ABSTRACTS

of Papers Presented at the Old Dominion University Math Awareness Conference

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SUBMISSION INFORMATION

ABSTRACTS PRESENTED are those submitted by authors who intend to present them at ODU Math Awareness Conference April 13th, 2024. The abstracts for the conference are sorted by the time and location of the 2024 Math Awareness Conference.

THE SUITABILITY OF A PAPER for presentation at the conference is judged by the editorial committee to promote mathematical understanding to the community. In addition, the editors of the abstracts have adopted the following policy: In order to be accepted for publication, an abstract must have mathematical content. It should not contain libelous, defamatory, or tasteless remarks, commercial promotions, nor political or religious arguments. ODU assumes no responsibility for the content or inappropriate remarks in any published abstract.

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THE ABSTRACT RECEIPT DEADLINES FOR ALL MEETINGS will be strictly enforced. Late papers cannot be accommodated. When all talks have been scheduled for a given meeting, the attendant abstracts will be available for viewing once the editorial committee has published all information.

1 ► *Invited Speakers*

09:00 OCNPS 200 **John Adam** (jadam@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Reflections on enjoying applied mathematics and mathematical physics (including academic encounters with Sir James Lighthill, FRS, and Sir Michael Berry)*

This will be a very personal talk about my academic background, including some false starts and dead ends encountered during graduate school. One common thread throughout my career has been my interest in the mathematical description of linear wave motion. I will also describe a life-changing event in 1996 and how it propelled me into the field of mathematical meteorological optics, and a subsequent life chapter (still ongoing) of writing books! There are also four Knights of the Realm, three of whom I have encountered personally, who have had significant impact on my career.
Biography: Dr. John A. Adam has been Professor of Mathematics at Old Dominion University since 1984. His Ph.D. from the University of London was in theoretical astrophysics (an exceedingly long time ago). As an undergraduate he was exposed to a concentrated diet of Monty Python's Flying Circus, and he has never fully recovered, even at his advanced age. His first introduction to the USA was through the humor of The Far Side cartoons by Gary Larson. He has broad interests in mathematical modeling and applied mathematics, ranging from mathematical biology to meteorological optics. He has been a frequent contributor to Earth Science Picture of the Day (http://epod.usra.edu/). In 2007 he was winner of an Outstanding Faculty Award for the State of Virginia. In 2012 he was a recipient of a Carl B. Allendoerfer Award from the Mathematical Association of America (MAA). The Award

is made to authors of expository articles published in the MAA journal Mathematics Magazine. He has published approximately 120 papers in mathematical and scientific journals and given over 180 talks and presentations to professional and university/college groups.

He is also interested in being a resource in Applied Mathematics for Middle and High-School teachers, and to that end has written (currently) six papers on a range of topics for the journal Virginia Mathematics Teacher. In addition, he is Section Editor of Mathematics in Nature for this journal. He also writes a monthly column on "Guesstimation" for The Physics Teacher journal. He has written several books (all published by Princeton University Press): Mathematics in Nature: Modeling Patterns in the Natural World, X and the City: Modeling Aspects of Urban Life and A Mathematical Nature Walk. He is also co-author (with physicist Lawrence Weinstein) of Guesstimation: Solving the World's Problems on the Back of a Cocktail Napkin. There are now several different translations of Guesstimation: Chinese, Italian, Japanese and Portuguese among others. His latest book, Rays, Waves and Scattering: Topics in Classical Mathematical Physics was published in June 2017. He is currently in the process of writing two other books. His website can be found at https://fs.wp.odu.edu/jadam/

10:00 OCNPS 200 **Oleksandr Misiats** (omisiats@vcu.edu) Department of Mathematics and Applied Mathematics, Virginia Commonwealth University. *Regularity and asymptotic properties of nonlocal stochastic evolution equations arising in chemical and biomedical models.*

