Scientific program

Day 1: Tuesday 12 April			
11:50-12:00	P. Tzallas	IESL	Opening of the workshop
Chair: P. Tzallas			
12:00-13:05 *(60 min+5 min)*	M. Lewenstein	ICFO	Quantum Information Science and Attophysics
13:05-14:30	Lunch		
Chair: D. Petrosyan			
14:30-15:15 *(40 min+ 5 min)*	I. Kominis	UoC	Quantum technology: from atoms to living systems
15:15-15:30	Coffee break		
15:30-16:15 *(40 min+ 5 min)*	W. von Klitzing	IESL	Quantum Matterwave Optics at IESL
16:15:16:30	Coffee break		
16:30-17:15 *(40 min+ 5 min)*	G. Nikolopoulos	IESL	Quantum safe entity authentication with physical unclonable functions
Day 2: Wednesday 13 April			
Chair: W. von Klitzing			
11:15-12:00 *(40 min+ 5 min)*	P. Savvidis	UoC/IESL	Polarion Condensate Lattices: Novel Platform for Quantum Simulations
12:00-12:15	Coffee break		
12:15-13:00 *(40 min+ 5 min)*	N. Pelekanos	UoC/IESL	Semiconductor quantum emitters at high temperatures
13:00-14:30	Lunch		
Chair: I. Kominis			
14:30-15:15 *(40 min+ 5 min)*	D. Petrosyan	IESL	Quantum interfaces and simulations with Rydberg atoms
15:15-15:30	Coffee break		
15:30-16:15 *(40 min+ 5 min)*	G. Vasilakis	IESL	Precision measurements at the quantum interface between atoms and light
16:15-16:20	P. Tzallas	IESL	Closing remarks

Abstracts

Day 1: Tuesday 12 Apr., 12:00-13:05

Quantum Information Science and Attophysics

M. Lewenstein[1,2]

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[2] *ICREA, Pg. Lluís Companys 23, 08010 Barcelona, Spain*

Abstract

Contemporary Quantum Technologies face major difficulties in fault tolerant quantum computing with error correction, and focus instead on various shades of quantum simulation (Noisy Intermediate Scale Quantum, NISQ) devices, analogue and digital Quantum Simulators and quantum annealers. There is a clear need and quest for such systems that, without necessarily simulating quantum dynamics of some physical systems, can generate massive, controllable, robust, entanglement and superpositions states. This will in particular allow the use of decoherence in a controlled manner, enabling the use of these states for quantum communications (e.g. to achieve efficient transfer of information in a safer and quicker way), quantum metrology, sensing and diagnostics (e.g. to precisely measure phase shifts of light fields, or to diagnose quantum materials). We propose an answer to these needs, by opening new avenues for QI science in symbiosis with Attoscience (AS) and Quantum Optics (QO). To date, there are no existing platforms that can bring processes at such short time-scales to Quantum Information systems. Our joint project ATTOQUIS aims at realizing a set of stable and reproducible methods to generate massive entangled states and massive quantum superpositions. This will be accomplished by: i) Studying the generation of entangled/quantum correlated states using conditioning methods; ii) Studying strong-field physics and attosecond science driven by quantum light; iii) Studying quantitative and measurable effects of decoherence in attoscience.

Day 1: Tuesday 12 Apr., 14:30-15:15

Quantum technology: from atoms to living systems

I. Kominis[1]

[1]*Department of Physics, University of Crete, P.O. Box 2208, GR71003 Crete, Greece*

Abstract

Biological systems have long been assumed to be a hostile environment for quantum coherent effects. In contrast to current physical realizations of qubits, biological systems are “warm and wet”, prone to strong decoherence. Contrary to the conventional wisdom, we have shown that the radical-pair mechanism of spin chemistry offers a fruitful playground for applying quantum information science in biological systems. In this talk we address three different yet interrelated directions of research. We will first review our long time work in quantum metrology with hot atomic vapors, and then draw analogies with our more recent work in quantum biology. Finally, we will describe recent work synthesizing quantum optics with the physiology of human vision.

Day 1: Tuesday 12 Apr., 15:30-16:15

Quantum Matterwave Optics at IESL

W. von Klitzing[1]

[1]*Institute of Electronic Structure and Laser, FORTH, GR- 70013, Heraklion, Greece*

Abstract

I will present the activities of the Cretan Matterwaves Group, which fall into two main directions: a) BEC and Matterwaves b) Space Optics. The Matterwaves Section focusses on BEC and atom-optical experiments. We have recently demonstrated the first fully coherent matterwave guide, where we losslessly propagated a BEC over a record distance of 27cm. Using this waveguide we demonstrated matterwave focussing and delta-kick cooling by a factor of 48 down to 800 pK. The Space Optics Laboratory works on ultra-stable optics, designed for matterwave experiments in space. I will also present shortly the EU-pathfinder mission for and atom-interferometric gravity map of earth and other ongoing mission proposals (AEDGE, STE-QUEST).

