Monday, March 17, Prescott 205:

- 9.30 a.m.  Coffee and Doughnuts
- 10.00 a.m. Stephen Fulling (TAMU) - *The Quantum Theory of Ceilings and Floors*
- 11.00 a.m. James N. Lyness (Argonne) - *Handling instability in extrapolation*
- 12.00 p.m. Lunch Break
- 2.00 p.m.  Klaus Kirsten (Baylor) - *Functional determinants by contour integration methods*
- 3.00 p.m.  Coffee and Cookies
- 3.30 p.m.  Lutz Weis (Karlsruhe) - *Vector-valued harmonic analysis*
- 4.30 p.m.  Cornelia Kaiser (Karlsruhe) - *Wavelets for functions with values in Banach spaces*
- 6.30 p.m.  Dinner at Mike Anderson’s

Tuesday, March 18, Prescott 205:

- 9.30 a.m.  Coffee and Doughnuts
- 10.00 a.m. Günter Lumer (Mons) - *Uniform aspects of Laplace estimates and other stability related developments*
- 11.00 a.m. Roland Schnaubelt (Halle) - *Asymptotic behaviour of parabolic problems with delays in the highest order derivatives*
- 12.00 p.m. Lunch Break
- 2.00 p.m.  Andreas Schmidt (Fraunhofer-Institute) - *Infinite infrared regularization in Krein spaces*
- 3.00 p.m.  Coffee and Cookies
- 3.30 p.m.  Javier Sanz (University of Valladolid) - *Summability of power series in several variables and applications*
- 4.30 p.m.  Soon-Yeong Chung (Sogang) - *ω-harmonic functions and inverse conductivity problems on networks*
- 5.30 p.m.  Happy Hour at The Chimes

Wednesday, March 19, Prescott 205:

- 9.30 a.m.  Coffee and Doughnuts
- 10.00 a.m. Yu Zhuang (Texas Tech) - *An alternating explicit implicit domain decomposition method*
- 11.00 a.m. Frank Neubrander (LSU) - *Asymptotic Laplace transforms, generalized functions, and evolution equations*
- 12.00 p.m. Lunch Break
- 2.00 p.m.  Ricardo Estrada (LSU) - *Asymptotic approximation of integrals*
- 3.30 p.m.  Excursion
Asymptotic analysis, generalized functions and the stability theory of evolution equations are interesting and rich subjects of mathematical analysis. Asymptotic analysis is used to approximate complicated integral expressions as well as the solutions of evolution equations, many times in terms of divergent series. Interestingly, these divergent series provide, by taking just a few terms, far better approximations than those given by convergent schemes. Generalized functions, or distributions as they are sometimes called – following the name of the best known class of generalized function –, provide an analytical framework to study divergent series and integrals as well as ”generalized” solutions of differential equations, by introducing new ”objects” that generalize the notion of a function, but in a way that preserves the possibility of performing algebraic and analytical operations and the use of integral transforms. Asymptotic analysis and generalized functions share many characteristics. Both were studied well before their ”official” invention, while their official invention came to justify, and in a sense to explain, several formal and perhaps non-rigorous procedures used in the solution of differential equations and in other areas. They both have an ample record of successful applications in a wide variety of fields, not only in applied but also in pure mathematics; the quantity of applications is such that they may be referred to as ”methods”, asymptotic and distributional methods, respectively. Furthermore, it has been realized recently that asymptotic analysis and generalized functions are actually closely related. Indeed, generalized functions provide a very appropriate framework for the analytical operations required in the asymptotic analysis and also give a systematic procedure to assign values to the divergent integrals that often arise. Asymptotic patterns, on the other hand, are some sort of generalized function to which analytical operations and transform analysis can be applied.
Abstracts

**Andreas U. Schmidt** (Fraunhofer-Institute Secure Telecooperation, Darmstadt, Germany): *Infinite Infrared Regularization in Krein Spaces*

After briefly reviewing the emergence of infrared singularities in axiomatic quantum field theory, I present a method for the construction of a Krein space completion for spaces of test functions, equipped with an indefinite inner product induced by a kernel which is more singular than a distribution of finite order. This generalizes a regularization method in quantum field theory to the case of singularities of infinite order. I give conditions for the possibility of this procedure in terms of local differential operators and the Gelfand-Shilov test function spaces, as well as an abstract sufficient condition. As a model case I construct a maximally positive definite state space for the Heisenberg algebra in the presence of an infinite infrared singularity.

**Klaus Kirsten** (Baylor University): *Functional determinants by contour integration methods*

We consider second order self-adjoint elliptic systems of differential operators on the one dimensional interval. For general boundary conditions, a contour integral method for the calculation of the related functional determinants is provided. For the case that all eigenvalues are positive, known answers are easily reproduced. For the case with zero modes present, a case relevant for 'practical' purposes in theoretical physics, new results are provided.

**Javier Sanz** (University of Valladolid, Spain): *Summability of power series in several variables and applications*

The main aim of this talk is to present a theory of summability in a direction for formal power series of several variables, so extending the tool introduced for one variable series by J.P. Ramis. Multidimensional Laplace and Borel transforms are studied, as well as their action on Gevrey strongly asymptotically developable functions on polysectors (as defined by H. Majima), with a given exponential growth in the first case. This summability method turns out to be, in a sense, equivalent to an iterative summation procedure, one variable at a time. Some applications to the study of formal power series solutions to certain classes of completely integrable Pfaffian systems or to some perturbation problems are discussed.
Yu Zhuang (Texas Tech University): An Alternating Explicit Implicit Domain Decomposition Method

As a same-order approximation of the Crank-Nicolson scheme, the Alternating Direction Implicit (ADI) method introduced by Peaceman and Rachford has substantially reduced computation cost compared to the Crank-Nicolson scheme for two dimensional parabolic equations. The usefulness of ADI-type operator splitting based temporal approximations has been well recognized. In this talk, we will present an Alternating Explicit Implicit Domain Decomposition (AEIDD) method, an ADI-type method with domain decomposition based operator splitting, for the numerical solution of parabolic equations, and analyze the AEIDD method in stability, consistency, and efficiency from the viewpoint of parallel computing.

