Evyatar Hacker

Title: Nonlinear Dynamics and Orbital Instabilities in Magnetic Resonance Force Microscopy

Magnetic resonance force microscopy (MRFM) is an imaging technique that enables acquisition of threedimensional magnetic images at nanometer scales which has been adapted for detection of the magnetic spin of a single electron. This technique is based on combining the technologies of magnetic resonance imaging (MRI) with atomic force microscopy (AFM), and is implemented mechanically using a vibrating sensor to directly detect a modulated spin gradient force between sample spins and a ferromagnetic particle attached to the tip of an AFM microcantilever. While MRFM systems are receiving a growing amount of interest, to date, a comprehensive theoretical treatment is still lacking. Existing models are based on simplistic lumped-mass reductions that include linear estimates of cantilever stiffness and damping complemented by a nonlinear approximation of the magnetic force. We thus formulate a nonlinear initial-boundary-value problem (IBVP) combining the micro-cantilever motion and the magnetic moments of the spin. We reduce the IBVP to a modal dynamical system and investigate its orbital stability via multiple-scale asymptotics augmented by numerical integration which reveal both local bifurcations and existence of lengthy chaotic-like transients in low damping operation conditions. This research is with Oded Gottlieb – Mechanical Engineering, Technion.

Jinkai Li

Title: Some recent developments on the primitive equations with partial dissipation

The primitive equations form a fundamental block in the models of oceanic and atmospheric dynamics. They are derived from the Navier-Stokes equations by applying the Boussinesq and hydrostatic approximations. Generally the viscosities and diffusion for the ocean and atmosphere are anisotropic. In this talk, I will talk about the global well-posedness of strong solutions to the primitive equations with only partial dissipation. These are joint works with Chongsheng Cao and Edriss S. Titi.
Reuven Segev

Title: Some Geometric Aspects of Stress Theory

Stress tensors are used in strength analysis of structures, fluid dynamics, electromagnetism, and general relativity. Yet, from the theoretical point of view, the stress tensor object is not a primitive one. It is derived on the basis of some physically motivated mathematical assumptions which one would like to weaken. A formulation of stress theory that applies to the geometry of differentiable manifolds, devoid of any particular Riemannian metric or a connection, will be presented. The properties of stresses emerge naturally from the structure of the configuration space, a manifold of mappings, of a material body in the physical space.

Ram Band

Title: Universality of the momentum band density of periodic graphs

The momentum spectrum of a periodic network (quantum graph) has a band-gap structure. We investigate the relative density of the bands or, equivalently, the probability that a randomly chosen momentum belongs to the spectrum of the periodic network. We show that this probability exhibits universal properties. More precisely, the probability to be in the spectrum does not depend on the edge lengths (as long as they are generic) and is also invariant within some classes of graph topologies. Based on a joint work with Gregory Berkolaiko.
Asher Yahalom

Title: Non-Stationary Barotropic Magnetohydrodynamics as a Four Function Field Theory

Variational principles for magnetohydrodynamics were introduced by previous authors both in Lagrangian and Eulerian form. In a previous work [1] we introduced a simpler Eulerian variational principles from which all the relevant equations of magnetohydrodynamics can be derived. The variational principle were given in terms of six independent functions for non-stationary flows and three independent functions for stationary flows. This is less than the seven variables which appear in the standard equations of magnetohydrodynamics which are the magnetic field the velocity field and the density. In this work [2, 3] we will attempt to improve on our previous results thus reducing the number of functions needed even further.


Nir Sharon  Department of Applied Math, Tel Aviv University, Israel

Title: Laplacian multi-wavelets bases for high-dimensional data and their applications

We introduce a framework for representing functions defined on high-dimensional data. In this framework, we propose to use the eigenvectors of the graph Laplacian to construct a multiresolution analysis on the data, resulting in a one parameter family of orthogonal bases. We describe the construction of such bases, their properties, and derive a bound on the decay rates of the expansion coefficients. In addition, the question of measuring the smoothness of discrete functions is addressed based on a discrete analogue of Besov spaces. We also present a few applications for this family of bases and report an ongoing research related to future applications.

This is a joint work with Yoel Shkolnisky.

Boaz Ilan

Title: Temporal – spectral symmetries in ultrafast optics

When two pulses with well-separated central frequencies co-propagate in a dispersive medium, their spectral amplitudes can be mirror images. This phenomenon, called spectral mirror imaging (SMI), has been observed in nonlinear optics. The physical system can be modeled using coupled nonlinear Schrodinger (NLS) equations. SMI is explained using asymptotic analysis of a simplified linear system. Direct numerical computations of the NLS system confirm the analytical predictions and also show that “parasitic” effects can break up the symmetries. This understanding can lead to new ways to control ultrashort optical pulses.
Title: The stochastic transport equation in nuclear physics: advances and applications

Perhaps the most basic equation in both reactor statics and dynamics is the transport equation, describing the neutron population in the system in term of the neutrons birth, death and scattering intensities. Unlike the classic transport equation (Boltzmann equation), where the conservation laws are written in terms of the average neutron population, in the stochastic transport equation conservation laws are written in terms of population distribution and the complete probability theorem. On one hand, this allows us to study higher moments of the neutron population, while on the other, the high complexity of the equations provides as from modeling even simple spatial, energetic and systematic effects. In the talk, I will introduce the stochastic transport equation in the context of nuclear physics, explain why the higher moments are of such importance, and introduce two advances from the recent years: the mathematical modeling of dead time effect, and a multi-energy multi-cell formalism for the stochastic transport equation. Finally, I will introduce some very natural question arising from the stochastic transport equation, with a surprisingly simple mathematical formalism, which are still open problems.