This talk is devoted to the influence of stochastic perturbations on the long time behavior of nonlocal evolution equations. I will start with a brief overview of the theory of stochastic evolution equations, and their applications. I will specifically focus on two of such models: the bidomain model of heart tissue, and the aggregation-diffusion equation (Keller-Segel model). The nonlocal character of these equations can be present either in the differential operator (bidomain) or in the reaction term (Keller-Segel). Using the fundamental concepts in the area of stochastic analysis, semigroup theory and PDEs, in my talk, I will address the effects of noise on the existence of global vs. local solutions (Keller-Segel) and their regularity, as well as the existence of invariant measures (for the bidomain model), which is the key step in establishing the qualitative behavior of the underlying physical system.
Biography: Oleksandr Misiats is an applied mathematician working in the areas of Partial Differential Equations, Calculus of Variations, and Stochastic Analysis. Oleksandr got his Bachelors and Masters degrees from the University of Kyiv, Ukraine, and PhD from Penn State University. He worked at Purdue University and New York University, prior to joining VCU in 2017. He is currently an Associate Professor at the Department of Mathematics and Applied Mathematics at VCU.

13:05 OCNPS 200 **Norou Diawara** & **Sasanka Adikari** (ndiawara@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Inference for Multiple Utilities in Time-Dependent Choice Pairs using Copula-Based Models.*

Discrete choice models (DCMs) are applied in many fields and in the statistical modelling of consumer behavior. The construction of the DCMs takes many forms such as Binary Logit, Binary Probit Multinomial Logit, Conditional Logit, Multinomial Probit Nested Logit, Generalized Extreme Value Models, Mixed Logit, and Exploded Logit Choice behaviors and their utilities are illustrated in social sciences, health economics, transportation research, marketing and health systems research. They have a time dependent behavior. We extend the DCMs with emphasis on time dependent best-worst choice and discrimination between choice attributes using a flexible distribution function for the time dependence the copula method. Here, we fit a bivariate best-worst copula distribution for consumer choice. We used conditional logit model to calculate initial utility. Expected utilities over

time are obtained using backward recursive method based on Markov decision processes. Using transition probabilities, we derived a copula method to predict the utilities in time (UiT) through Flynn 2007 estimated covariates, and we illustrate the behavior of the UiTs and their confidence/credible intervals. The properties of the transition probabilities are assessed in bootstrap study.
Biography: Norou Diawara is Professor of Statistics in the Mathematics and Statistics Department, at Old Dominion University, Norfolk, VA, USA. Prof. Diawara received his B.S. at the University Cheick Anta Diop in Dakar, Senegal; Maîtrise in Mathematics at University of Le Havre, France; Master's in Statistics at University South Alabama; and Ph.D. in Statistics at Auburn University, AL in 2006. His research areas are in estimation techniques of time to event data analyses in choice models, statistical pattern recognition using copulas and spatial-temporal models.

14:10 OCNPS 200 **Xiang Xu** (x2xu@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *A new proof of the number of steady state solutions to a Smoluchowski equation*

We re-examine a Smoluchowski equation employed for modeling nematic liquid crystalline polymers. Specifically, we provide a novel proof concerning the investigation of steady-state solutions to the 2D Smoluchowski equation. We establish that when the intensity constant is less than or equal to 4, a unique (trivial) solution exists. Conversely, when the intensity constant exceeds 4, precisely two solutions emerge, corresponding to the isotropic and nematic phases, respectively. Notably, the proof relies solely on calculus, rendering it more transparent and accessible.
Biography: Dr. Xu received his Ph.D. degree in mathematics from the Pennsylvania State University in 2011, with Prof. Chun Liu as his thesis supervisor. Afterwards he did his postdoctoral research at Carnegie Mellon University and Purdue University, respectively. He joined Old Dominion University as a tenure track assistant professor in 2015, and became an associate professor in 2021. His main research interests are in partial differential equations with applications in materials science and complex fluids, as well as calculus of variations.