Day 1: Tuesday 12 Apr., 16:30-17:15

Quantum safe entity authentication with physical unclonable functions

G. Nikolopoulos[1]

[1] *Institute of Electronic Structure and Laser, FORTH, GR- 70013, Heraklion, Greece*

Abstract

The development of quantum-safe cloning-resistant entity authentication protocols is of particular importance for cryptography, and optical schemes that rely on physical unclonable functions are currently considered to be among the most prominent candidates. In such schemes authentication relies on the optical response of disordered tokens that are materialized by optical multiple-scattering media. In this talk I will discuss some of our activities on this topic.

Day 2: Wednesday 13 Apr., 11:15-12:00

Polarion Condensate Lattices: Novel Platform for Quantum Simulations

P. Savvidis[1,2]

[1] *Institute of Electronic Structure and Laser, FORTH, GR- 70013, Heraklion, Greece*
[2] *Department of Materials Science & Technology, University of Crete*

Abstract

Exciton-polaritons, are mixed light-matter quasiparticles resulting from the strong coupling of photons confined in a microcavity and quantum well excitons. Being bosons, polaritons can condense into macroscopically coherent many-body state and have thus emerged as prime candidates for the study of non-equilibrium systems of interacting bosons. Our recent studies, exploit non-equilibrium nature of polariton condensates, showing that polariton condensates can spontaneously magnetize, and how their spin can be controlled both optically and electrically. Direct coupling of polaritons to leaking microcavity photons provides on-the-fly information of all characteristics of the polariton condensates such as energy, momentum, spin, and their phase. We employ spatially patterned external laser excitation to create arbitrary potential landscapes for polaritons and demonstrate ferromagnetic and antiferromagnetic coupling between neighbouring condensates. Furthermore, using such techniques, polariton condensates can now be imprinted into arbitrary two dimensional lattices with tunable intra- and inter-site interactions providing exciting opportunities for devising novel and versatile quantum simulation platforms.

Day 2: Wednesday 13 Apr., 12:15-13:00

Semiconductor quantum emitters at high temperatures

N. Pelekanos[1,2]

[1]*Institute of Electronic Structure and Laser, FORTH, GR- 70013, Heraklion, Greece*
[2]*Department of Materials Science & Technology, University of Crete*

Abstract

We will review own work on semiconductor quantum emitters, focusing mainly on InAs quantum dot-based **single photon emitters** operating at non-cryogenic temperatures and on nitride-based **polariton lasers** operating at room temperature with state-of the art characteristics. Main results will be highlighted and new directions will be indicated.

Day 2: Wednesday 13 Apr., 14:30-15:15

Quantum interfaces and simulations with Rydberg atoms

D. Petrosyan[1]

[1]*Institute of Electronic Structure and Laser, FORTH, GR- 70013, Heraklion, Greece*

Abstract

Atoms in the highly excited Rydberg states posses unique properties, including long lifetimes and huge dipole moments, which facilitate their use in various quantum technology applications. I will present some of our recent work on interfacing Rydberg atoms with superconducting microwave resonators and optical photons, and on quantum simulations of many-body physics with strongly-interacting Rydberg atoms.

Day 2: Wednesday 13 Apr., 15:30-16:15

Precision measurements at the quantum interface between atoms and light

G. Vasilakis[1]

[1]*Institute of Electronic Structure and Laser, FORTH, GR- 70013, Heraklion, Greece*

Abstract

Quantum features of atom-light interaction have been among the central issues in physics since the early days of quantum mechanics. Recent technological breakthroughs have transformed the light-atom quantum interface to a powerful tool for performing measurements with unprecedented accuracy. In this talk I will describe two frameworks that

aim to harness quantum features of the light interaction with warm atomic ensembles for precision sensing.

In the first part, I will discuss theoretically the spin-noise spectrum of hot alkali metals in the high-density case, where spin-exchange collisions dominate the spin dynamics. I will show that rapid spin-exchange collisions create correlations between the two hyperfine multiplets and consider their implication on the spin-noise spectrum as measured with off-resonant light. Interestingly, a reduction of the measured spin-noise power can be achieved in realistic scenarios.

In the second part, I will discuss a setup which can address and simultaneously reduce all sources of quantum noise that limit the performance of atomic-optical magnetometers. A novel source of polarization squeezed light is introduced based on the off-resonant Faraday interaction of light with an atomic ensemble. This light is engineered to decouple its quantum noise from the atomic spins, which can then be probed with quantum-enhanced sensitivity.