ABSTRACTS

New Approximations of the Total Variation and Filters in Image Processing

By Haim Brezis

I will present new results concerning the approximation of the BV-norm by nonlocal, nonconvex, functionals. The mode of convergence introduces mysterious novelties and numerous problems remain open.
The original motivation comes from Image Processing.
The talk is based on a joint work with H.-M. Nguyen.

A New Class of Constrained Minimization Problems

By Philippe G. Ciarlet

We describe and analyze an approach to the pure Neumann problem of three-dimensional linearized elasticity, whose novelty consists in considering the strain tensor field as the sole unknown, instead of the displacement vector field as is customary. This approach leads to a well-posed minimization problem of a new type, constrained by a weak form of the classical Saint Venant compatibility conditions. Interestingly, this approach also provides a new proof of Korn's inequality. We also describe an analyze a natural finite element approximation of this problem.

References:
P.G. Ciarlet, P. Ciarlet, Jr.: Another approach to linearized elasticity and a new proof of Korn's inequality, Mathematical Models and Methods in Applied Sciences, Vol. 15 (2005), 259-271.
P.G. Ciarlet, P. Ciarlet, Jr.: Direct computation of stresses in planar linearized elasticity, Mathematical Models and Methods in Applied Sciences, Vol. 19 (2009), 1043-1064.

On a Problem Posed by Steve Smale

By Felipe Cucker

At the request of the International Mathematical Union, in 1998, Steve Smale proposed a list of 18 problems for the mathematicians of the 21st century. The 17th of these problems asks for the existence of a deterministic algorithm computing an approximate solution of a system of n complex polynomials in n unknowns in time polynomial, on the average, in the size N of the input system. Our talk describes fundamental advances in this problem including the smoothed analysis of a randomized algorithm and a deterministic algorithm working in near-polynomial (i.e., N^O(log log$N$)) average time.

On Exact Recovery of a Free-Knot Spline from the Projection onto Polynomial Spaces

By Shai Dekel

Joint work with Tamir Ben-Dory and Arie Feuer (Technion).

In the talk we'll review some recent contributions (as well as ours) to the following problem: We are given the projection of a piecewise polynomial function onto a polynomial space (e.g. Fourier basis, algebraic polynomials) and we wish to recover the function exactly and in particular, the locations of the knots.

Multivariate Polynomial Interpolation on Monotone Sets

By Nira Dyn

Joint work with Michael Floater from the Univedrsity of Oslo.

This talk discusses multivariate polynomial interpolation
on monotone sets of points in any number of dimension.
Such a set can be expressed as the union of blocks of points.
A natural polynomial space in which the interpolation problem is correct,
is the span of a collection of monomials with powers taken from
a similar monotone set of indices.

The main result of this talk is that the natural interpolant on a monotone set
can be expressed as a linear combination
of tensor-product interpolants over various intersections
of the blocks that define the monotone set.

The Averaging Principle

By Gadi Fibich

Joint work with Arieh Gavious and Eilon Solan

Typically, models with a heterogeneous property are considerably harder to analyze than the corresponding homogeneous models, in which the heterogeneous property is replaced with its average value. In this talk I will show that any outcome of a heterogeneous model that satisfies the two properties of differentiability and interchangeability, is O(\epsilon^2)$ equivalent to the outcome of the corresponding homogeneous model, in which the heterogeneous quantity is replaced with its average, where ϵ is the level of heterogeneity. We then use this averaging principle to obtain new results in queuing theory, game theory (auctions), and social networks (marketing).

Extrapolation Models

By David Levin

We discuss the role of linear models for two extrapolation problems. The first is the extrapolation to the limit of infinite series, i.e. convergence acceleration. The second is an extension problem: Given function values on a domain *D*0, possibly with noise, we would like to extend the function to a larger domain *D*, containing *D*0 . In addition to smoothness at the boundary of *D*0, the extension on *D* \ *D*0 should also resemble behavioral trends of the function on *D*0, such as growth and decay or even oscillations. In both problems we discuss the univariate and the bivariate cases, and emphasize the role of linear models with varying coefficients.

High-Dim Sampling and Interpolation of Signals with bounded Spectrum

By Alexander Olevskii

I plan to remind classical background and to focus on some recent progress in the subject.

Universality for Chebyshev-Type Quadratures

By Ron Peled

Joint work with Shoni Gilboa.

A Chebyshev-type quadrature for a density f is a quadrature formula having equal weights which integrates polynomials up to a given degree exactly as f does. Bernstein considered the case that f is the uniform density on an interval and proved that the minimal number of nodes possible in a Chebyshev-type quadrature of degree k is of order k^2. We prove the same for any Lipschitz density on an interval which is bounded away from zero.

