Annual Meeting of the Israel Mathematical Union-2024

Mathematical Physics Session

Abstracts

The effect of "unnatural" rotation rate on cholesteric liquid crystals

Yaniv Almog

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We study the minimization of the energy functional associated with cholesteric liquid crystals. We consider two types of problems:

1. Stability of a stationary solution where the molecules rotate at an "unnatural" rate (and which cannot be, therefore, the global minimizer of the associated energy functional).
2. Assuming one-dimensional behavior, we obtain the global minimizer for the same boundary conditions as in the first problem.

Mean curvature flow in spaces with positive cosmological constant

Or Hershkovits

Hebrew University

In this talk, I will describe an approach of using Lorentzian mean curvature flow (MCF) to probe "expanding universes" (such as, presumably, ours) with matter that is assumed to be attracted to matter (formally, this assumption is called the "strong energy condition").

Assuming 2-dimensional symmetry, I will explain how the mean curvature flow can be used to show that such universes become asymptotic, in some sense, to the maximally symmetric such universe - de Sitter space. This proves a special case of the de Sitter no hair conjecture of Hawking and Gibbons.

Unfortunately, the early universe did not support such two-dimensional symmetry, rendering the above mentioned result physically insignificant. As a first step for removing the above symmetry assumption, I will illustrate a condition, natural in the above context, such that any local graphical mean curvature flow (without symmetry) in de Sitter space satisfying that condition converges to a certain "universal flow".

Effort will be made to make the talk accessible to the wide mathematical audience. In particular, no "physics reasoning" will be involved. This is based on a joint work with Creminelli, Senatore and Vasy, and on a joint work with Senatore

On some Impact-like Hamiltonian systems

Vered Rom-Kedar

Weizmann Institute of Science

The dynamics associated with mechanical Hamiltonian systems with smooth potentials that include sharp fronts is traditionally modeled by Hamiltonian impact systems: a class of generalized billiards by which the dynamics in the domain's interior are governed by smooth potentials and at the domain's boundaries by elastic reflections. I will first discuss the properties of this singular limit, culminating in the recent work with D. Turaev in which we established the non-ergodicity of smooth N repelling particles in a box at arbitrarily high energy. Then, I will introduce the class of quasi-integrable Hamiltonian impact systems, where the motion on some level sets is conjugated to a directed motion on a translation surface of a genus larger than one. We propose mechanical realizations of such systems, analyze ergodic properties and quantum properties of classes of such systems, and study their behavior under perturbations (in joint works with L. Becker, S. Elliott, B. Firester, S. Gonen Cohen, I. Pazi, M. Pnueli, K. Fraczek, O. Yaniv and A. Zobova).

Semiclassical asymptotics of spectrum for operators on Lie algebras $su(1,1)$

Evgeny Vybornyi

Braude College of Engineering

We will consider the problem of constructing semiclassical spectral asymptotic including the tunneling asymptotic for operators on Lie algebra $su(1,1)$. Operators on Lie algebra $su(1,1)$ naturally arise from the averaging of small perturbations in multidimensional magnetic Schrodinger equations with corresponding groups of symmetries. The pure algebraic formulation of the problem allows us to choose an irreducible representation to simplify the study of semiclassical asymptotics. We construct the special irreducible representation on coherent states and a unitary coherent transform that reduces the problem to the one-dimensional differential operator in the space of holomorphic functions. We also construct other representations which are more suitable for numerical simulations. Using the constructed representations, we obtain and prove semiclassical asymptotic of the spectral series and asymptotic of the exponentially small tunneling effect for this class of operators. The highly excited energy states as well as the low lying eigenvalues, which are close to points of stable equilibriums of the corresponding classical system, are considered. We will also discuss the methods of the proofs and the topology meaning of the obtained results.