Fall 2022

Dr. Xiaoshu Sun Post-Doctorate, University of Tennessee at Chattanooga

- **Date:** Friday, December 2, 2022
- **Time:** 3:30pm
- **Location:** Lupton 393
- **Title:** The numerical computation of Casimir energies and related spectral problems
- **Abstract**. Computing the Casimir force and energy between objects is a classical problem of quantum theory going back to the 1940s. Since then, various approaches have been developed based on different physical principles, such as zeta function regularizations, stress tensors, and determinant of boundary layer operators. Most notably, the representation of the Casimir energy in terms of determinants of boundary layer operators makes it accessible to a numerical approach, but its mathematical derivation involves ill-defined path integrals. Until recently, the connections between these methods have been proved, i.e. the formulae arising from these methods all give the same Casimir forces. In addition, a full mathematical justification of the determinant formulae as the trace of a linear combination of powers of Laplace operators describing the Casimir energy was also achieved for both scalar and electromagnetic (EM) field. In this talk, I will give an overview of the relative trace formula that derives the Casimir energy formula as a representation of the integral of the log determinant of boundary integral operators. Afterwards, I will present the numerical framework for computing the Casimir energy and compare the result with various reference values. I will end this talk by improving this numerical scheme with iterative methods, which are based on the spectral properties of the block matrices for the boundary layer operators. These methods allow for Casimir energy calculation for large-scale practical problems and significantly speeds up the computations in that case.

JB Murphy, Stephen Adams, Stephanie Passmore, and Jeremiah Ludwinski

Actuaries, Blue Cross Blue Shield

- **Date:** Friday, November 11, 2022
- **Time:** 2:45pm
- **Location:** Lupton 393
- **Title:** Want to be an Actuary?
- **Abstract**. We will describe our individual jobs and typical day-to-day experience. Then we will go over the Actuarial Department as a whole, emphasizing the three main areas: pricing, forecasting and valuation. We will also talk about risk adjustment with some examples and outline its increasing impact due to the medical insurance industry no longer being allowed to rate on health status. We will follow up with the impacts of COVID and how it has affected pricing and forecasting. We will conclude with details of BlueCross' Actuarial Development Program, speaking about study hours, increased pay for passing exams and other benefits.

Dr. Lan Gao, UTC Math Department

- **Date:** Friday, November 4, 2022
- **Time:** 3:30pm
- **Location:** Lupton 393
- **Title:** Predicting COVID-19 Outcomes During Pandemic via Analysis of Google Trends Data: A Statistical Deep Learning Study
- **Abstract:** The still ongoing global outbreak of COVID-19 is affecting many countries throughout the entire world. The US is one of the most affected countries. Search engines like Google provide a useful near real-time indicator of public interest during a pandemic. The Google Trends data allows users to measure interest in particular search keywords across the United States, down to the city-level. We proposed a workflow with pre-processing procedure to test stationarity of time series data and then feed the inputs to two predictive models: a classical statistical method vector autoregressive model (VAR) and a deep learning neural network Long Short-Term Memory (LSTM). Performance of these two models is evaluated using four performance metrics. We will also discuss the reliability issues of Google Trend data and necessity of pre-processing procedure to remove seasonality.

Dr. Ziwei Ma, Assistant Professor UTC Math Department

- **Date:** Friday, October 21, 2022
- **Time:** 2:15pm
- **Location:** Lupton 393
- **Title:** Estimate parameters of COVID-19 Dynamics models by deep neural network approach
- **Abstract:** In the talk, a deep neural networks (DNNs) approach to fit COVID-19 dynamics model is introduced based on recently developed computational packages. Consider the model involving the long COVID component or the concentration of the coronavirus in the environment, it is a challenge task to estimate the key parameters of those models in traditional numerical methods. We employed the feed-forward neural network structure and optimization algorithms to estimate the key parameters. The results indicate that the proposed methods provides better estimation of the parameters than the classical method.

Dr. Xiunan Wang Assistant Professor, UTC Math Department

- **Date:** Friday, October 7, 2022
- **Time:** 3:30pm
- **Location:** Lupton 393
- **Title:** Modeling Rabies Transmission in Spatially Heterogeneous Environments
- **Abstract:** Spatial heterogeneity plays an important role in determining spatial patterns of rabies and the cost-effectiveness of vaccinations. In this talk, I will introduce a spatially heterogeneous dog rabies transmission model by using the θ-diffusion equation, where θ reflects the way individual dogs make movement decisions in the underlying random walk. I will show the dynamics of the model in two cases: homogeneous and city-wild diffusion, discuss the impact of initial conditions on the steady-state solutions and the progressing speed of traveling waves, and present some interesting phenomena including an “active” interface between city and wild regions. At last, I will compare the efficiencies of different vaccination strategies.

Tanner Smith

Ph.D. Student, University of Tennessee at Chattanooga

- **Date:** Thursday, October 6, 2022
- **Time:** 1:00pm
- **Location:** Grote 317
- **Title:** Optimization for a Sturm--Liouville Problem with the Spectral Parameter in the Boundary Condition
- **Abstract:** We find an optimal mass of a structure described by a Sturm-Liouville (S-L) problem with a spectral parameter in the boundary conditions. While previous work on the subject focused on a somewhat simplified model, we consider a more general S-L problem. We use the calculus of variations approach to determine a set of critical points of the corresponding functional - yet these “predesigns” themselves do not represent meaningful solutions. We additionally introduce a set of solvability conditions on the data of the S-L problem which confirm that these critical points do represent meaningful solutions we refer to as designs.

Spring 2023

Mohammad Khan, Ph.D. student, Department of Mathematics

- **Date:** Friday, February 3, 2023
- **Time:** 2:00pm
- **Location:** Lupton 393
- **Title:** Numerical Evaluation of Wavenumbers of an Acoustic Wave Propagating in an Ice-Covered Ocean
- **Abstract***:* We consider acoustic wave propagation in a layered ocean waveguide covered by a thick ice cover. Standard separation of variables leads to a Sturm-Liouville problem in the cross-section of the waveguide. We are specifically interested in the two leading modes that are the separated solutions for the maximal eigenvalues. We consider the homogeneous waveguide. We prove the differentiability of the eigenvalues with respect to the frequency, the monotonicity of the eigenvalues with respect to the frequency, and the existence of the cut-off frequency. We compare these eigenvalues with the eigenvalues for the case of a waveguide with a free surface. To better understand the influence of global warming on ice covers, we study the change of these eigenvalues with respect to air temperature. Assuming that the speed of propagation varies within the given limits, we develop a numerical algorithm, based on the formalism for the layered media, that allows evaluating the minimum and maximum of the wavenumbers of the leading modes for a given continuous profile of the speed and the given values of Young's Modulus and ice thickness. After finding numerical results, we compare them with the results of the asymptotic considerations and find the simplified dispersion relations. We further consider the model of pack ice, a limiting case of thick ice. We also find the analytical, numerical, and asymptotic results for this limiting case. These results were compared with the results of the thick ice model. With the help of our results, we hope to develop the corresponding inverse problem methods for future work to further study the influence of global warming on ice covers.