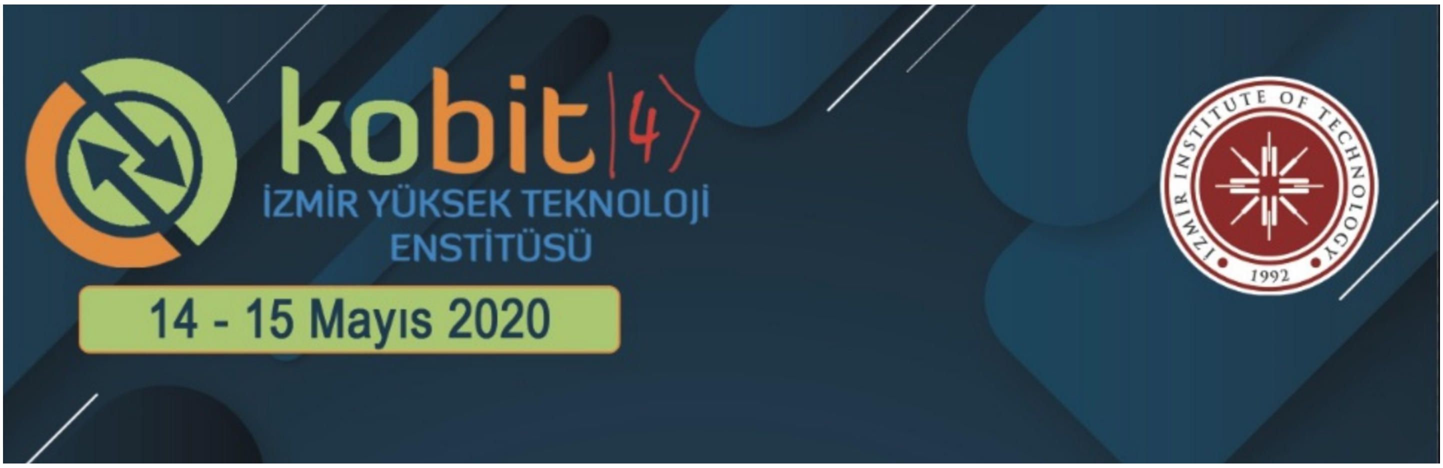

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Önsöz

2016 yılından beri ülkemizde kuantum optiği ve bilişim alanında halihazırda çalışmakta olan veya çalışmayı hedefleyen araştırmacıları bir araya getirmek amacıyla yapılan toplantımızın 2020 yılında İzmir Yüksek Teknoloji Enstitüsü ev sahipliğinde İzmir'de düzenlenmesi planlanmaktaydı. Fakat bütün dünyayı etkisi altına alan COVİD-19 salgını nedeniyle toplantının 14-15 Mayıs 2020 tarihlerinde video konferans olarak yapılmasına karar verildi. Ana konuşmacı olarak Charles Fabry Laboratuvarı'ndan Philippe Grangier'in iki konuşma vereceği toplantımızda 8 davetli ve 6 kısa sunum yapılacaktır. Ayrıca poster sunumlarıyla 7 araştırmacı da toplantıya katkıda bulunacaktır.

Desteklerinden dolayı İzmir Yüksek Teknoloji Enstitüsü ve sponsorlarımız Optomek ve Eduline Bilişim'e teşekkür ederiz.

Bütün katılımcılara katkıları için teşekkür eder, iyi bir toplantı geçirmenizi dileriz.

Düzenleme Kurulu

Serkan Ateş
Özgür Çakır
Sevilay Sevinçli

Foreword

Quantum Optics and Information meeting series have been held since 2016 in Turkey and this year the fourth meeting of the series was scheduled to be held at Izmir Institute of Technology on 14-15 May 2020. However due to COVID-19 pandemic the meeting was converted into an online event. This year our plenary speaker Philippe Grangier from Laboratoire Charles Fabry will present two talks. In our program we will have 8 invited talks and 6 short talks along with 7 poster presentations.

We would like thank Izmir Institute of Technology for their support in the organization of this event and our sponsors OPTOMEK and EDULINE.

We thank all the participants for their interest and contributions in this meeting. We wish you to have a nice meeting.

