One-day Discussion Meeting
on
Random Walks

Department of Physics
Ramakrishna Mission Vivekananda Educational and Research Institute
Belur Math, Howrah

Date: 16th January, 2019
Venue: Prajna Bhavan Seminar Hall

Schedule

10:00 am -- 11:00 am: **Luca Giuggioli** (University of Bristol, Bristol)

Title: *Territorial random walks and their application to the formation of animal territories*

Abstract: Various animals, mammals in particular, display some form of territorial behaviour for which they make their presence conspicuous to others claiming exclusive ownership of regions of space. The signals employed to perform this form of spatial exclusion may be visual, auditory or olfactory depending on the species and the environment. When the mechanism of territorial exclusion occurs via marks deposited on the terrain (olfactory cues), the interaction between the individuals is indirect and mediated by the environment. For these cases biologists have coined the name stigmergy to indicate that an action occurs upon finding marks on the terrain.

To study the emergence of spatial segregation in these stigmergic systems I have introduced a new type of collective animal movement model where alignment of the agents does not play any role. It is called the territorial random walk. It consists of agents that move freely as random walkers on a lattice, scent-marking the terrain wherever they go. As deposited marks remain active for a finite amount of time, each walker retreats upon encountering an active foreign scent. The emerging spatio-temporal dynamics of the system can be quite rich and can be studied at the meso-scale (the territories) as well as at the micro-scale (the agents). At the meso-scale short-lived marks produce rapidly morphing and highly mobile territories, while long-lived marks yield slow territories with a narrowly defined shape distribution.

I will focus the talk on showing that complex ecological/biological systems, such as a population of scent-marking territorial animals, may undergo phase transition that one might naively think can only happen in physical systems. I will show that the full spectrum of territory mobility, as a function of the time for which individual marks remain active, is accompanied by a liquid-hexatic-solid transition akin to the so-called Kosterlitz-Thouless melting scenario observed in some 2D material systems when temperature is increased.

If time allows, I will present some findings on how some of these ideas can be used to construct algorithms that improve coverage efficiency in a swarm of autonomous moving robots.

References

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11:00 am – 11:30 am Tea/Coffee

11:30 am – 12:30 pm: **C M Chandrashekar** (Institute of Mathematical Sciences, Chennai)

Title: *Quantum random walks and its operational perspective of quantum simulations*
Abstract: Simulations of one quantum system by an other system has an implications in realization of quantum machine that can imitate any quantum systems and solve problems that are not accessible to classical computers. Classical random was has played an important role in simulating and understanding the dynamics of various classical systems around us. Quantum walks are considered to be quantum counterparts of classical random walk. Therefore, a similar role is envisioned to be played by quantum walk in simulating and understanding the dynamics of quantum systems. With the advancements in quantum information theory, different version of quantum walks and quantum random walks have been developed for application in quantum algorithms and mimicking/simulating dynamics of various physical systems. In this talk I will introduce different operational forms of quantum walks that has been developed and its potential to simulate Dirac equation (in flat and curved space [3]). In particular will focus on the accelerated quantum walks which allows us to study the transition from localization to deloclaization as a function of acceleration.

References
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12:30 pm – 1:30 pm: **P K Mohanty** (Saha Institute of Nuclear Physics, Kolkata):

Title: *Random walkers: Diffusive modes of transport*
Abstract: Driven systems are associated with a net flow of some physical quantity, namely “current”, which is the main observable that distinguishes non-equilibrium steady states from their equilibrium counterparts. Interacting particle systems have multiple current carrying modes, which are usually diffusive and can be modeled by random walkers; we show that slowing down of some of the non-driven modes can lead to (a) negative response: current decreases with increasing bias (b) current reversal or uphill current : for a fixed bias, the direction of current can be reversed by changing the particle density. We demonstrate these phenomena in several driven interacting particle systems where the steady state probabilities can be obtained exactly.

1:30 pm – 2:30 pm Lunch

2:30 pm – 3:30 pm: **É Roldán** (ICTP, Trieste)

Title: *Stochastic resetting in RNA transcription*
Abstract: Transcription is a key process in gene expression, in which RNA polymerases produce a complementary RNA copy from a DNA template. RNA polymerization is frequently interrupted by backtracking, a process in which polymerases perform a random walk along the DNA template. Recovery of polymerases from the transcriptionally-inactive backtracked state is determined by a kinetic competition between 1D diffusion and RNA cleavage, as shown by single-molecule high-resolution experiments [1].

We describe backtrack recovery as a continuous-time random walk, where the time for a polymerase to recover from a backtrack of a given depth is described as a first-passage time of a random walker to reach an absorbing state. We describe RNA cleavage as a stochastic resetting process, and derive exact expressions for the recovery time distributions and mean recovery times from a given initial backtrack depth [2]. Furthermore, we use our stochastic-resetting model to describe quantitatively experimental data from yeast RNA polymerase I and II, unraveling the distinct physical mechanisms used by these enzymes to recover from transcriptional pauses.

References

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3:30 pm – 4:00 pm Tea/Coffee

4:00 pm – 5:00 pm: **S Gupta** (RKMVERI, Belur Math)

Title: *Classical random walks with stochastic resetting*

Abstract: *What happens when a classical random walk is interrupted with abrupt resets to a fixed location* at random intervals of time? This talk will unveil a wide spectrum of rich long-time behavior that the resulting dynamics exhibits, from an ever-preading spatial distribution, to one that is time independent and characterizes a nonequilibrium stationary state. The implication of the results for physical situations of relevance will be discussed.

References

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