Institute for Advanced Studies
in Basic Sciences
Gava Zang, Zanjan, Iran

27th Annual IASBS Meeting on Condensed Matter Physics – May 18-19, 2022

First day, Wednesday, May 18, 2022

Time (Tehran) Time (CET)	Speaker	From	Title	Chair
9:00-9:30(Tehran) 6:30-7:00(CET)			Opening	
9:30-10:30 (Tehran) 7:00-8:00 (CET)	**Nahid Azimi**	Institute for Advanced Studies in Basic Sciences	Interaction between disease spreading and preventive measures	Z. Faraei
10:30-11:30 (Tehran) 8:00-9:00 (CET)	**Ali Esfandiar**	Sharif University of Technology	Selective Ion transport through angstrom scale channels for Highly efficient Osmotic Power Generator	Z. Faraei
11:30-12:30 (Tehran) 9:00-10:00 (CET)	**Giovanni Volpe**	University of Gothenburg	The AnDi Challenge: Objective comparison of methods to decode anomalous diffusion	A. Najafi
60 Min.	Lunch Break			
13:30-14:30 (Tehran) 11:00-12:00 (CET)	**Weria Pezeshkian**	University of Copenhagen	Spatial Organization of Biomembranes: A Computational View	A. Najafi
14:30-15:30 (Tehran) 12:00-13:00 (CET)	**Andre E. Botha**	University of South Africa	Josephson junction-based models of neurons	M. Kolahchi
15:30-16:30 (Tehran) 13:00-14:00 (CET)	**Abolfazl Ramezanpour**	Shiraz University	Statistical Physics of Cities	M. Kolahchi
15 Min.	Coffee Break			
16:45-18:00 (Tehran) 14:15-15:30 (CET)	**Poster**			

Second day, Thursday, May 19, 2022

Time (Tehran) Time (CET)	Speaker	From	Title	Chair
9:00-10:00(Tehran) 6:30-7:30(CET)	**Poster**			
10:00-11:00 (Tehran) 7:30-8:30 (CET)	**Contributed Talks**		1- Fatemeh Heydarinasab 2- Forouh Maleki 3- Sepideh Mehramouz 4- Fatemeh Taghizadeh	A. Najafi
30 Min.	Coffee Break			
11:30-12:30 (Tehran) 9:00-10:00 (CET)	**Rosario Fazio**	ICTP	Collective effects in quantum heat engines	S. Jahromi
12:30-13:30 (Tehran) 10:00-11:00 (CET)	**Frédéric Mila**	EPFL	Tensor network investigation of frustrated quantum magnets	S. Jahromi
13:30-14:30 (Tehran) 11:00-12:00 (CET)	**Akbar Jafari**	Sharif University of Technology	Solid-state spacetimes	Z. Faraei
14:30-15:00 (Tehran) 12:00-12:30 (CET)			Closing	

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Abstracts

First day, Wednesday, May 18, 2022

Nahid Azimi
Institute for Advanced Studies in Basic Sciences

Title: Interaction between disease spreading and preventive measures

Abstract:
The prevention and control of the spread of diseases have always been important issues in human societies. Social behaviors such as wearing face masks and vaccination clearly influence disease prevalence, and in contrast the spreading of disease can determine the behavioral responses of individuals. In this talk, first we introduce a model in which individuals are influenced by their social contacts in the process of opinion formation about a vaccination process. The effect of the vaccine efficiency on the epidemic threshold and prevalence is investigated. At the following, we study the coevolution of the individual's protective behaviors and the spread of a disease by considering two different social attitudes within the same population: concerned and risky. In the framework of game theory, we find the effect of the protection strategy on the epidemic threshold for each of the two subpopulations and study under which conditions risky individuals are persuaded to protect themselves or, on the contrary, can take advantage of a herd immunity.

