A 13: Fundamentals

Time: Monday 16:15–18:00 Location: K 1.011

Invited Talk A 13.1 Mon 16:15 K 1.011

Quantum teleportation via electron-exchange collisions — •Bernd Lohmann[1,2], Karl Blum[2], and Burkhard Langer[3] — [1]The Hamburg Centre For Ultrafast Imaging, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Straße 9, 48149 Münster, Germany — [3]Physikalische Chemie, Freie Universität Berlin, Takustraße 3, 14195 Berlin, Germany

In recent research [1,2], we have shown that strong correlations exist in elastic electron-exchange collisions of light hydrogen-like atoms, violating Bell's inequalities significantly, which allow for generating tunable spin pairs with any desired degree of entanglement. Utilizing our tunable entanglement resource, we will discuss the possibility of performing quantum teleportation with free massive particles applying a twofold elastic electron-exchange scattering. In a first collision, an unpolarized electron will be scattered on an unpolarized atom, generating an entangled electron-atom pair. Subsequently, in a second scattering, an arbitrarily polarized electron will collide with the entangled atom thereby generating interference which allows for teleporting the degree of spin polarization onto the former unpolarized electron. We will demonstrate the feasibility of such experiments.

[1] Blum K., and Lohmann, B., Phys. Rev. Lett. 116, 033201 (2016).
[2] Lohmann, B., Blum, K., and Langer, B., Phys. Rev. A 94, 032331 (2016).

Invited Talk A 13.2 Mon 16:45 K 1.011

Probing the forces of blackbody radiation and dark energy with matter waves — •Philipp Haslinger[1], Viktoria Xu[1], Matt Jaffe[1], Osip Schwartz[1], Paul Hamilton[2], Benjamin Elder[3], Justin Khoury[3], Matthias Sonnleitner[5], Monika Ritsch-Marte[4], Helmut Ritsch[5], and Holger Müller[1] — [1]UC Berkeley, USA — [2]UC Los Angeles, USA — [3]UPenn, USA — [4]Med-Uni Innsbruck, AUT — [5]Uni Innsbruck, AUT

In this talk I will give an overview of our recent work using an optical cavity enhanced atom interferometer to sense with gravitational strength for fifths forces and for an on the first-place counter intuitive inertial property of blackbody radiation. Blackbody (thermal) radiation is emitted by objects at finite temperature with an outward energy-momentum flow, which exerts an outward radiation pressure. At room temperature e.g. a Cs atom scatters on average less than one of these photons every 10^8 years. Thus, it is generally assumed that any scattering force exerted on atoms by such radiation is negligible. However, particles also interact coherently with the thermal electromagnetic field and this leads to a surprisingly strong force acting in the opposite direction of the radiation pressure. If dark energy, which drives the accelerated expansion of the universe, consists of a screened scalar field (e.g. chameleon models) it might be detectable as a "5th force" using atom interferometric methods. By sensing the gravitational acceleration of a 0.19kg in vacuum source mass, we reach a natural bound for cosmological motivated scalar field theories and were able to place tight constraints.

A 13.3 Mon 17:15 K 1.011

New Laboratory Probes for Low-Mass Dark Matter and Dark Bosons — •Yevgeny Stadnik[1] and Victor Flambaum[2] — [1]Johannes Gutenberg University of Mainz, Germany — [2]University of New South Wales, Australia

Low-mass bosonic dark matter particles produced after the Big Bang may form an oscillating classical field, which can be sought for in a variety of low-energy laboratory experiments based on spectroscopic, interferometric and magnetometric techniques. Dark bosons can also mediate anomalous fifth forces between ordinary-matter particles that can be sought for in laboratory experiments. Recent measurements in atoms and astrophysical phenomena have already allowed us to improve on existing constraints on various non-gravitational interactions between dark bosons and ordinary-matter particles by many orders of magnitude.

References: Phys. Rev. D 89, 043522 (2014); Phys. Rev. Lett. 113, 081601 (2014); Phys. Rev. D 90, 096005 (2014); Phys. Rev. Lett. 113, 151301 (2014); Phys. Rev. Lett. 114, 161301 (2015); Phys. Rev. A 93, 063630 (2016); Phys. Rev. Lett. 115, 201301 (2015); Phys. Rev. A 94, 022111 (2016); Phys. Rev. Lett. 117, 271601 (2016); arXiv:1708.00486; arXiv:1708.06367 - Phys. Rev. X (In press); arXiv:1709.10009 - Phys. Rev. Lett. (In press).

A 13.4 Mon 17:30 K 1.011

Spin nonconservation in Compton scattering — •Sven Ahrens and Chang-Pu Sun — Beijing Computational Science Research Center Building 9, East Zone, ZPark II, No.10 East Xibeiwang Road, Haidian District, Beijing 100193, China

Spin effects of diffracted electrons in standing light waves opens the question, on whether the dynamics might be determined by selection rules based on spin conservation [1]. To answer this question, we investigate the simplest possible system (an electron interacting with a single photon field) and investigate the corresponding S-matrix for the case of 180 degree back scattering of the photon [2]. We construct a scenario with specific incoming and outgoing particle momenta, in which it becomes clear that the combined spin (intrinsic angular momentum) of the photon and electron is not conserved, when comparing before and after their interaction. We also show the angle resolved behavior of electron and photon spin and discuss the establishment of spin entanglement between the outgoing particles.

[1] D. L. Freimund and H. Batelaan, Laser Phys. 13, 892 (2003).
[2] arXiv:1708.09606 (accepted, to appear in Phys. Rev. A)

A 13.5 Mon 17:45 K 1.011

Entanglement in doubly excited states of helium — •Alejandro Gonzalez Melan and Javier Madroñero Pabon — Physics department, Universidad del Valle, Cali, Colombia

We compute the entanglement of doubly excited states of helium below the 3rd and 4th ionization thresholds. For that purpose we use a planar representation of the helium atom. The amount of the entanglement tends to increase with energy and allows us to classify series of doubly excited states. We also discuss the effect of a peridic driving by an external field on entanglement. In particular, we focus on the entanglement for two-electron nondispersive wave packets in planar helium. These are quantum objects that propagate along periodic trajectories of the classical three-body Coulomb problem and they are formed by a near-resonantly periodic driving of the Zee configuration of helium.