On A Well-Tempered Diffusion

By Philip Rosenau

The classical transport theory as expressed by, say, the Fokker-Planck equation, lives in an analytical paradise but, in sin. Not only its response to initial datum spreads at once everywhere oblivious of the basic tenets of physics, but it also induces an infinite flux across a sharp interface. Attempting to overcome these difficulties one notices that the moment expansion of any of the micro ensembles of the kind that beget the equations of the classical mathematical physics, say the Chapman-Enskog expansion of Boltzmann Eq., if extended beyond the second moment, yields an ill posed PDE (the Pawla Paradox)!
We shall describe mathematical strategies to overcome these generic difficulties. The resulting flux-limited transport equations are well posed and capture some of the crucial effects of the original ensemble lost in moment expansion. For instance, initial

discontinuities do not dissolve at once but persist for a while. There is a critical transition from analytical to discontinuous states with embedded sub-shock(s).

Singular Limits of Nonlinear Evolution Equations and their Numerical Approximations

By Steve Schochet

After reviewing the classical theory of singular limits for nonlinear evolution equations, several extensions of the theory will be presented, including results for systems with variable-coefficient large terms, for systems having multiple scales, and for finite difference schemes.

Certainties and Uncertainties in the Principle of Uncertainty

By Nir Sochen

Joint work with H.-G. Stark, R. Levie, F. Lieb and D. Lantzberg

Measuring simultaneously two features in a signal/image involves in a natural way the principle of uncertainty for two self-adjoint operators. We show in this talk that unlike the time-frequency case we have a completely different behaviour once other Lie groups are relevant. We further show that the interpretation, and therefore, the generalisation of the principle of uncertainty to other Lie groups is more subtle than expected. The new concepts developed are used to enhance the analysis of signals/images and to create new bases/frames which best suit our needs in signal/image processing.

Regularizing Effect for the Boltzmann Equation

By Tong Yang

In this talk, we will present our recent works on the smoothing effect on solutions to the Boltzmann equation without angular cutoff. Firstly, for the spatially homogeneous Boltzmann equation, in a joint work with Alexandre-Morimoto-Ukai-Xu, we show that every L^1 weak solution with finite moments of all order acquires C^1 regularity in any positive time. And then in a joint work with Morimoto, we show that Villani conjecture holds for the Maxwellian molecule type cross section.
That is, any weak solution with measure initial datum except a single Dirac mass acquires C1 regularity in any positive time. Here, the coercivity estimate plays an important role. In particular, to prove Villani conjecture, a new time degenerate coercivity estimate is given. And then we will present some works on the spatially inhomogeneous Boltzmann equation which are joint works with R. Alexandre, Y. Morimoto, S. Ukai and C.-J. Xu.

Asymptotic Expansions for Second-Order Difference Equations

By Roderick Wong

While asymptotic theory for second-order linear differential equations is now well known, the same cannot be said about the second-order linear difference equations. In this talk, I will mention some of the difficulties we have encountered in the development of such a theory for difference equations, and present some of the results that we have obtained in the last 10 to 15 years.

Asymptotic Analysis of a Viscous Drop Falling Under Gravity

By Jonathan Wylie

Despite extensive research on extensional flows, there is no complete explanation of why highly viscous fluids falling under gravity can form such persistent and stable filaments. We therefore investigate the motion of a slender axisymmetric viscous drop that is supported at its top by a fixed horizontal surface and extends downward under gravity. We consider the full initial-boundary-value problem for arbitrary initial shape of the drop in the case in which inertia and surface tension are initially negligible. We show that, eventually, the accelerations in the thread become sufficiently large that the inertial terms become important. We therefore keep the inertial terms and obtain asymptotic solutions for the full initial-boundary-value problem. The asymptotic procedure requires a number of novel techniques and the resulting solutions exhibit surprisingly rich behavior. The solution allows us to understand the mechanics that underlies highly persistent filaments.

Mathematical Theories on Linear and Nonlinear Wave Motions in Viscous Compressible Fluid

By Shih-Hsien Yu

In this talk we will briefly review the mathematical theories on the compressible viscous fluid developed in terms of pointwise structure of the wave propagators. The mathematical compressible viscous fluids include conservation laws with artificial viscosity, compressible Navier-Stokes equations, Boltzmann equations, and Lax-Friedrichs scheme.

One interest is on constructing the wave propagators around the far fields and use it to construct the nonlinear waves scattering theory over a shock layer for planar wave perturbation; and one can use the wave propagators to construct the invariant manifolds for the Boltzmann equation and study the bifurcation problems of the condensation-evaporation problem for the Boltzmann equation in a half space domain. This condensation-evaporation problem was introduced by Y. Sone.

A Singular Perturbation Approach to PDE: an Application to Option Prices with Stochastic Volatility

By Qiang Zhang

We consider a PDE in high dimensions. This PDE has an important application in modern finance. It determines the prices of options under Heston model of stochastic volatility. The solution of this PDE is expressed in terms of integrals in the complex plane. However, there are difficulties in evaluating these expressions numerically. We present closed-form approximate solutions for this PDE. We method is based on a multiple-scale analysis in singular perturbation theory. Our theoretical predictions are in excellent agreement with numerical solutions. Usually, an singular perturbation method gives an asymptotic expansion and the solution diverges when the perturbation parameter becomes large. We show a surprising result in our approach: our approximate solution is valid not only in the regime where the perturbation parameter is small, but also in the regime where the perturbation parameter is large! This means that the solutions in these two different regions can be approximated by the same function.