Gate-Dependent Orbital Magnetic Moments in Carbon Nanotubes T. S. Jespersen, K. Grove-Rasmussen, K. Flensberg, J. Paaske, K. Muraki, T. Fujisawa, and J. Nygard, Phys. Rev. Lett. **107**, 186802 (2011). We investigate how the orbital magnetic moments of electron and hole states in a carbon nanotube quantum dot depend on the number of carriers on the dot. Low temperature transport measurements are carried out in a setup where the device can be rotated in an applied magnetic field, thus enabling accurate alignment with the nanotube axis. The field dependence of the level structure is measured by excited state spectroscopy and excellent correspondence with a single-particle calculation is found. In agreement with band structure calculations we find a decrease of the orbital magnetic moment with increasing electron or hole occupation of the dot, with a scale given by the band gap of the nanotube.

Entanglement Detection in the Vicinity of Arbitrary Dicke States Exploring the Thermodynamic Limits of Computation in Integrated Systems, Phys. Rev. Lett. **107**, 0108502 (2011). Dicke states represent a class of multipartite entangled states that can be generated experimentally with many applications in quantum information. We propose a method to experimentally detect genuine multipartite entanglement in the vicinity of arbitrary Dicke states. The detection scheme can be used to experimentally quantify the entanglement depth of many-body systems and is easy to implement as it requires measurement of only three collective spin operators. The detection criterion is strong as it heralds multipartite entanglement even in cases where the state fidelity goes down exponentially with the number of qubits.

Entanglement Cost of Implementing Controlled-Unitary Operations , Akihito Soeda, Peter S. Turner, and Mio Murao, Phys. Rev. Lett. **107**, 180501 (2011). We investigate the minimum entanglement cost of the deterministic implementation of two-qubit controlled-unitary operations using local operations and classical communication (LOCC). We show that any such operation can be implemented by a three-turn LOCC protocol, which requires at least 1 ebit of entanglement when the resource is given by a bipartite entangled state with Schmidt number 2. Our result implies that there is a gap between the minimum entanglement cost and the entangling power of controlled-unitary operations. This gap arises due to the requirement of implementing the operations while oblivious to the identity of the inputs.

Quasiparticle Interference around a Magnetic Impurity on a Surface with Strong Spin-Orbit Coupling, Anna Strozecka, Asier Eiguren, and Jose Ignacio Pascual, Phys. Rev. Lett. **107**, 186805 (2011). On surfaces with strong spin-orbit coupling, backscattering is forbidden since it requires flipping of the spin of the electron. It has been proposed that the forbidden scattering channels in such systems can be activated if time reversal symmetry is locally broken, for example, by a magnetic scattering center. Scanning tunneling spectroscopic maps of quasiparticle interference patterns around a single magnetic MnPc molecule on a Bi(110) surface reveal only spin-conserving scattering events. Simulations based on the Greens functions approach confirm that the charge-density interference patterns are unaffected by the magnetic state of the impurity. A fingerprint of backscattering processes appears, however, in the magnetization patterns, suggesting that only spin-polarized measurements can access this information.

Molecular Symmetry Governs Surface Diffusion, Tobias Sonnleitner, Ingmar Swart, Niko Pavlicek, Andreas Pollmann, and Jascha Repp, Phys. Rev. Lett. **107**, 186103 (2011). In chemistry and physics symmetry principles are all important, for example, leading to the selection rules governing optical transitions. We have investigated the influence of the molecular symmetry on the surface potential landscape of molecules in the limit of weak molecule-substrate binding. For this purpose, the induced lateral motion of Cu(II)-tetraazaphthalocyanine molecules, for which four symmetry distinct isomers exist, on NaCl(100) was studied by scanning tunneling microscopy. This nonthermal diffusion induced by inelastic excitations is found to be qualitatively different for all four symmetry distinct isomers, demonstrating that symmetry governs the surface potential landscape.

Rashba Spin-Splitting Control at the Surface of the Topological Insulator Bi_2 Se_3 Z.-H. Zhu, G. Levy, B. Ludbrook, C. N. Veenstra, J. A. Rosen, R. Comin, D. Wong, P. Dosanjh, A. Ubaldini, P. Syers, N. P. Butch, J. Paglione, I. S. Elfimov, and A. Damascelli, Phys. Rev. Lett. **107**, 186405 (2011). The electronic structure of Bi2 Se3 is studied by angle-resolved photoemission and density functional theory. We show that the instability of the surface electronic properties, observed even in ultrahigh- vacuum conditions, can be overcome via in situ potassium deposition. In addition to accurately setting the carrier concentration, new Rashba-like spin-polarized states are induced, with a tunable, reversible, and highly stable spin splitting. Ab initio slab calculations reveal that these Rashba states are derived from 5-quintuple-layer quantum-well states. While the K-induced potential gradient enhances the spin splitting, this may be present on pristine surfaces due to the symmetry breaking of the vacuum-solid interface.

Damping of Bloch Oscillations in the Hubbard Model, Martin Eckstein1 and Philipp Werner, Phys. Rev. Lett. **107**, 186406 (2011). Using nonequilibrium dy-

namical mean-field theory, we study the isolated Hubbard model in a static electric field in the limit of weak interactions. Linear response behavior is established at long times, but only if the interaction exceeds a critical value, below which the system exhibits an ac-type response with Bloch oscillations. The transition from ac to dc response is defined in terms of the universal long-time behavior of the system, which does not depend on the initial condition.

Spatially Modulated Tunnel Magnetoresistance on the Nanoscale, Hirofumi Oka, Kun Tao, Sebastian Wedekind, Guillemin Rodary, Valeri S. Stepanyuk, Dirk Sander, and Jurgen Kirschner, Phys. Rev. Lett **107**, 187201 (2011). We investigate the local tunnel magnetoresistance (TMR) effect within a single Co nanoisland using spin- polarized scanning tunneling microscopy. We observe a clear spatial modulation of the TMR ratio with an amplitude of 20% and a spacing of 1.3 nm between maxima and minima around the Fermi level. This result can be ascribed to a spatially modulated spin polarization within the Co island due to spin-dependent quantum interference. Our combined experimental and theoretical study reveals that spin-dependent electron confinement affects all transport properties such as differential conductance, conductance, and TMR. We demonstrate that the TMR within a nanostructured magnetic tunnel junction can be controlled on a length scale of 1 nm through spin-dependent quantum interference.

Pair Creation Constrains Superluminal Neutrino Propagation Andrew G. Cohen and Sheldon L. Glashow, Phys. Rev. Lett. **107**, 181803 (2011). The OPERA collaboration claims that muon neutrinos with a mean energy of 17.5 GeV travel 730 km from CERN to the Gran Sasso at a speed exceeding that of light by about 7.5 km/s or 25 ppm. However, we show that superluminal neutrinos may lose energy rapidly via the bremsstrahlung of electron-positron pairs ($\nu \to \nu + e^- + e^+$). For the claimed superluminal velocity and at the stated mean energy, we find that most of the neutrinos would have suffered several pair emissions en route, causing the beam to be depleted of higher energy neutrinos. This presents a significant challenge to the superluminal interpre- tation of the OPERA data. Furthermore, we appeal to Super-Kamiokande and IceCube data to establish strong new limits on the superluminal propagation of high-energy neutrinos.