THE UNIVERSITY *of* NORTH CAROLINA
GREENSBORO
Department *of* Mathematics & Statistics

Helen Barton Lecture Series in Mathematical Sciences Spring 2018

Dr. Erik S. Van Vleck

Professor of Mathematics
University of Kansas

Erik S. Van Vleck is Professor of Mathematics at the University of Kansas. He received his PhD in Applied Mathematics from Georgia Institute of Technology in 1991, MSc at the University of Colorado-Boulder in 1987, and BS from the University of Kansas in 1985.

Dr. Van Vleck's research areas are in numerical analysis, differential equations and dynamical systems, and applications of mathematics to problems in science and engineering. His primary research interests are in computation of time dependent stability spectra and applications of these techniques, and analysis and computation of lattice differential equations with applications in materials, physiology, and biology. In recent years, his interests have expanded to include applications in climate science including modeling and analysis of cloud dynamics, competition models for forests and grasslands, and data assimilation techniques and their application.

He has published over 75 articles on topics ranging from numerical analysis and analysis of differential equations to applications of mathematics to materials, biology, and climate science.

Erik is an active member of the Mathematics and Climate Research Network (MCRN) and is active in developing distributed learning environments for undergraduate and graduate mathematics students in the mathematics of climate and sustainability. His pedagogical interests include active learning and project oriented techniques for the teaching of mathematics. He has held visiting positions at NIST, IMA, UC-Berkeley, Sussex, and Auckland. During Spring 2018, Dr. Van Vleck is a visiting research fellow at SAMSI for the Program on Mathematical and Statistical Methods for Climate and the Earth System.

Time Dependent Stability: Theory, Computation, and Applications

Dynamical systems of many different types are employed in science and engineering as models of physical and biological phenomena. These dynamical systems include linear and nonlinear mappings, ordinary and partial differential equations, delay equations and other non-local equations. Mathematically, the first step in understanding the behavior of solutions is to determine the existence and uniqueness of solutions. This is often followed by analysis of the stability of solutions, typically equilibrium or steady state solutions. Stability of solutions determine whether nearby solutions are attracted or repelled. If they repel nearby solutions, then it is of interest to understand the types of perturbations associated with such repelling behavior. Spectral analysis of linear operators or matrices provides insight into the stability of time independent solutions. For time varying solutions such as periodic orbits, e.g., via Floquet theory, and for more general time dependent solutions stability analysis depends on understanding time dependent linear operators or matrix functions. Lyapunov exponents as first developed in the thesis of A.M. Lyapunov are among time dependent stability theories that provide information on the stability of time dependent solutions as well as other information (existence of chaotic behavior, dimension of attractors, entropy, etc.). In general, stability spectra for time dependent solutions play the role that the real parts of eigenvalues play for linearization about time independent solutions.

In these lectures, we discuss the theoretical development of time dependent stability, uses of stability spectral, computational techniques for their approximation, and applications of these techniques. For time dependent linear differential equations, stability spectra such as Lyapunov exponents and Sacker-Sell spectrum are extracted via time dependent change of variables based upon continuous matrix factorizations (QR and SVD) of fundamental matrix solutions. We derive these numerical techniques for the approximation of stability spectra, justify the use of these techniques, and develop a quantifiable error analysis on the approximation both in terms of rates of growth and decay and the associated time dependent subspaces. We illustrate the use computational stability spectra with applications in climate science, the detection of stiffness in the numerical solution of differential equations, and time dependent splitting techniques in data assimilation.

Lecture 1: Motivation and Theory

Monday, February 12, 2018
Reception: Petty 116, 3:30–4:00
Lecture: Petty 219, 4:00 PM

Lecture 2: Computation and Numerical Analysis

Wednesday, February 14, 2018
Reception: Petty 116, 3:30–4:00
Lecture: Petty 219, 4:00 PM

Lecture 3: Applications

Friday, February 16, 2018
Reception: Petty 116, 3:30–4:00
Lecture: Petty 219, 4:00 PM

For more information, please see: http://www.uncg.edu/math/talks/index.html or contact Dr. Maya Chhetri at maya@uncg.edu.