**Journal Club**, $19^{th}$ March, 2013 (Rakesh Tiwari)

**Super-magnetoresistance effect in triplet spin valves**
*F. Romeo and R. Citro*, arXiv:1303.0375
We study a triplet spin valve obtained by intercalating a triplet superconductor spacer between two ferromagnetic regions with non-collinear magnetizations. We demonstrate that the magnetoresitance of the triplet spin valve depends on the relative orientations of the d-vector, characterizing the superconducting state, and the magnetization directions of the ferromagnetic layers. For devices characterized by a long superconductor, the Cooper pairs spintronics regime is reached allowing to observe the properties of a polarized current sustained by Cooper pairs only. In this regime a super-magnetoresistance effect emerges, and the chiral symmetry of the order parameter of the superconducting spacer is easily recognized. Our findings open new perspectives in designing devices based on the cooperative nature of ferromagnetic and triplet correlations in a spintronic framework.

**Rashba spin-orbit coupling effects in quasiparticle interference of non-centrosymmetric superconductors**
*Alireza Akbari and Peter Thalmeier*, arXiv:1303.1974
The theory of quasiparticle interference (QPI) for non-centrosymmetric (NCS) superconductors with Rashba spin-orbit coupling is developed using T-matrix theory in Born approximation. We show that qualitatively new effects in the QPI pattern originate from the Rashba spin-orbit coupling: The resulting spin coherence factors lead to a distinct difference of charge- and spin- QPI and to an induced spin anisotropy in the latter even for isotropic magnetic impurity scattering. In particular a cross - QPI appears describing spin oscillation pattern due to nonmagnetic impurity scattering which is directly related to the Rashba vector. We apply our theory to a 2D model for the NCS heavy fermion unconventional superconductor CePt3Si and discuss the new QPI features for a gap model with accidental node lines due to its composite singlet-triplet nature.

**Photon mediated interaction between distant quantum dot circuits**
*M.R. Delbecq, L.E. Bruhat, J.J. Viennot, S. Datta, A. Cottet, and T. Kontos*, arXiv:1303.2639
Engineering the interaction between light and matter is an important goal in the emerging field of quantum opto-electronics. Thanks to the use of cavity quantum electrodynamics architectures, one can envision a fully hybrid multiplexing of quantum conductors. Here, we use such an architecture to couple two quantum dot circuits . Our quantum dots are separated by 200 times their own size, with no direct tunnel and electrostatic couplings between them. We demonstrate their interaction, mediated by the cavity photons. This could be used to scale up quantum bit architectures based on quantum dot circuits or simulate on-chip phonon-mediated interactions between strongly correlated electrons.

**Detecting Majorana fermions in quasi-1D topological phases using non-local order parameters**
*Yasaman Bahri and Ashvin Vishwanath*, arXiv:1303.2600
Topological phases which host Majorana fermions cannot be identified via local order parameters. We give simple non-local order parameters to distinguish quasi-1D topological superconductors of spinless fermions, for any interacting model in the absence of time reversal symmetry. These string or brane-type order parameters are amenable to measurements via quantum gas microscopy in cold atom systems, which could serve as an alternative route towards Majorana fermion detection that involves bulk rather than edge degrees of freedom. We also discuss our attempts at accessing 2D topological superconductors via the quasi-1D limit of coupling N identical chains with $Z_N$ translation symmetry. We classify the resulting symmetric topological phases and discuss general rules for constructing non-local order parameters that distinguish them. The phases include quasi-1D analogs of (i) the p+ip topological superconductor, which can be distinguished up to the 2D Chern number mod 2, and (ii) the 2D weak topological superconductor. The non-local order parameters for some of these phases simply involve a product of the string order parameters for the individual chains. Finally, we sketch a physical picture of the topological phases as a condensate of Ising charged domain walls, which motivates the form of the non-local order parameter.

**Microwave spectroscopy of Josephson junctions in topological superconductors**
*Pauli Virtanen, Patrik Recher*, arXiv:1303.2353
We consider microwave spectroscopy of Josephon junctions composed of hybridized Majorana states in topological 1-D superconductors. We point out how spectroscopic features of the junction appear in the current phase relation under microwave irradiation. Moreover, we discuss a way to directly probe the nonequilibrium state associated with the $4\pi$ periodic Josephson effect. In particular, we show how the microwave driving can be used to switch from a $4\pi$ to a $2\pi$ Shapiro step in the current voltage relation.

