MS Organized by: SIAG/LA

**Abstract:** A nonlinear eigenvalue problem (NLEVP) is to find scalars x (eigenvalues) and nonzero vectors v,w (eigenvectors) satisfying F(x)v=0, w*F(x)=0, where F:C→Cnxn is a matrix-valued function. NLEVPs can be extended to multiparameter eigenvalue problems (MPEPs) F(x1,...,xd)v=0, w*F(x1,...,xd)=0, with F:Cd→Cnxn. Important cases of NLEVPs are the polynomial and rational eigenvalue problems, where the entries of F(x) are polynomial or rational functions. NLEVPs and MPEPs arise in many applications, and much research on these problems has been performed in the last years from computational and theoretical perspectives. This minisymposium presents the most recent advances in NLEVPs and MPEPs, and on their applications.

**17:00-17:30**

**An algorithm for dense nonlinear eigenvalue problems**

Françoise Marie Louise Tisseur — School Of Mathematics, University Of Manchester, UK
Gian Maria Negri Porzio — University of Manchester

**Abstract:** There have been numerous breakthroughs in the past ten years in the development of numerical methods for nonlinear eigenvalue problems mostly concentrating on algorithms and software for large sparse problems. The dense case has drawn less attention and there is lack of reliable software. In this talk we present an algorithm for the computation of all the eigenvalues of dense nonlinear eigenvalue problems in a given region of the complex plane and describe its implementation.

**17:30-18:00**

**The Nonlinear FEAST Algorithm**

Agnieszka Miedlar — University of Kansas
Mohamed El Guide — University of Minnesota
Brendan Gavin — University of Massachusetts Amherst
Eric Polizzi — University of Massachusetts Amherst
Yousef Saad — University of Minnesota

**Abstract:** Eigenvalue problems in which the coefficient matrices depend nonlinearly on the eigenvalues arise in a variety of applications, e.g., computational nanoelectronics. In this talk we will discuss how Cauchy integral-based approaches offer an attractive framework to develop highly efficient and flexible techniques for solving large-scale nonlinear eigenvalue problems. The nonlinear FEAST algorithm is used to determine eigenpairs corresponding to eigenvalues that lie in a user-specified region in the complex plane, thereby allowing for parallel calculations.

**18:00-18:30**

**Nonlinear eigensolvers in SLEPc**

José E. Román — Universitat Politècnica de València
Carmen Campos — Universitat Politècnica de València

**Abstract:** This talk gives an overview of the developments carried out in SLEPc, the Scalable Library for Eigenvalue Problem Computations, related to nonlinear eigenvalue problems (both polynomial and general). We describe the available solvers, and discuss implementation details such as parallelization. Attention will also be paid to applications that make use of our solvers.

**18:30-19:00**

**NEP-PACK: a Julia package for nonlinear eigenproblems**

Elias Jarlebring — KTH Royal Institute of Technology
Max Bennedich — KTH Royal Instititue of Technology
Giampaolo Mele — KTH Royal Instititue of Technology
Emil Ringh — KTH Royal Instititue of Technology
Parikshit Upadhyaya — KTH Royal Instititue of Technology

**Abstract:** We present an open-source library for nonlinear eigenvalue problems (NEPs): determine non-trivial solutions to , where is a holomorphic function. The library is designed for scientists working on algorithm development for high-performance computing, as well as scientists with specific NEP-applications. We provide efficient implementations of many state-of-the-art algorithms and also give access to recent research on applications. Transformations of the problem, such as rescaling and deflation, are supported natively by the library.

## MS FE-1-3 7 — 17:00-19:00

**Network based model reduction in large-scale simulations, imaging and data-science - Part 3**

For Part 1 see: MS FE-1-3 5
For Part 2 see: MS FE-1-3 6

Organizer: Mikhail Zaslavskiy — Schlumberger
Organizer: Vladimir Druskin — Worcester Polytechnic Institute

**Abstract:** Model-driven and data-driven reduced-order models (ROMs) have been proven to be a useful tool for robust simulations of the response of large-scale dynamical systems as well as for reducing the complexity of inverse problems. Rather recently the list of applications has been extended by data science. ROM representation by sparsely-connected networks is crucial for both the approach efficiency and proper interpretation of ROM parameters. We will discuss various model reduction techniques and sparse network-based approximations with applications to both forward and inverse PDE problems as well as to machine learning and data science.

**17:00-17:30**

**Ladder Network Realizations for dissipative wave equations**

Jörn Zimmerling — University of Michigan
Vladimir Druskin — WPI
Murthy Guddati — NC State University
Rob Remis — TU Delft

**Abstract:** We extend the finite-difference Gaussian quadrature rules a.k.a. optimal grid from parabolic or lossless hyperbolic problems to dissipative wave propagation. For passive problems we show that data-driven reduced-order models of wave-impedances can be realized as a mechanical or electrical ladder networks with lumped elements or a coarse grid discretizations of the underlying PDE.

**17:30-18:00**

**DISTANCE PRESERVING MODEL ORDER REDUCTION OF GRAPH-LAPLACIANS AND CLUSTER ANALYSIS**

Mikhail Zaslavskiy — Schlumberger
Vladimir Druskin — Worcester Polytechnic Institute
Alexander Mamonov — University of Houston

**Abstract:** We design a reduced order proxy of the graph-Laplacian that allows to preserve the distances between nodes of priori chosen arbitrary vertex subset the full graph. Our approach is based on MIMO model-reduction of diffusive LTI systems approximating random walks on graphs. The constructed proxy can be applied on its own for accurate clustering of any graph vertices subset as well as a building block for multi-level clustering of entire graph.

**18:00-18:30**

**REDUCED ORDER MODELS FOR SPECTRAL DOMAIN INVERSION: EMBEDDING INTO THE CONTINUOUS PROBLEM AND GENERATION OF INTERNAL DATA. TBD**

Shari Moskow — Drexel University
Liliana Borcea — University of Michigan
Vladimir Druskin — WPI
Alexander Mamonov — University of Houston
Mikhail Zaslavsky — Schlumberger

**Abstract:** We generate reduced order Galerkin models for inversion of the Schrodinger equation given boundary data in the spectral domain for one and two dimensional problems. We show that in one dimension, after Lanczos orthogonalization, the Galerkin system is precisely the same as the three point staggered finite difference system on the corresponding spectrally matched grid. The reduced order model yields highly accurate internal solutions. We present inversion experiments based on the internal solutions.

**18:30-19:00**

**Model reduction for modeling and simulation of viscoelastic materials**

Elena Cherkaev — University of Utah

**Abstract:** The talk deals with model order reduction in application to modeling and simulation of the fields in viscoelastic microstructured media. The approach is based on matrix Pade approximation and network based model reduction of the spectral measure in the Stieltjes integral representation of the effective response of composite materials. We also discuss the fractional operator case.

## MS A6-3-4 7 — 17:00-19:00

**Electrodiffusion, fluid flow and ion channels: modeling, analysis and numerics - Part 2**

For Part 1 see: MS A6-3-4 6

Organizer: Nir Gavish — Technion