynomial if all its coefficients belong to $\{-1, 0, 1\}$ and $f(0) \neq 0$. In this work we study the Borwein polynomials divisible by cyclotomic polynomials. During my Ph.D in [1, 2] we studied polynomials with integer coefficients divisible by cylcotomic polynomials. The work in [3–5] is a continuation of the same.

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[1] A.Satyanarayana Reddy, Shashank K Mehta and A.K.Lal, *Representation of Cyclotomic Fields and their Subfields*, Indian J. Pure Appl. Math., 44(2)(2013),203–230.

[2] A.K.Lal and A.Satyanarayana Reddy, *Non-singular circulant graphs and digraphs*, Electronic Journal of Linear Algebra, Volume 26,(2013), 248–257.

[3] Biswajit Koley, A.Satyanarayana Reddy, *Cyclotomic factors of Borwein polynomials*, The Bulletin of the Australian Mathematical Society, Vol. 100, Issue- 1 (2019), 41–47.

[4] Biswajit Koley, A.Satyanarayana Reddy, *An irreducibility criterion for polynomials over integers*, Bulletin Mathematique de la Societe des Sciences Mathematiques de Roumanie, Volume 63 (111) 2020, Issue no. 1, pages 83–89.

[5] Biswajit Koley, A.Satyanarayana Reddy, *An irreducible class of polynomials over integers* accepted for publication in Journal of Ramanujan Mathematical Society.