Organization Committee

Serkan Ateş
Özgür Çakır
Sevilay Sevinçli

	14 Mayıs 2020
	1. Oturum, Oturum Bşk.: Ö. Müstecaplıoğlu, A. Bek
	10:00 – 12:10 (GMT+3)
10:00	**Açılış**
10:15-11:15	Quantum Optics and Quantum Communications using Gaussian and Non-Gaussian States of Light **Philippe Grangier**, Charles Fabry Laboratuvarı, Fransa
11:30-12:00	Quantum entanglement for sensing with atoms and light **Onur Hoşten**, IST, Avusturya
12:10	**Ara**
13:00	**Poster Sunumu I**
	2. Oturum, Oturum Bşk.: S. Turgut, O. Umucalılar
	14:00 – 16:20 (GMT+3)
14:00-14:30	Quantum coherence in biology **Iannis Kominis**, Girit Üniversitesi
14:40-15:10	Quantum Computing with Fourier Optics **Burhan Gülbahar**, Özyeğin Üniversitesi
15:20-15:35	Role of quantum coherence and correlations in heat flow **Onur Pusuluk**, Koç Üniversitesi
15:40-15:55	Topological Friction in a Finite-Length Kitaev Chain Engine **Elif Yunt**, Malta Üniversitesi
16:05-16:20	Quantum coherence protection by using auxillary qubits **Esfendyar Faizi,** Azerbaijan Shahid Madani Üniversitesi
16:20	**Ara**
	3. Oturum, Oturum Bşk.: C. Bulutay, E. Taşgın
	17:00 – 18:40 (GMT+3)
17:00-17:30	Loss and non-Hermiticity in quantum processes **Şahin Kaya Özdemir**, Pensilvanya Eyalet Üniversitesi
17:40-17:55	The Landscape of Academic Literature in Quantum Information Technologies **Zeki Seskir**, Ortadoğu Teknik Üniversitesi
18:05-18:35	Optical photon generation from a superconducting qubit **Alp Sipahigil,** Kaliforniya Teknoloji Enstitüsü

	15 Mayıs 2020
	1. Oturum, Oturum Bşk.: Z. Gedik, K. Durak
	10:00 – 11:55 (GMT+3)
10:00-11:00	Quantum cryptography with continuous variables : theory and implementations **Philippe Grangier**, Charles Fabry Laboratuvarı, Fransa
11:15-11:45	Engineering a quantum satellite constellation **Alexander Ling**, Kuantum Teknolojileri Merkezi, Singapur
11:55	**Ara**
12:45	**Poster Sunumu II**
	2. Oturum, Oturum Bşk.: S. Ateş, Ö. Çakır, S. Sevinçli
	14:00 – 16:15 (GMT+3)
14:00-14:30	Controlling Photophysics of Carbon Nanotubes for Enhanced Optoelectronic and Quantum Photonic Devices **İbrahim Sarpkaya**, UNAM, Bilkent Üniversitesi
14:40-15:10	Quantum Travel Time and Tunnel Ionization of Atoms **Durmuş A. Demir**, Sabancı Üniversitesi
15:20-15:35	Quantum Coin Flipping, Qubit Measurement and The Generalized Fibonacci Sequences **Oktay K. Pashaev**, İzmir Yüksek Teknoloji Enstitüsü
15:45-16:00	Kovaladıkça kaçan kuantum parçacığı **İskender Yalçınkaya**, Prag Çek Teknik Üniversitesi
16:00	**Kapanış**

	Poster Sunumu I
	14 Mayıs 2020
	13:00 – 13:45 (GMT+3)
13:00	Atom localization using Rydberg-EIT/ CPT with spatially dependent fields **T. Kirova**, *University of Latvia*
13:15	Spin-polarized DFT calculations of nitrogen-vacancy color centers in diamond with various XC potentials **B. Sarıkavak-Liseşivdin**, Gazi Üniversitesi
13:30	Effect of Eccentric Dimple Potentials on Propagation, Squeezing and Localization of Matter Waves **Devrim Tarhan**
	Poster Sunumu II
	15 Mayıs 2020
	12:45 – 13:45 (GMT+3)
12:45	Nuclear Spin Noise Spectra for Extremely Small Baths **Ekrem Taha Güldeste**, Bilkent Üniversitesi
13:00	Spin-coherence time measurements of NV^- centers in ${}_{15}N^+$, ${}_{15}N_2^+$ and O^+ implanted diamond **S. B. Liseşivdin**, Gazi Üniversitesi
13:15	Entanglement Generation and Its Transfer in Quantum Walks **Yusuf Karlı**, İzmir Yüksek Teknoloji Enstitüsü
13:30	Eigenstate clustering around exceptional points **Cem Yüce**, Eskişehir Teknik Üniversitesi

Konuşmalar / Talks

Quantum Optics and Quantum Communications using Gaussian and Non-Gaussian States of Light

Philippe Grangier

Laboratoire Charles Fabry, Institut d'Optique Graduate School, 91127 Palaiseau, France

During recent years, much progress has been achieved for generating non-Gaussian states of the light, such as Fock states, or optical "Schrödinger's cat" states [1]. Such states can be used for various quantum information protocols, including remote entanglement preparation [2], or non-deterministic noiseless amplification [3]. Generating high-purity Fock state is also possible [4]. We will review these recent developments, and discuss open perspectives for quantum information processing and communications.

