SYSL 1: Classical and Quantum Structured Light

Time: Monday 17:00–19:00 Location: P 1

Invited Talk SYSL 1.1 Mon 17:00 P 1

Structured-light-matter interaction for quantum cryptography and nanoscale modal control — •Eileen Otte[1,2], Asma Fallah[1], William A. Jarrett[2], Alexander D. White[2], Giovanni Scuri[2], Seungjun Eun[2], Nicholas A. Guesken[3,2], Hossein Taghinejad[4], Jelena Vuckovic[2], and Mark L. Brongersma[2] — [1]University of Rochester, Rochester, NY, USA — [2]Stanford University, Stanford, CA, USA — [3]Paderborn University, Paderborn, Germany — [4]University of California Berkeley, Berkeley, CA, USA

Structured optical fields with spatially varying properties such as amplitude, phase, and polarization pave the way to controlling light-matter interactions down to the nanoscale. We will explore how tailored non-paraxial vectorial fields can be used both to interrogate nanostructures and to process information in compact photonic platforms. We first demonstrate a metasurface-based platform, obtained through inverse design, that enables encoding and decoding sets of non-paraxial vectorial beams for high-dimensional quantum key distribution. Secondly, we introduce a theoretical framework for controlling multipolar excitations in nanoparticles using tightly focused Generalized Cylindrical Vector Beams (GCVBs). By tuning the polarization topology and focusing conditions, electric and magnetic resonances can be selectively enhanced or suppressed, offering a high degree of modal control. Together, these results highlight the versatility of engineered vectorial light fields, enabling both advanced optical control and quantum functionality in metasurfaces and nanoscale systems.

Invited Talk SYSL 1.2 Mon 17:30 P 1

Attosecond Structured Light Pulses with Topology and Polarization Textures — •Carlos Hernandez-Garcia — Grupo de Investigación en Aplicaciones del Láser y Fotónica, Departamento de Física Aplicada. Universidad de Salamanca — Unidad de Excelencia en Luz y Materia Estructuradas (LUMES). Universidad de Salamanca

We will review recent advances that have boosted the emerging area of spatio-temporal and polarization-structured light pulses at the attosecond timescale. We will discuss how to tailor the angular-momentum content of attosecond pulses, emphasizing how the topology of extreme-ultraviolet (EUV)/soft-x-ray wavefronts and polarization textures can be tailored at the ultrafast timescale. Since the first demonstrations of high harmonic generation driven by vortex beams, the use of driving fields with engineered orbital angular momentum has enabled control of the spatiotemporal properties of high harmonics, including the generation of attosecond vortices with controlled polarization, self-torqued high-harmonic waveforms, EUV vector beams and attosecond vortex pulse trains, and EUV spatiotemporal and spatiospectral optical vortices. We will present the latest results on generating attosecond spatiotemporal optical-vortex pulses and on generalized attosecond polarization textures, including the first proposal to create attosecond pulse skyrmions.

Invited Talk SYSL 1.3 Mon 18:00 P 1

Structured light for the creation of squeezed multiplets to encode quantum information in trapped ions — •Corina Révora[1,2], Christian Tomás Schmiegelow[1,2], and Juan Pablo Paz[1,2] — [1]Universidad de Buenos Aires, FCEyN, Departamento de Física. Buenos Aires, Argentina — [2]CONICET-Universidad de Buenos Aires, IFIBA, Buenos Aires, Argentina.

Structured light can be used to squeeze the motion of a cold trapped ion. In this talk, I will introduce how it can be used to obtain squeezed multiplets, which are highly non-Gaussian motional states defined as superpositions of D squeezed quantum states.

Squeezed multiplets can be used to encode a quDit, or a single qubit, in a way that makes the errors induced by the loss of D/2 photons detectable by superparity measurements (for even D). The exact analytic expressions for the Wigner function of these states enable us to understand the extreme sensitivity to perturbations, which opens the way to metrological applications. I will show how structured light can be used to generate spin dependent squeezing. And I will also demostrate how to create superpositions of D squeezed states using only a quTrit and projective measurements.

Invited Talk SYSL 1.4 Mon 18:30 P 1

Atomic Magnetometry Employing Vector Light Beams — •Riaan Philipp Schmidt[1,2], Richard Aguiar Maduro[4], Anton Peshkov[1,2], Sonja Franke-Arnold[4], and Andrey Surzhykov[1,2,3] — [1]PTB Braunschweig, Germany — [2]TU Braunschweig, Germany — [3]LENA Braunschweig, Germany — [4]University of Glasgow, UK

During recent years, interest has been rising for applications of vector light beams toward magnetic field sensing. In particular, a series of experiments were performed to extract information about properties of static homogeneous magnetic fields from absorption profiles of vector light passing through an atomic gas target [1].

The talk will follow two directions. First, it will discuss an extension to the method described in Ref. [1] for oscillating homogeneous magnetic fields and static inhomogeneous magnetic fields. Second, we will discuss theoretical and experimental developments on Doppler-free polarization spectroscopy experiments including vector beams. These experiments open up new opportunities for the application of vector light in atomic magnetometry with warm atomic vapors, while experiments from Ref. [1] require temperatures in the sub-mK regime.

[1] F. Castellucci, T. Clark, A. Selyem, J. Wang, and S. Franke-Arnold, Phys. Rev. Lett. 127, 233202 (2021).