2 ► *Contributed Speakers*

11:05 OCNPS 100 **Zachary Hilliard** (zhilliard@regent.edu) Department of Science and Mathematics, Regent University. *Modeling Poroelasticity Using Particle Simulations Fluid Simulations, and Upscaling*

Poroelasticity is the recoverable deformation of a porous media such as sandstone. One standard model for this phenomenon is the Biot model, which is quite well known. Here, we consider a less known nonlinear variant in which the permeability is a function of the porosity. In order to estimate this function, we simulate the pore-scale dynamics as follows. First, we approximate the rock phase of the porous medium as an assembly of spheres and use the Discrete Element Method (DEM) to simulate the deformation under a load-unload cycle. Second, at several steps along this load-unload cycle, we use the Stokes equations to model fluid flow through the pore-space. Third, the solutions to the Stokes equations are then upscaled to estimate the Darcy-scale permeability. When this is done for the entire load-unload cycle, we can approximate the relationship between permeability and porosity at the Darcy-scale and use this relationship in the nonlinear Biot model. Additionally, we will discuss a few of the challenges in this process.

11:05 PSII 1100 **James Tipton** (jetipton@nsu.edu) Department of Mathematics, Norfolk State University. *Community detection via generalized modularity*

We present a community detection algorithm based generalized modularity matrices.

11:35 OCNPS 100 **Mohammed Sayyari** (malsayya@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *A short introduction to summation-by-parts (SBP) for non-linearly stable schemes*

An overview the application of summation-by-parts (SBP) operators for mimicking non-linear stability conditions. Including a short review of SBP operators and their implementation on Legendre–Gauss–Lobatto (LGL) points. Additionally, a brief review of non-linear stability with entropy stability. The Burgers equation is used as an example for the development of an entropy stable semi discrete scheme. Then, the relaxation RK scheme is used to preserve the structure for the fully-discrete scheme.

11:35 PSII 1100 **Mingsong Yan** (myan007@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Sparse learning in reproducing kernel Banach spaces*

Sparsity of a learning solution is a desirable feature in machine learning. Certain reproducing kernel Banach spaces (RKBSs) are appropriate hypothesis spaces for sparse learning methods. In this talk, we will discuss what kind of RKBSs can promote sparsity for learning solutions. We consider a typical learning model in an RKBS, which is the minimum norm interpolation (MNI) problem. We shall first establish an explicit representer theorem for solutions of these problems, which represents the extreme points of the solution set by a linear combination of the extreme points of the subdifferential set, of the norm function, which is data-dependent. We then propose sufficient conditions on the RKBS that can transform the explicit representation of the solutions to a sparse kernel representation having fewer terms than the number of the observed data. We further show that two specific RKBSs: the sequence space l1(N) and the measure space can have sparse representer theorems.

15:20 OCNPS 100 **Kubilay Dagtoros, Sujan Pant, Bretia Green** (kdagtoros@nsu.edu) Department of Mathematics, Norfolk State University. *Direct and Indirect Simulation Techniques*

In this talk, we will go over some direct and indirect simulation techniques. Principal integral transform allows us to simulate from a population with a cost of solving an integral equation. Often times, finding inverse of a cdf comes with its own challenges. Another approach is to use some indirect methods such as the Accept/Reject Algorithm. We will compare these methods and review their perfromances as well as their advantages and disadvantages. Moreover, we will go over a thorough analysis of family of axuillary functions to find the best performing functions in the indirect method.

15:20 PSII 1100 **Ana Vivas** (alvivas@nsu.edu) Department of Mathematics, Norfolk State University. *A Mathematical Model for the Dynamics of Alcohol-Marijuana Co-abuse*

A mathematical model for the dynamics of alcohol-marijuana co-abuse is presented in this work. In the past years legalization of recreational marijuana in several states in the United States has added a new layer to alcohol addiction. Much research has been done for alcohol addiction or drug abuse independently, but few include the incidence of marijuana use for alcohol users. A compartmental epidemiological model is used, and results such as the existence and boundedness of solutions, the basic reproduction number using the next-generation method, the disease-free equilibrium, and an analytical expression for the endemic equilibrium are included. Numerical simulations with parameters obtained from data in the United States are performed for different compartments of the population as well as the reproduction number for the alcohol and marijuana sub-models. The model can be adapted for different regions worldwide using appropriate data. This work contributes to understanding the dynamics of the co-abuse of addictive substances. Even though alcohol and marijuana are both legal, they can be of great harm to the brain of the individual when combined, having tremendous consequences for society as a whole. Creating awareness of a public health concern with facts based on scientific research is the ultimate goal of this work.

