NEW AWARD!

We are happy to congratulate Kypros Kossifos, one of our PhD research students, for being the 3rd place winner of the Student Paper Competition at the 2021 International Applied Computational Electromagnetics Society (ACES) Symposium for the paper titled: "Agile and Multifunctional Integrated-Circuit-Enabled Metasurface".

FEATURED LAB:

The Laboratory of Ultrafast Science was established in 2005 in the Department of Physics at the University of Cyprus through several competitive infrastructure grants, and since then it has been one of the most well-equipped and advanced laser laboratories in Cyprus and abroad. The primary objective of the laboratory is to unravel fundamental physical processes in the nanoscale using a range of ultrafast spectroscopic techniques. Some key research directions include the investigation of the dynamics of non-equilibrium photo excitations (electrons, phonons, plasmons, etc) and their interactions with light in nanostructures and novel materials using ultrashort laser pulses.

Over the past few years, we have been studying novel materials such as semiconducting nanowires, organic semiconductors, nanocrystals, perovskites etc. Understanding the fundamental physical processes governing such novel materials could find applications in existing optoelectronic devices, and it is likely to generate new research and commercial opportunities.

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Professor of Physics
Head of the Laboratory of Ultrafast Science

Given that most of technology is based on the fast response of small and high-speed electronics devices, there has been considerable interest in exploring the limitations of nanostructures by investigating at a fundamental level the underlying fast processes which occur on a picosecond or even a femtosecond time scale. We use ultrafast femtosecond amplified laser pulses to manipulate, control, and detect carriers in nanomaterials, in order to understand momentum and energy relaxation, real space transport, and radiative recombination as well as mechanisms such as carrier-carrier scattering, optical phonon scattering, and carrier diffusion of the excited states. Other general-purpose optical characterization techniques are also utilized to provide complementary information thereby improving our understanding of light-mater interactions.
SPECIALIZED TECHNIQUES DEVELOPED AND UTILIZED IN THE LABORATORY OF ULTRAFAST SCIENCE:

- **OPA Transient Differential absorption** - Ultrafast Amplifier – Legend (45fs, 1kHz)
  A non-collinear differential absorption spectroscopy with the pump and probe pulses generated from different Optical Parametric Amplifiers running at 1kHz providing time resolve measurements at different photon energies with 45 fs resolution.

- **White Light Transient Differential absorption** - Ultrafast Amplifier – Spitfire (100fs, 1kHz)
  A differential absorption spectroscopy with the pump 1kHz 100fs at 800nm, 400nm or 266nm and white light generated with Sapphire or YAG crystals covering a spectral-range from 400nm to 1600nm. Measurements are carried out using a fast CCD camera capturing a range of wavelengths at the same time.

- **Time-Domain THz Spectroscopy**
  Time-domain and time-resolved THz spectroscopy has been developed using femtosecond amplified pulses in zinc telluride crystals through optical rectification. These techniques are utilized to probe charge transport in condensed matter.

- **Differential Absorption and Reflection at 250kHz** - Ultrafast Amplifier – RegA (250kHz, 70fs)
  A differential transmission and absorption measurements using an Ultrafast Amplifier running at 250kHz with 70 fs resolution. The high repetition rate of the pulses provides an unmatched signal to noise ratio when utilizing low energy excitation.

- **Transient Photoluminescence** - Ultrafast Amplifier – RegA (250kHz, 70fs)
  Transient photoluminescence provides information on the dynamics of the excitations at time scales longer than nanoseconds thus complimenting the ultrafast pump-probe measurements.
Optical gain in the infrared part of the spectrum is of great importance in telecommunications, silicon photonics and medical diagnostics. In this project we are investigating the ultrafast dynamics in Heavily doped PbS colloidal quantum dots to determine optical gain and Auger recombination.

**FastBind: Optical binding of micro and nanoparticles in ultrafast evanescent waves**

FastBind proposes a technique of integrating optical manipulation and ultrafast laser physics with the prospect of enhancing optical confinement via the optical binding force and to investigate new phenomena. The optical binding force allows for the synchronized control of multiple particles with high precision in the close vicinity of an interface. The aim here is to demonstrate and study the stable confinement of micro- and nano-objects into self-organized optically bound photonic matter, using evanescent field surface traps generated by femtosecond laser pulses.
Organic-polaritons are bosonic quasiparticles formed when a confined optical field within a microcavity strongly couples to an electronic excitation of matter (exciton). They are a linear superposition of excitons and photons, and therefore inherit their properties from these two constituents. Polaritons are manifested with a normal mode splitting at the points where photon and exciton energies become degenerate, and can be modelled using a two-level classical coupled oscillator model.

Organic polaritons have become a popular platform to study fundamental physics at room temperature, such as Bose-Einstein condensation, superconductivity and superfluidity, as well as a tool for alteration of material’s photophysical functionalities.

In this project, we aim to study polariton phenomena using femtosecond laser amplifiers in conjunction with a Fourier-space imaging setup. Answering fundamental questions in polariton physics is likely to unlock a range of polariton-related applications.

**Photoconductivity in Perovskite Nanocrystals**

Time-domain THz spectroscopy and time-resolved THz spectroscopy techniques are being used to provide insight into the physical properties of nanostructured semiconductor materials.

Currently, the Laboratory of Ultrafast Science uses these techniques to study the photo-induced conductivity of lead halide perovskite nanocrystals (NCs). Specifically, this work investigates the influence of ligand stripping on the optoelectronic properties of CsPbBr3 and FAPbi3 weakly confined NCs samples.
LAB MEMBERS:

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*in the order in which they appear in the picture above

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