Coherence and Screening in Multi-Electron Spin Qubits
A. P. Higginbotham, F. Kuemmeth, M. P. Hanson, A. C. Gossard, and C. M. Marcus
arXiv:1306.2720 [cond-mat.mes-hall]

The performance of multi-electron spin qubits is examined by comparing exchange oscillations in coupled single-electron and multi-electron quantum dots in the same device. Fast (> 1 GHz) exchange oscillations with a quality factor Q > 15 are found for the multi-electron case, compared to Q ~ 2 for the single-electron case, the latter consistent with previous experiments. A model of dephasing that includes voltage and hyperfine noise is developed that is in good agreement with both single- and multi-electron data, though in both cases additional exchange-independent dephasing is needed to obtain quantitative agreement across a broad parameter range.

Exactly soluble lattice models for non-abelian states of matter in 2 dimensions
Maciej Koch-Janusz, Michael Levin, Ady Stern
arXiv:1306.2789 [cond-mat.str-el]

Following an earlier construction of exactly soluble lattice models for abelian fractional topological insulators in two and three dimensions, we construct here an exactly soluble lattice model for a non-abelian ν = 1 quantum Hall state and a non-abelian topological insulator in two dimensions. We show that both models are topologically ordered, exhibiting fractionalized charge, ground state degeneracy on the torus and protected edge modes. The models feature non-abelian vortices which carry fractional electric charge in the quantum Hall case and spin in the topological insulator case. We analyze the statistical properties of the excitations in detail and discuss the possibility of extending this construction to 3D non-abelian topological insulators.

The spin Hall effect in a quantum gas
M. C. Beeler, R. A. Williams, K. Jiménez-García, L. J. LeBlanc, A. R. Perry, and I. B. Spielman
Nature **498**, 201 (2013)

The spin Hall effect, whereby flowing particles experience orthogonally directed, spin-dependent Lorentz-like forces, is observed in a quantum-degenerate gas and used to produce a cold-atom spin transistor.

Optimal blind quantum computation
A. Mantri, C. A. Perez-Delgado, and J. F. Fitzsimons
arXiv:1306.3677 [quant-ph]

Blind quantum computation allows a client with limited quantum capabilities to interact with a remote quantum computer to perform an arbitrary quantum computation, while keeping the description of that computation hidden from the remote quantum computer. While a number of protocols have been proposed in recent years, little is currently understood about the resources necessary to accomplish the task. Here we present general techniques for upper and lower bounding the quantum communication necessary to perform blind quantum computation, and use these techniques to establish a concrete bounds for common choices of the client's quantum capabilities. Our results show that the UBQC protocol of Broadbent, Fitzsimons and Kashefi [1], comes within a factor of 8/3 of optimal when the client is restricted to preparing single qubits. However, we describe a generalization of this protocol which requires exponentially less quantum communication when the client has a more sophisticated device.

Spin dynamics of a Mn atom in a semiconductor quantum dot under resonant optical excitation

S. Jamet, H. Boukari, and L. Besombes
Phys. Rev. B **87**, 245306 (2013)

We analyze the spin dynamics of an individual magnetic atom (Mn) inserted in a II-VI semiconductor quantum dot under resonant optical excitation. In addition to standard optical pumping expected for a resonant excitation, we show that for particular conditions of laser detuning and excitation intensity, the Mn spin population can be trapped in the state which is resonantly excited. This effect is modeled considering the coherent spin dynamics of the coupled electronic and nuclear spin of the Mn atom optically dressed by a resonant laser field. This "spin population trapping" mechanism is controlled by the combined effect of the coupling with the laser field and the coherent interaction between the different Mn spin states induced by an anisotropy of the strain in the plane of the quantum dot.

Correlations, indistinguishability and entanglement in Hong–Ou–Mandel experiments at microwave frequencies

C. Lang, C. Eichler, L. Steffen, J. M. Fink, M. J. Woolley, A. Blais, and A. Wallraff
Nature Phys. **9**, 345 (2013)

Two indistinguishable single photons that simultaneously enter a beam splitter will always leave together, and this Hong-Ou-Mandel effect is now observed with microwave photons for the first time. Coherence between the beam-splitter output arms is demonstrated, enabling two-mode entanglement, which is useful for quantum communication processing at microwave frequencies.

Superconductor-nanowire devices from tunneling to the multichannel regime: Zero-bias oscillations and magnetoconductance crossover

H. O. H. Churchill, V. Fatemi, K. Grove-Rasmussen, M. T. Deng, P. Caroff, H. Q. Xu, and C. M. Marcus
Phys. Rev. B **87**, 241401(R) (2013)

We present transport measurements in superconductor-nanowire devices with a gated constriction forming a quantum point contact. Zero-bias features in tunneling spectroscopy appear at finite magnetic fields and oscillate in amplitude and split away from zero bias as a function of magnetic field and gate voltage. A crossover in magnetoconductance is observed: Magnetic fields above ~0.5 T enhance conductance in the low-conductance (tunneling) regime but suppress conductance in the high-conductance (multichannel) regime. We consider these results in the context of Majorana zero modes as well as alternatives, including the Kondo effect and analogs of 0.7 structure in a disordered nanowire.

Long-distance coherent coupling in a quantum dot array

F. R. Braakman, P. Barthelemy, C. Reichl, W. Wegscheider, and L. M. K. Vandersypen
Nature Nanotech. **8**, 432 (2013)

Controlling long-distance quantum correlations is central to quantum computation and simulation. In quantum dot arrays, experiments so far rely on nearest-neighbour couplings only, and inducing long-distance correlations requires sequential local operations. Here, we show that two distant sites can be tunnel-coupled directly. The coupling is mediated by virtual occupation of an intermediate site, with a strength that is controlled via the energy detuning of this site. It permits a single charge to oscillate coherently between the outer sites of a triple dot array without passing through the middle, as demonstrated through the observation of Landau-Zener-Stückelberg interference. The long-distance coupling significantly improves the prospects of fault-tolerant quantum computation using quantum dot arrays, and opens up new avenues for performing quantum simulations in nanoscale devices.

Circuit QED with hole-spin qubits in Ge/Si nanowire quantum dots

C. Kloeffel, M. Trif, P. Stano, and D. Loss
arXiv:1306.3596 [cond-mat.mes-hall]