[1] A. Ourjoumtsev, R. Tualle-Brouri, J. Laurat, and Ph. Grangier, “Generating Optical Schrödinger Kittens for Quantum Information Processing”, Science 312, 83 (2006).
[2] A. Ourjoumtsev, F. Ferreyrol, R. Tualle-Brouri, P. Grangier, “Preparation of non-local superpositions of quasi-classical light states”, Nature Physics 5, 189 (2009).
[3] F. Ferreyrol, M. Barbieri, R. Blandino, S. Fossier, R. Tualle-Brouri, and P. Grangier, “Implementation of a nondeterministic optical noiseless amplifier”, Phys. Rev. Lett. 104, 123603 (2010).
[4] E. Bimbard, R. Boddeda, N. Vitrant, A. Grankin, V. Parigi, J. Stanojevic, A. Ourjoumtsev, and P. Grangier, "Homodyne tomography of a single photon retrieved on demand from a cavity-enhanced cold atom memory", Phys. Rev. Lett. 112, 033601 (2014)

Quantum entanglement for sensing with atoms and light

Onur Hoşten

Institute of Science and Technology Austria

Recent advances in the level of precision in controlling atomic and optical systems have enabled the routine generation of quantum entanglement for sensing and information processing applications. Drawing from our experiments, in this talk I will focus on the properties, generation and usage of a particular set of entangled states called spin squeezed states, and, discuss the prospects of using them to improve the precision of cold atom based sensors.

After reviewing our recent spin squeezing experiments, I will mainly focus on the experimental demonstration of a concept we call quantum phase magnification [1]. To eliminate the detection-noise bottleneck in quantum metrology experiments, our particular realization of this conceptutilizes optical cavity-aided interactions between atoms to magnify quantum observables to-be-measured. The technique eliminates the need for low noise detection to achieve phase sensitivitiesbeyond the standard quantum limit.

[1] O. Hosten , R. Krishnakumar, N. J. Engelsen, M. Kasevich, Science 352, 1552 (2016).

Quantum coherence in biology

Iannis Kominis

Department of Physics, University of Crete

Quantum biology is in recent years emerging as an unanticipated extension of the conceptual framework of quantum information science to the realm of complex biological phenomena. The radical-pair mechanism of biological magnetic sensing is one of the main pillars of quantum biology. We will first review our work over the last ten years, which unraveled the wealth of quantum phenomena underlying the spin-dependent and magnetic-sensitive radical-pair reactions, central in avian magnetoreception and photosynthetic spin transport. We will then discuss our most recent work, defining and exploring the first formal quantifier of singlet-triplet coherence in radical-pairs, based on quantum relative entropy. Using this quantifier, we conclusively show that singlet-triplet coherence is indeed a resource for biological magnetic sensing.

Quantum Computing with Fourier Optics

Burhan Gülbahar

Applied Research Center of Technology Products,Department of Electrical and Electronics Engineering, Ozyegin University, Cekmekoy, 34794 Istanbul, Turkey

A novel quantum computing (QC) hardware design is proposed based on Fourier optics. It exploits spatial sampling of photon counts of coherent laser sources after diffracting through a multi-plane-diffraction (MPD) set-up composed of consecutive planar and thin diffraction planes with many slits on each one and thin lenses between them creating a quadratic phase optical design. It promises scalable quantum resources, lower complexity hardware requirements and practical problem solving capability compared with existing linear optic implementations. It does not require challenging multi-photon entanglement as in conventional linear optical QC while not requiring synchronized single photon generation and detection as in Boson sampling which prohibits distinguishable photon count. The proposed system exploits temporal correlation and interference among exponentially increasing number of Feynman paths denoted as quantum path entanglement (QPE) and interference (QPI) resources. The unconventional proposal of QC hardware and entanglement resources promises important future applications if complexity theoretical open issues and experimental challenges are solved in the near future. The applications include generalization of the partial summation of Riemann theta function, MPD based quantum supremacy experiments, implementation of quantum neural networks with intrinsic non-linearity of MPD in terms of diffraction slit positions and the solutions of nonlinear Schrodinger equation significantly important for fiber optic systems.

Role of quantum coherence and correlations in heat flow

Onur Pusuluk and Özgür E. Müstecaplıoğlu

Department of Physics, Koç University, İstanbul, Turkey

Quantum coherence and correlations (QCCs) are the characteristic traits of quantum information that enforce its entire departure from classical lines of thought. They are interchangeable between different parties, usable catalytically without being consumed, and interconvertible with both work and heat. These abilities make them valuable resources as real as energy for specific information processing and thermodynamic tasks.