Ali Esfandiar
Sharif University of Technology

Title: Selective Ion transport through angstrom scale channels for Highly efficient Osmotic Power Generator

Abstract:
Ion-exchange membrane-based reverse electrodialysis (RED) shows great potential for harvesting osmotic energy from seawater and converting to electricity. However, low energy conversion efficiency and huge ionic resistance hinder the traditional membranes to be used in viable applications. Implementation of Nanofluidic channels in the RED devices can greatly improve the performance of osmotic power generators due to their selective and fast ion transport. Technical challenges in the scalable processing at the nanoscale on ion-selective membranes restrict their development in economically efficient generators. Here, we report fibrous based channels as positively and negatively charged MXene fiber (P-MF and N-MF) to extract osmotic energy from the salt gradient of river and seawater. Due to the narrow (<2 nm), two-dimensional and high surface charge densities (~ 4 mC/m2) of nanochannels, the oppositely charged fiber membranes provide excellent transmissibility and ion selectivity, and a stable output power density of 12.3 Wm-2. This record is much higher than the commercialization benchmark (5 Wm-2) and promises the osmotic power harvesters a sustainable and renewable energy source. In this talk in addition to review on experimental approaches, the ionic separation mechanisms will be discussed.

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Giovanni Volpe
University of Gothenburg

Title: The AnDi Challenge: Objective comparison of methods to decode anomalous diffusion

Abstract:
Deviations from Brownian motion leading to anomalous diffusion are found in transport dynamics from quantum physics to life sciences. The characterization of anomalous diffusion from the measurement of an individual trajectory is a challenging task, which traditionally relies on calculating the trajectory mean squared displacement. However, this approach breaks down for cases of practical interest, e.g., short or noisy trajectories, heterogeneous behaviour, or non-ergodic processes. Recently, several new approaches have been proposed, mostly building on the ongoing machine-learning revolution. To perform an objective comparison of methods, we gathered the community and organized an open competition, the Anomalous Diffusion challenge (AnDi). Participating teams applied their algorithms to a commonly-defined dataset including diverse conditions. Although no single method performed best across all scenarios, machine-learning-based approaches achieved superior performance for all tasks. The discussion of the challenge results provides practical advice for users and a benchmark for developers.

Weria Pezeshkian
University of Copenhagen

Title: Spatial Organization of Biomembranes: A Computational View

Abstract:
Biomembranes are essential functional elements of the cellular architecture, providing identity to the cell as a whole, through the enveloping plasma membrane, and many internal organelles and actively participating in vital cellular processes. Live cell membranes are characterized by heterogeneity in their chemical composition and complexity in their shape, which are adapted constantly. Advanced experimental methods, e.g., super-resolution microscopy and electron tomography, have greatly enhanced our understanding of the lateral and spatial organization of biomembranes and will undoubtedly continue to do so. However, the inherent limitations of these approaches have rendered certain features of processes involving cellular membranes inaccessible. Computer simulation techniques have emerged as an indispensable complement. Recently-developed, multiscale simulation schemes bridge the necessary spatiotemporal gaps and offer a unique opportunity to explore complex cellular processes.

In this talk, I will present our recent advances in exploring biomembrane spatial organizations using multiscale computer simulations. I will discuss how simulations can provide detailed insight into these processes and provide predictions for experimental validation. I specifically focus on membrane-mediated interactions between proteins, protein cooperativity induced membrane deformations, and membrane-curvature-induced lipid and protein sorting. Finally, I will also discuss how close we are, in terms of complexity and scale, to simulating realistic membranes and sketch a possible way ahead.

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Andre E. Botha
University of South Africa

Title: Josephson junction-based models of neurons

Abstract:
One of the main reasons for introducing the Josephson junction neuron was to provide a relatively cheap and efficient way to manufacture large artificial neural networks containing tens of thousands of junctions; a number which is still well beyond the present-day reach of numerical simulations, and relatively small in comparison to real biological neural networks. In the last decade, or so, Josephson junction circuit models of the electric activity in neurons have been shown to replicate important phenomena, such as, bursting and even memory. Furthermore, the action potentials provided by the Josephson junction neuron match those of the Hodgkin-Huxley neuron, which is arguably the most accurate neuron model. In this brief introduction and review I will consider the existing Josephson junction-based neuronal models and some of their many potential applications, e.g., in neuromorphic computing.

Abolfazl Ramezanpour
Shiraz University

Title: Statistical Physics of Cities

Abstract:
The number of people living in big cities is rapidly increasing. Understanding the structure and function of these cities is essential for sustainable development. For instance, characterizing the movement of people from their homes to work places would be helpful in managing the efficiency of such a process. In this talk, we see how the tools and concepts of statistical physics can help us in the study of cities and briefly review the related works and questions in this field.