15:50 OCNPS 100 **Seth Nelson** (srnelson01@wm.edu) Department of Mathematics, College of William and Mary. *Strong Edge Coloring and Euler's Polyhedral Formula*

We will talk about the graph theoretic problem of strong edge coloring and discuss its connection to previous coloring problems. We focus in particular on the conjectured upper bound for strong chromatic index given by Erdos and Nesetril. We will explore the specific case of strong edge coloring in the family of planar graphs, and demonstrate the technique of discharging and its connection to Euler's Polyhedral Formula.

15:50 PSII 1100 **Subhash Paudel** (spaud002@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *New Parallel-in-time First-order Implicit Scheme for Nonlinear Differential Equations*

We present a new approach to parallelization of the first-order backward difference discretization (BDF1) of the time derivative in nonlin- ear partial differential equations, such as nonlinear heat and viscous Burgers equations. The time derivative term in the governing equation is discretized by using the method of lines bsaed on the implicit BDF1 scheme, while the inviscid and viscous terms are approximated by using conventional 2nd-order 3-point upwind and central discretizations of the 1st- and 2nd-order deriva- tives in each spatial direction, respectively. The global system of nonlinear discrete equations in the space-time domain is solved by the Newton method for all time levels simultaneously. To solve this all-at-once system at each Newton iteration in parallel, the discrete equations are recast to derive a set of fully decoupled equations associated with each time step. As a result, the computational complexity of each local problem is nearly identical to that of the sequential BDF1 scheme to advance the solution over one time step. This allows for an efficient parallel-in-time implementation of the implicit BDF1 discretization which can be directly combined with standard spatial domain- decomposition algorithms, thus providing a much higher speedup on large computer platforms as compared with the current state-of-the-art methods based on parallelization of the spatial discretization alone. Numerical results show that the new time-parallel BDF1 scheme provides a nearly ideal speedup on up to 28 computing cores for the 2-D nonlinear heat and Burgers equations with both smooth and discontinuous solutions.

16:20 OCNPS 100 **Ridha Moussa** (rmoussa@nsu.edu) Department of Mathematics, Norfolk State University. *Experimental Mathematics in Action: Heine - Stieltjes polynomials*

In this talk we give an overview of Heine - Stieltjes polynomials and their electrostatic interpratation. We also present some symbolic and numerical results on obtaining the zeros of the polynomials and the corresponding eigenvalues.

16:20 PSII 1100 **Md Ibrahim Kholil** (mikholil@nsu.edu) Department of Mathematics, Norfolk State University. *A Uniquness Theorem for Inverse Problems in Quasilinear Anisotropic Media*

In this presentation, I will begin by discussing inverse problems related to Calderon's problem. I'll give an overview of both the isotropic and anisotropic cases. For an anisotropic case, my study investigates the question of whether one can uniquely determine a scalar quasilinear conductivity in an anisotropic medium by making voltage and current measurements at the boundary whose quasilinear conductivity coefficient has smooth regularity. The result is to explore the outcomes in the situation of smooth quasilinear (non-analytic) coefficient matrices with dimensions greater than or equal to three.

16:50 OCNPS 100 **Vu Giang** (vgian002@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Approaches to Solving the Time-Independent Schrödinger Equation for Multiple Bodies: A Comparative Study of Neural Networks and Numerical Methods*

The Time-Independent Schrödinger Equation is a class of linear elliptic PDE's that governs the wave function of a quantum-mechanical system. The equation's importance to the sciences of submicroscopic phenomena, hence quantum mechancics, has the same central role as Newton's laws of motion to the study of classical mechanics. In this study we use various methods to first solve the one-dimensional one-body equation with novel physics informed neural networks and finite difference schemes which is compared to analytical solutions. Then we adjust the models to solve highly complex multibody Schrödinger equation and compare our results with experimental data.