Here, we will focus on the role QCCs in heat flow. First, using a global master equation approach, we will investigate the open system dynamics of heat transfer in phononic devices working out of equilibrium. In particular, we will reveal the relation of heat current rectification to the production of QCCs in a thermal diode recently introduced in [1].

Second, using a collision model approach, we will explore the local energy changes in a system exposed to non-thermal heat baths which are initially possessing QCCs while their individual subsystems are in thermal equilibrium. Surprisingly, we will show that this approach opens up the possibility for a persistent heat current driven by purely QCCs in the absence of any effective temperature gradient.

[1] Kargı, C., Naseem, M.T., Opatrný, T., Müstecaplıoğlu, Ö.E., Kurizki, G., 2019. Quantum optical two-atom thermal diode. Phys. Rev. E 99: 042121.

Topological Friction in a Finite-Length Kitaev Chain Engine

Elif Yunt

University of Malta

A topological heat engine is a classical or a quantum heat engine, which uses topological materials as its working substance. Topological materials display different bulk and boundary properties. In this talk, I will introduce a topological heat engine with a finite-length Kitaev chain in an ideal Otto cycle [1].
Finite size effects are taken into account using the method of Hill's nanothermodynamics. We identify the bulk and boundary thermal cycles of the Kitaev chain engine and find that they are non-ideal Otto cycles.
The physics of deviation from ideal Otto cycle is identified as a finite size effect, which we dub as ``topological friction'', leading to heat transfer from the bulk to the boundary during adiabatic transformation of the whole system. This is introduced as a spatial analog of the finite time internal friction introduced in [2].

[1] E.Yunt, M. Fadaie, Ö. E. Müstecaplıoğlu, C. Morais Smith, *Topological friction in a Kitaev chain heat engine*, **arXiv: 2003.08836**[cond-mat.stat-mech][quant-ph]
[2] Ronnie Kosloff and Tova Feldmann, "Discrete four-stroke quantum heat engine exploring the origin of friction," Phys. Rev. E 65, 055102 (2002)

Quantum coherence protection by using auxillay qubits

Esfendyar Faizi

Azerbaijan Shahid Madani Üniversitesi

There are two major properties in quantum physics, quantum coherence, and quantum information. Besides they are resources for quantum information tasks, coherent states and entangled states that are also fragile sensitive to environmental noises. It seems that quantum coherence as a necessity for entanglement is more important than entanglement. Then the protection of it against noise is unavoidable. Looking for the ways of such protections is an important task. We study quantum coherence protection based on auxiliary qubits and we see that these auxiliary qubits act as a defence shield against the environmental noise, and we see that if the number of auxiliary qubits increases the coherence protection increases too.

Loss and non-Hermiticity in quantum processes

Şahin Kaya Özdemir

Pennsylvania State University

In this talk after briefly reviewing our experimental results on quantum interferences in plasmonic systems and effects of plasmonic losses on quantum correlations and statistics, we will discuss how non-Hermitian spectral degeneracies known as exceptional points may lead to new paths to quantum processes. We will end the talk with a discussion of opportunities and challenges within the framework of non-Hermitian dynamics in quantum systems.

The Landscape of Academic Literature in Quantum Information Technologies

Zeki C. Seskir[1*], Arsev U. Aydinoglu[2]

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[2] *Center for Science and Technology Policies, Middle East Technical University, Ankara, Turkey*
* *Email address: zseskir@metu.edu.tr*

In this study, we investigated the academic literature in quantum information technologies (QIT) using bibliometric tools. In the first part, we used a set of 50,822 articles obtained from the Web of Science (WoS) using a search query constructed through expert opinion. Analysis of this section revealed that QIT is deeply rooted in physics, and over 80% of the articles are published in physics journals. Additionally, it has been observed that the number of published scientific articles are almost on par for the US, China, and Europe. Furthermore, a keyword analysis revealed that the literature could be clustered into three distinct sets, which are (i) quantum communication/cryptography, (ii) quantum computation, and (iii) physical realizations of quantum systems. Finally, for the first section, a burst analysis showed the emergence and fading away of certain key concepts in the literature. In the second part, we focused on 808 'highly cited' articles provided by the WoS. Using co-citation analysis, we devised a set of core corpus of 34 publications. Finally, for the second set, using bibliographic coupling, we mapped collaboration networks on the country and institutional levels.

Optical photon generation from a superconducting qubit

Alp Sipahigil

Institute for Quantum Information and Matter, California Institute of Technology

The ability to store, transfer, and process quantum information promises to transform how we calculate, communicate, and measure. The realization of large-scale quantum systems that can achieve these tasks is an outstanding challenge and an exciting frontier in modern physics. In the past two decades, superconducting circuits based on Josephson junctions emerged as a promising platform for processing quantum information. However, these systems operate at low temperatures and microwave frequencies, and require a coherent interface with optical photons to transfer quantum information across long distances.