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Second day, Thursday, May 19, 2022

Rosario Fazio

ICTP

Title: Collective effects in quantum heat engines

Abstract:
Recent predictions for quantum-mechanical enhancements in the operation of small heat engines have raised renewed interest in their study from both a fundamental perspective and because of applications. One essential question is whether collective effects may help to carry enhancements over larger scales when increasing the number of constituents composing the working substance of the engine (with possibly the presence of spontaneous symmetry breaking). Such enhancement may consider not only its performance but also the stability of the engine concerning unavoidable environmental fluctuations. After a first analysis on the ultimate power in a simple model of a thermal machine (a two-level quantum system), I will discuss the properties of a quantum heat engine in which the working substance is composed by a system of interacting spins.

Frédéric Mila

EPFL

Title: Tensor network investigation of frustrated quantum magnets

Abstract:
Frustrated quantum magnetism is a fascinating subject in its own right due to the numerous experimental examples that are continuously discovered and to the possibility to realise exotic phases such as quantum spin liquids. This field is however also interesting as an example of strongly correlated systems with only spin degrees of freedom, yet with a severe minus sign problem typical of fermionic systems for quantum Monte Carlo simulations. In this talk, I will review recent progress that has been made on this problem using tensor networks, with emphasis on finite-temperature properties and on the numerical verification of the long standing prediction of an Ising transition in the spin-1/2 J1-J2 Heisenberg model on the square lattice

Seyed Akbar Jafari

Sharif University of Technology

Title: Solid-state spacetimes

Abstract:
The energy band structure of certain solids is composed of tilted Dirac cones. In this talk I will try to convince the audience that an emergent spacetime metric is behind the scenes. I will point out some outstanding novel solid-state phenomena that can take place in a non-trivial spacetime background. I will end by discussion of perspectives for engineering curvature in solid-state systems and its consequences.

Contributed Talks:

Mehramouz, Sepideh; Rasouli Jamnani, Samaneh; Milani Moghaddam, Hossain

Title: An Investigation of the effect of Polyvinylpyrrolidone concentration on the morphology and optical band gap of cerium oxide

Abstract:

In this work, the nanostructures of CeO2 were synthesized by hydrothermal method with different concentrations of Polyvinylpyrrolidone (PVP) as a surfactant. The effect of concentration of PVP was evaluated on structural, morphological and optical properties of Cerium Oxide, with characterizations such as X-Ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM) and Ultraviolet–Visible spectroscopy (UV-Vis) respectively. Tauc equation was applied to calculate the optical energy bandgap. The obtained results showed that synthesized samples have good and single phase crystallinity with micropolyhedron morphology that composed of triangular nanoplates. Furthermore, with decreasing the concentration of PVP the optical band gaps have been decreased.

Heydarinasab, Fatemeh; Abouie, Jahanfar

Title: Spin liquid phase in frustrated mixed-spin chains: effects of three-site four-spin interactions

Abstract:

The ground state phase diagram of frustrated mixed-spin (1, 1/2) chains with three-site four-spin interactions is investigated by means of cluster mean field theory and cluster variational method. We show that the interplay of next-nearest-neighbors and three-site interactions leads to the emergence of different quantum phases such as antiferro-quadrupole and quantum spin-liquid phases.

Maleki, Forouh; Najafi, Ali

Title: Growth in an active nematic system

Abstract:

Growth and morphogenesis in biological systems, including cancerous tissue and bacterial colonies, are important challenges in the field of medicine and food safety. Much is known about the molecular and genetic bases of this processes, but less about the underlying physical mechanisms. In this paper, in order to investigate these systems, we provide a hydrodynamic description of a growing two-component system (active nematic cells and intercellular fluid) , and then

investigate instability in this system. We observe that activity and growth effects induce instability and waves propagation in the system.

Taghizadeh, Fatemeh; Zarei, Mina

Title: Investigating the structure and dynamics of adaptive networks under Hebbian rule

Abstract:

Structure of many real-world networks is changed during the dynamics. These networks are called adaptive networks. One of the important adaptive rules is Hebbian rule. In this paper, we investigate synchronization dynamics on adaptive networks under Hebbian rule. We used a rewiring method to model the Hebbian rule. Indeed, the structure of network evolves by rewiring of its links, according to the Hebbian rule. During Hebbian rewiring, the interactions are appeared more between in-phase nodes. Hence, by applying Hebbian rule, communities are appeared in the graph structure, and we will have local synchrony. Moreover, our results show that the strength of coupling effects on the number and size of communities.