SYTL 1: Symposium on interactions between twisted light and particles I (SYTL)

Time: Friday 11:00–13:00 Location: C/gHS

Invited Talk SYTL 1.1 Fri 11:00 C/gHS

Optical curl forces and beyond — •Michael Berry — H H Wills Physics Laboratory, University of Bristol, UK

A physical example of a force that depends on position but is not derivable from a potential, that is, a nonconservative force with nonzero curl, is the force on a dielectric particle in an optical field. The resulting dynamics need not be Hamiltonian or Lagrangian, yet is nondissipative. Noether's theorem does not apply, so the link between symmetries and conservation laws is broken. The physical existence of curl forces has been controversial and the subject of intense debate among engineers. Motion under curl forces near optical vortices can be understood in detail, and the full series of 'superadiabatic' correction forces derived, leading to an exact slow manifold in which fast (internal) and slow (external) motion of the particle is separated.

Invited Talk SYTL 1.2 Fri 11:30 C/gHS

Quantum memories for twisted photons — •Elisabeth Giacobino, Julien Laurat, Dominik Maxein, Lambert Giner, Lucile Veissier, and Adrien Nicolas — Laboratoire Kastler Brossel, UPMC, ENS, CNRS, Paris, France

For quantum information, critical resources are quantum memories, which enable the storage of quantum data. They will also allow the distribution of entanglement at large distances, in order to overcome transmission losses, since the no-cloning theorem prevents the amplification of a quantum signal. A quantum memory relies on an efficient coupling between light and matter, in order to achieve reversible mapping of quantum photonic information in and out of the material system. In our system this transfer involves electromagnetically induced transparency (EIT) based on three-level transitions in a cold cesium atomic ensemble. With this set-up we have shown efficient storage of pulses carrying orbital angular momentum (OAM) at the single photon level. Laguerre-Gauss LG+1 and LG-1 modes were imprinted on the signal pulse, using a spatial light modulator. Then superpositions of LG modes, i.e. Hermite Gaussian modes were stored and retrieved. A full memory characterization (process tomography) over the Bloch sphere was performed and allowed us to demonstrate quantum fidelity. We thus demonstrated a quantum memory for orbital angular momentum photonic qubits. Single photons carrying OAM are promising for the implementation of qubits and qudits since OAM constitutes a quantized and infinite space. Interfacing them with quantum memories opens the way to their use in quantum networks.

SYTL 1.3 Fri 12:00 C/gHS

Spatially dependent electromagnetically induced transparency — •Neal Radwell[1], Thomas William Clark[1], Bruno Piccirillo[2], Stephen Mark Barnett[1], and Sonja Franke-Arnold[1] — [1]SUPA, School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, UK — [2]Dipartimento di Fisica, Universita di Napoli *Federico II*, Complesso Universitario di Monte S. Angelo, 80126 Napoli, Italy

Recent years have seen vast progress in the generation and detection of structured light, with potential applications in high capacity optical data storage and continuous variable quantum technologies. Here we measure the transmission of structured light through cold rubidium atoms and observe regions of electromagnetically induced transparency (EIT). We use q-plates to generate a probe beam with azimuthally varying phase and polarisation structure, and its right and left circular polarisation components provide the probe and control of an EIT transition. We observe an azimuthal modulation of the absorption profile that is dictated by the phase and polarisation structure of the probe laser. Conventional EIT systems do not exhibit phase sensitivity. We show, however, that a weak transverse magnetic field closes the EIT transitions, thereby generating phase dependent dark states which in turn lead to phase dependent transparency, in agreement with our measurements.

SYTL 1.4 Fri 12:20 C/gHS

Chiral optical force — •Robert P. Cameron and Stephen M. Barnett — School of Physics and Astronomy, University of Glasgow, Glasgow, G12 8QQ

Light carrying helicity in unusual ways can be employed to accelerate the opposite enantiomers of a chiral molecule in opposite directions; a remarkable phenomenon that may find use in a wealth of new applications.

SYTL 1.5 Fri 12:40 C/gHS

Ionization and excitation of atoms by twisted light — •Andrey Surzhykov — Helmholtz Institute Jena, Fröbelstieg 3, 07743 Jena

Owing to the progress in the production and application of twisted (or vortex) light beams, more possibilities arise to explore the role of of the orbital angular momentum (OAM) in the coupling between radiation and matter. In the past, a number of studies have focused on the orbital momentum transfer to colloidal particles, Bose–Einstein condensates or even semiconductors. More recent studies, moreover, aim to better understand the OAM–effects in *fundamental* light–matter interaction processes such as the photon absorption and scattering by atoms, as well as the atomic photoeffect. In this contributions, therefore, we present a theoretical study of the photo–ionization [1] and excitation [2,3] of many–electron atoms and ions by twisted light. By making use of the density matrix theory we analyze the interaction of vortex beams with macroscopic targets of randomly distributed atoms. We argue that for such a (realistic) scenario the OAM of the incident light may strongly affect both the angular distribution of photo–ionized electrons and the magnetic sublevel population of photo–excited atoms. In order to illustrate the effect of the OAM–transfer, detailed calculations will be presented for the interaction of alkali atoms with twisted light.

[1] O. Mayula *et al.*, J. Phys. B **46**, 205002 (2013).
[2] H. M. Scholz–Marggraf *et al.*, Phys. Rev. A **90**, 013425 (2014).
[3] A. Surzhykov *et al.*, Phys. Rev. A *submitted.*