In this talk, I will present our recent experiments demonstrating quantum transduction of a superconducting qubit excitation to an optical photon. I will describe how we use mesoscopic mechanical oscillators in their quantum ground states to convert single photons from microwave frequencies to the optical domain. I will conclude by discussing the prospects of this approach for realizing future quantum networks based on superconducting quantum processors and mechanical quantum memories.

Quantum cryptography with continuous variables : theory and implementations

Philippe Grangier

Laboratoire Charles Fabry, Institut d'Optique Graduate School, 91127 Palaiseau, France

We will describe the basic principle and implementations of continuous variable quantum key distribution (CVQKD) [1-3], which is much closer to standard optical telecommunication techniques than discrete variable (DV) QKD. In particular, CVQKD does not use photon counters, but coherent (homodyne or heterodyne) detections, which are now very usual in high-speed commercial telecom systems [4]. Recent developments of CVQKD include on-chip demonstration of the main functionalities for continuous variables, based on integrated silicon photonics [5]. We will also discuss more general issues about CVQKD, related to recent security proofs [6], and to hardware improvement. For instance, using a "truly local" oscillator allows one to simplify security issues, and to eliminate potentially unsecure side channels. This illustrates the potential of CVQKD for a widespread use of this technology in communication networks.

[1] F. Grosshans, G. V. Assche, J. Wenger, R. Brouri, N. J. Cerf, P. Grangier, "Quantum key distribution using Gaussian-modulated coherent states", Nature 421, 238 (2003).
[2] P. Jouguet, S. Kunz-Jacques, A. Leverrier, P. Grangier, E. Diamanti, "Experimental demonstration of long-distance continuous-variable quantum key distribution", Nature Photon. 7, 378 (2013).
[3] E. Diamanti and A. Leverrier, "Distributing Secret Keys with Quantum Continuous Variables: Principle, Security and Implementations", Entropy 17, 6072 (2016)
[4] A. Ghazisaeidi et al., Journal of Lightwave Technology 35, 1291-1299 (2017).
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[6] S. Ghorai, P. Grangier, E. Diamanti, A. Leverrier, "Asymptotic Security of Continuous-Variable Quantum Key Distribution with a Discrete Modulation", Phys. Rev. X 9, 021059 (2019)

Engineering a quantum satellite constellation

Alexander Ling

The Centre for Quantum Technologies - Singapore

A global quantum network could be built using quantum satellites to augment terrestrial links. The first proof-of-concept experiments have been achieved by the Micius satellite; a real network would require a constellation. I will discuss Singapore's efforts to build quantum nano-satellites that could bring such a constellation closer to reality, and present results that we have collected from in-orbit experiments.

Controlling Photophysics of Carbon Nanotubes for Enhanced Optoelectronic and Quantum Photonic Devices

İbrahim Sarpkaya

UNAM, Bilkent University - Turkey

Single-walled carbon nanotubes (SWCNTs) have recently gained tremendous interest as a nanomaterial for next generation optoelectronics and quantum photonic devices. However, the photophysics of excitons in SWCNTs is not yet fully understood and is largely affected by detrimental extrinsic effects, which give rise to strongly reduced device performance. In this talk I will focus on the novel methods and techniques to better understand and control the photophysics of excitons in SWCNTs.

The first part of my talk presents novel ways and techniques to completely remove detrimental spectral diffusion and blinking in the emission of surfactant dispersed SWCNTs on millisecond time scales and also demonstrates pronounced single photon emission in combination with 50-fold enhanced emission efficiency. The demonstrated single photon emission is promising for applications in quantum cryptography, while the achieved stable long term emission is important for optoelectronic devices.

In the second part of my talk, I will discuss a new regime of intrinsic exciton photophysics in air-suspended ultra-clean SWCNTs that is characterized by ultra-narrow exciton linewidth and prolonged emission times up to 18 ns. These lifetimes are two orders of magnitude better than prior measurements and in agreement with values predicted by theorists a decade ago. Moreover, we measured for the first time exciton decoherence times of individual nanotubes in the time-domain and demonstrate fourfold prolonged values up to 2 ps compared to previous ensemble studies.

Finally, I will present a novel method which controls exciton-acoustic phonon interaction at the nanoscale by utilizing laser vaporization growth of SWCNTs combined with copolymer wrapping. The phonon sideband-resolved emission spectra of these SWCNTs are successfully described by a model relying on acoustic-phonon localization created by copolymer wrapping.