Günter Lumer (University of Mons-Hainaut, Mons, Belgium and Solvay Institutes for Physics and Chemistry, Brussels, Belgium): Uniform aspects of Laplace estimates and other stability related developments

We obtain better than asymptotic estimates of $\|\tilde{u}(\lambda)\|$ (usual exponents of $|\lambda|$ but uniform coefficients, valid for $|\lambda| \geq$ some uniformly large $\lambda_0$) - applied to stability levels, growth orders. We also look at monotone versus non-monotone depletion rates $\mu(t, \cdot)$ in superstability: influence of time-dependence. Reinterpretation as $\mu(\cdot, \cdot)$ of erosion "wind factor" $V(t)$.

James N. Lyness (Argonne National Laboratory) Handling Instability in Extrapolation

Many of the standard formulas used in Numerical Computation are asymptotic in nature. Unless the function under consideration is entire and of order 1 or less, series such as finite difference expansions or the Euler Maclaurin summation formula diverge for fixed step length. In this talk, I indicate how consequent problems are handled in a heuristic manner in the particular computational context of the multidimensional quadrature of a singular integrand.

Lutz Weis (University of Karlsruhe, Germany): Vector-valued harmonic analysis

In recent years singular integral operators with operator-valued kernels on Bochner spaces have found many applications in evolution equations, from regularity theory to asymptotic analysis. We explain these results and some of their mathematical background in Banach space theory in the context of their applications.
**Cornelia Kaiser** (University of Karlsruhe, Germany): *Wavelets for functions with values in Banach spaces*

After a short introduction to the scalar-valued theory of wavelets, I will present some recent results on the continuous and discrete wavelet transform for functions with values in Banach spaces. The main tools for the proofs are the operator-valued Mihlin multiplier theorem and singular integral operators.

**Soon-Yeong Chung** (Sogang University, Korea, and University of Maryland): *
\(\omega\)-harmonic functions and inverse conductivity problems on networks

In this lecture, we discuss an inverse problem to identify the connectivity and the conductivity of the links between each adjacent pair of nodes on the network, in terms of cause-to-effect map. To do this we introduce an elliptic operator \(\Delta_\omega\) and \(\omega\)-harmonic function on graph, with its physical interpretation as a diffusion equation on the graph modeled by the electric network. With many useful properties of \(\omega\)-harmonic functions derived ahead, we prove the solvability of the direct problem such as the Dirichlet BVP and Neumann BVP. Finally, as the main theorem we prove the global uniqueness result of the inverse conductivity problem of network under the monotonicity condition.

**Roland Schnaubelt** (University of Halle, Germany): *Asymptotic behaviour of parabolic problems with delays in the highest order derivatives*

We investigate the partial functional differential equation

\[
  u'(t) = Au(t) + \int_{-r}^{0} dB(\theta)u(t + \theta)
\]

for a sectorial operator \(A\) on a Banach space \(X\) and a function \(B : [-r, 0] \to \mathcal{L}(\mathcal{D}(A), X)\) of bounded variation vanishing at 0. In particular, exponential dichotomy and stability of solutions are established if certain estimates on the operator \(\lambda - A - \hat{dB}(\lambda)\) hold. Our approach is based on the solution semigroup on a product space and spectral theory of semigroups. The case \(B = \eta A\) with scalar valued \(\eta\) is treated in some detail. It already exhibits interesting phenomena. This is joint work with Andras Batkai, Budapest.
Stephen Fulling (Texas A&M University): *The Quantum Theory of Ceilings and Floors*

The semiclassical analysis of the propagator of a particle subject to both a linear potential and a reflecting boundary is surprisingly nontrivial, and it provides a prototype for the study of systems with both potentials and boundaries, as the Airy problem does for ordinary turning-point problems. Finding all classical trajectories connecting two points in space-time requires the solution formula for the general cubic equation. There is a forbidden region at large time separation where no solutions exist. The edge of this region is not a caustic in the usual sense, and the standard Maslov theory of caustics does not apply. The semiclassical solution of the quantum problem is actually less singular there than for a caustic, but there is no obvious way to continue it into the forbidden region. Numerical solutions of approximating models with smooth potentials (“soft walls”) show how this barrier arises as a limiting case of caustics.

Frank Neubrander (LSU): *Asymptotic Laplace transforms, generalized functions, and evolution equations*

The application of classical Laplace transform techniques to differential or integral equations requires one to impose restrictive growth assumptions on the functions involved. To avoid this flaw, the Argentinian mathematician J.C. Vignaux extended in 1939 the concept of asymptotic power series to Laplace transforms. In this talk we will give an overview of recent developments in the theory of asymptotic Laplace transforms of generalized functions and various applications to evolution equations.

Ricardo Estrada (LSU): *Asymptotic approximation of integrals*

We study the asymptotic approximation of integrals of the type \( \int_V F(x, \lambda)dx \) as \( \lambda \to \infty \), where \( V \subset \mathbb{R}^n \), by using techniques from the theory of distributions. We give several applications of these techniques.