Quantum Travel Time and Tunnel Ionization of Atoms

Durmuş Ali Demir

Sabancı University

Time it takes to travel from one position to another, a quantity having no quantum description, has been modeled variously, especially for quantum tunneling. The model time, if universally valid, must be subluminal, must hold everywhere (inside and outside the tunneling region), must comprise interference effects, and must have a sensible classical limit. In this talk, based on Ref. [1], we voice that the quantum travel time, hypothesized to emerge along with the state vector, varies with the probability current and satisfies all the criteria above. We compute it inside and outside potential barrier and find physically sensible results. Moreover, we contrast quantum travel time with recent ionization time measurements of the He as well as Ar and Kr atoms, and find good agreement with the data. The quantum travel time holds good for stationary systems, and can have various applications in tunneling-driven phenomena. In this regard, we comment briefly on the DNA mutation.

Quantum Coin Flipping, Qubit Measurement and The Generalized Fibonacci Sequences

Oktay K. Pashaev
Department of Mathematics, Izmir Institute of Technology, 35430 Izmir

The quantum analog of classical problem from probability theory is formulated as a single qubit measurement problem, with repeated pattern without intermission in arbitrary number of n-trials. For corresponding probabilities, solution of the problem is found in terms of the generalized Fibonacci sequences. We show that the quantum coin flipping for the Hadamard qubit state is determined by Fibonacci numbers and ratio of consecutive probabilities asymptotically is half of the golden ratio. Depending on size of repeated pattern, probabilities are given by the generalized Tribonacci numbers and in general, the N-bonacci numbers. Generalizations of these formulas for the qutrit and generic qudit states measurements are obtained. By using the generalized Born rule, the measurement procedure is extended to description of n-qubit states. For maximally random n-qubit states, the set of the projection operators to the subspaces with repeated patterns are derived.

Kovaladıkça kaçan kuantum parçacığı

İskender Yalçınkaya

Prag Çek Teknik Üniversitesi

Klasik rastgele yürüyüşler moleküllerin difüzyonu, bir ağın büyüklüğünü tespit etme, bir yığın içinde belli bir nesneyi arama gibi birçok problemi çözmek için kullanılan, literatürde bolca çalışılmış bir konudur. Rastgele yürüyüşlerin karakteristik özelliği zamanla doğru orantılı bir hızla bulundukları ortamda yayılmalarıdır. Öte yandan, klasik rastgele yürüyüşlerin kuantum karşılığı olarak ortaya atılan kuantum yürüyüşleri ise yaklaşık otuz yıldır aktif bir araştırma alanı haline gelmiş ve bu yürüyüşlerin çeşitli kuantum sistemlerinin benzetimi, topolojik fazların benzetimi, kuantum algoritmaları oluşturma ve evrensel kuantum hesaplama gibi konularda çok faydalı bir model oldukları gösterilmiştir. Kuantum yürüyüşler klasik rastgele yürüyüşlerin aksine zamanın karesi ile orantılı bir yayılma hızına sahiptirler ve bu özellik kuantum yürüyüşlerine klasik rastgele yürüyüşlere göre bilhassa arama algoritmalarında avantaj sağlar.

Konuşma kapsamında kuantum yürüyüşü yapan bir parçacığın, klasik yürüyüş yapan bir soğurma merkezi tarafından adım adım takip edilmesi durumunda soğurulma olasılığı tartışılacaktır. Sezgisel olarak, soğurma merkezinin klasik rastgele yürüyüş yaptığında, durağan olmasına kıyasla kuantum parçacığını yakalama olasılığının daha yüksek olduğu söylenebilir ki bu doğrudur. Ancak, soğurma merkezinin her adımda bulunduğu konumdan muhakkak ayrılmak yerine belli bir olasılıkla mevcut konumunda kalabildiği "tembel rastgele yürüyüş" yaptığı varsayılırsa algıya ters sonuçlar ortaya çıkabilmektedir. Öyle ki, soğurma merkezi durağan olmak yerine belli bir olasılıkla adım atıyorsa, kuantum yürüyüşü yapan parçacığı daha büyük bir şansla yakalaması beklenirken bilakis daha küçük bir şansla yakalayabilmektedir. Tembel klasik yürüyüşün adım atma olasılığı doğrudan difüzyon katsayısı ile doğru orantılı olduğundan sonuç ilk bakışta şaşırtıcıdır. Konuşmada bu mesele açıklığa kavuşturulacak ve söz konusu modelin bir kuantum optik deney düzeneği ile nasıl gerçekleştirilebileceği de gösterilecektir.

Posterler / Posters

Atom localization using Rydberg-EIT/ CPT with spatially dependent fields

T. Kirova[1], N. Jia[2], S. H. Asadpour[3], J. Qian[4], H. R. Hamedi[5] and G. Juzeliūnas[5]

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Atom localization [1] has been of constant interest in quantum mechanics, however modern quantum optics tools have made realization of such experiments possible. Different methods exist for subwavelength atom localization, while in this work we investigate the possibility to attain localization using interacting Rydberg atoms.
We consider a scheme of two Rydberg atoms interacting via van der Waals (vdW) interaction, where each atom is in a three-level ladder EIT configuration [2]. The ground and middle states are coupled by a travelling wave probe field, while the middle and Rydberg states are connected via a standing-wave coupling field.

We derive an analytical expression for the steady state Rydberg level population, as well as the form of the parameter S [3], which describes the energy shift to the Rydberg state induced by the vdW interaction with other excited atoms, which are usually situated beyond the blockade radius [4].

Our numerical calculations show that when the coupling field detuning equals S at the nodes of the standing-wave, one can obtain perfect atom localization with Rydberg level population equal to 1. Localization is possible also when the probe field intensity is increased. However, it is accompanied by spectral line widening and a loss of localization sharpness. Similar numerical results are obtained with a coupling field standing-wave in two directions, leading to lattice-like structure of localized atoms in XY plane, e. g. 2D localization. In order to confirm atom localization in x-space, we also study localization in p-space, according to Heisenberg uncertainty principle. Finally, we investigate the possibilities to attain atom localization using a coupling field which carries Optical Angular Momentum.

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Spin-polarized DFT calculations of nitrogen-vacancy color centers in diamond with various XC potentials

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The nitrogen-vacancy (NV) color center in diamond is one of the most promising candidates for future solid-state quantum-enhanced sensor and quantum communication applications. The solid-state defect-related qubit with usable coherence time up to room temperature makes this structure extensively investigated in the last decade. Density Functional Theory (DFT) is one of the important tools to investigate the details of the electronic structure of diamond and radiative and non-radiative defect states related to the NV color center. In this study, we implement DFT calculations with several different exchange-correlation functionals (BLYP, XLYP, PBE, PBES, RPBE) used in Spin-Polarized Generalized Gradient Approximation (SGGA) to explain the defect structure of NV centers in diamond better.

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Keywords: spin-polarized, NV, exchange-correlation, DFT.

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Effect of Eccentric Dimple Potentials on Propagation, Squeezing and Localization of Matter Waves

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We numerically investigate the time evolution of a matter wave in a harmonic trap decorated with an eccentric time independent and time dependent repulsive or attractive dimple potential. We also compute the time evolution of matter wave in one-dimensional optical lattice in the presence of repulsive dimple potential. One-dimensional Gross-Pitaevskii equation or nonlinear Schrodinger equation is used in order to get time evolution of the matter wave soliton. Dark and bright soliton can be generated by repulsive and attractive dimple potential respectively. Also, we theoretically demonstrate the posibility of the generation of nonclassical states of matter waves in a harmonic trap decorated with an eccentric dimple potential. We find that the squeezing can be controlled by the depth of the dimple potential if we neglect the atomic interactions. The variance of the system and Wigner function of the harmonic oscillator with a dimple potential are calculated analytically. Moreover, localization effect is observed in one-dimensional optical lattice in the presence of repulsive dimple potential.

Nuclear Spin Noise Spectra for Extremely Small Baths

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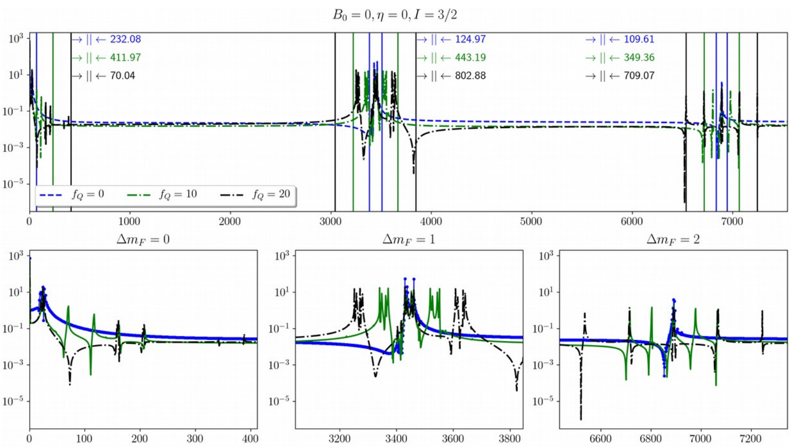
The nuclear spin noise (NSN) is the main source of loss of information for quantum information applications in solid-state systems. The spin qubit, so called central spin (CS) interacts with background nuclear spins in semiconductor matrix via hyperfine interaction which results in the decoherence of information stored in CS. Our work addresses noise frequency content of the spin environment due to site dependent dipole-dipole interaction which is conditioned on CS. Moreover, we investigate the basic dependencies on typical interactions such as quadrupolar and Zeeman in extremely tiny baths to shed light on how noise spectra get synthesized under relatively complex Hamiltonians. Cluster-Correlation Expansion (CCE) is employed since it yields consistent results for predicting many-body dynamics of even large spin baths as in self-assembled quantum dots.

Figure: NSN spectra for two spin-3/2 under dipole-dipole and various quadrupolar coupling constant. The upper panel displays the full noise spectra, whereas lower panel classifies the whole spectra with respect to



various transitions, namely $\Delta m_F = 0,1,2$.

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Spin-coherence time measurements of NV^- centers in $_{15}N^+$, $_{15}N_2^+$ and O^+ implanted diamond

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For the solid-state qubit studies, NV- defects in the diamond are one of the most promising and most studied candidates. With its stable negative charge state, long coherence time at room temperature and spectral stability properties, the fabrication of NV- defects with improving these properties are getting more importance. In this study, NV- centers with introducing Oxygen impurity nearby an NV- center. Required Nitrogen and Oxygen impurities are implanted into diamond samples as $_{15}N^+$, $_{15}N_2^+$ and O^+ ions with different ion flux values. Nitrogen impurities and oxygen impurities are merged into a lattice with the separate annealing processes. Optically detected magnetic resonance (ODMR), Rabi oscillation and Hahn echo measurements are performed. The coherence times up to 78 µs are reported.

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Keywords: NV- center, diamond, coherence time, ODMR, Rabi oscillation, Hahn echo.

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Entanglement Generation and Its Transfer in Quantum Walks

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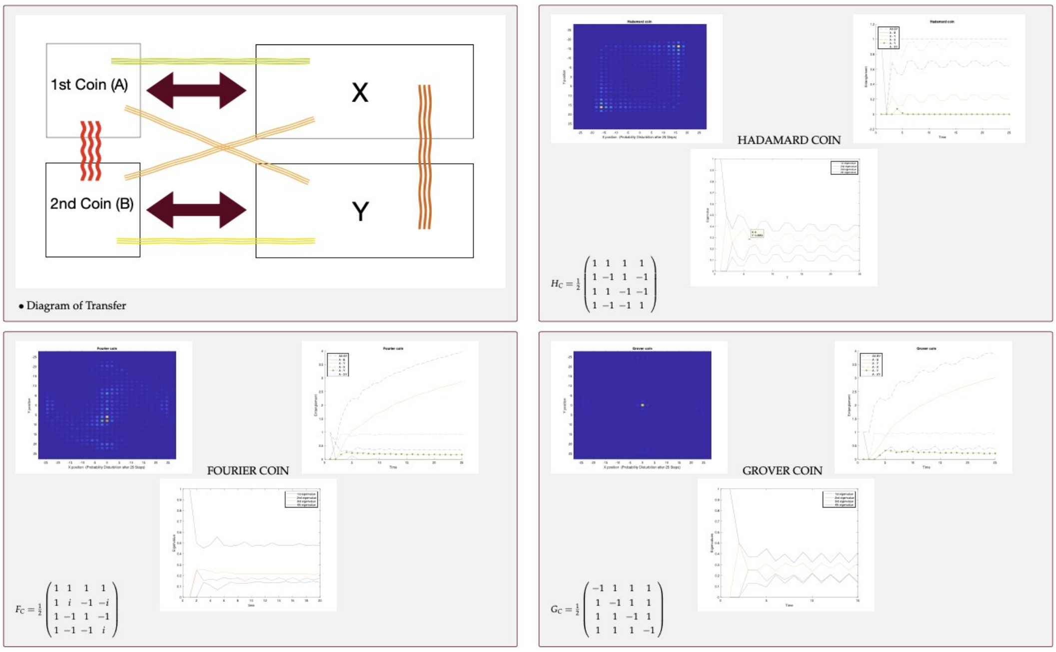
Quantum walks are quantum analogues of classical random walks where the walk direction is dictated by quantum state of a coin in a coherent fashion. Unlike classical random walk, quantum walk has non-Markovian property.
First, we studied 2-D quantum walk analytically and numerically with one-walker and two entangled coins to investigate the transfer of the entanglement in initial coins state to spatial degrees of freedom. The coins are “Hadamard Coin” “Fourier Coin” Grover's Coin” and “Kempe's coin”, among which the Fourier and Grover’s coin generate entanglement, thus increase entanglement between spatial degrees of freedom. Here we calculated the amount of entanglement using negativity. In the second part we studied average photon number correlations for 1-D quantum walk with many body bosonic walkers to investigate bosonic effects. We compared the resulting correlations for various initial many body states.



Eigenstate clustering around exceptional points

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The non-Hermitian skin effect implies that not only topological but also bulk states are exponentially localized at edges. Here, we extend this idea and predict eigenstate clustering in nonreciprocal systems. We show that it is possible around exceptional points and illustrate our idea on some models. We use fidelities and the standard k-means clustering algorithm of machine learning to study clustered eigenstates.