**Charge ordering in metals with antiferromagnetic spin correlations**
*Subir Sachdev and Rolando La Placa*, arXiv:1303.2114
Metals with antiferromagnetic spin correlations have an instability to the superconductivity of spin-singlet Cooper pairs with d symmetry (for the Fermi surface of the cuprates). Metlitski et al. (arXiv:1005.1288) noted that in two dimensions, in the low

energy continuum theory, this superconductivity is degenerate with a charge density wave ordering which has a local d symmetry under rotations about the lattice points. We present a momentum-space Hartree-Fock computation on a simple lattice model, and find that the d symmetry is dominant for a range of small ordering wavevectors including those observed in recent experiments. We propose a charge order parameter for the underdoped cuprates.

**Frequency-dependent admittance of a short superconducting weak link**
*F. Kos, S. E. Nigg, and L. I. Glazman*, arXiv:1303.2918
We consider the linear and non-linear electromagnetic responses of a nanowire connecting two bulk superconductors. Andreev states appearing at a finite phase bias substantially affect the finite-frequency admittance of such a wire junction. Electron transitions involving Andreev levels are easily saturated, leading to the nonlinear effects in photon absorption for the sub-gap photon energies. We evaluate the complex admittance analytically at arbitrary frequency and arbitrary, possibly non-equilibrium, occupation of Andreev levels. Special care is given to the limits of a single-channel contact and a disordered metallic weak link. We also evaluate the quasi-static fluctuations of admittance induced by fluctuations of the occupation factors of Andreev levels. In view of possible qubit applications, we compare properties of a weak link with those of a tunnel Josephson junction. Compared to the latter, a weak link has smaller low-frequency dissipation. However, because of the deeper Andreev levels, the low-temperature quasi-static fluctuations of the inductance of a weak link are exponentially larger than of a tunnel junction. These fluctuations limit the applicability of nanowire junctions in superconducting qubits.

**Proximity effects in a topological-insulator/Mott-insulator heterostructure**
*Suguru Ueda, Norio Kawakami, Manfred Sigrist*, arXiv:1303.2781
We investigate proximity effects in a correlated heterostructure of a two-dimensional Mott insulator (MI) and a topological insulator (TI) by employing inhomogeneous dynamical mean-field theory. We show that the edge state of the TI induces strongly renormalized mid-gap states inside the MI region, which still have a remnant of the helical energy-spectrum. The penetration of low-energy electrons, which is controlled by the interface tunneling $V$, largely enhances the electron mass inside the MI and also splits a single Dirac-cone at edge sites into the spatially-separated two Dirac-cones in the strong $V$ region.

**Superconductivity with extremely large upper critical fields in Nb2Pd0.81S5**
*Q. Zhang, G. Li, D. Rhodes, A. Kiswandhi, T. Besara, B. Zeng, J. Sun, T. Siegrist, M. D. Johannes, and L. Balicas*, arXiv:1303.3193
Here, we report the discovery of superconductivity in a new transition metal-chalcogenide compound, i.e. Nb2Pd0.81S5, with a transition temperature Tc ¿ 6.6 K. Despite its relatively low Tc, it displays remarkably high and anisotropic superconducting upper critical fields, e.g. $mu_0 H_{c2}$ (T approaching 0 K). 37 T for fields applied along the crystallographic b-axis. For a field applied perpendicularly to the b-axis, $mu_0 H_{c2}$ shows a linear dependence in temperature which coupled to a temperature-dependent anisotropy of the upper critical fields, suggests that Nb2Pd0.81S5 is a multi-band superconductor. This is consistent with band structure calculations which reveal nearly cylindrical and quasi-one-dimensional Fermi surface sheets having hole and electron character, respectively. The static spin susceptibility as calculated through the random phase approximation, reveals strong peaks suggesting proximity to a magnetic state and therefore the possibility of unconventional superconductivity.

**Coupling spin qubits via superconductors**
*Martin Leijnse and Karsten Flensberg*, arXiv:1303.3507
We show how superconductors can be used to couple, initialize, and read out spatially separated spin qubits. When two single-electron quantum dots are tunnel coupled to the same superconductor, the singlet component of the two-electron state partially leaks into the superconductor via crossed Andreev reflection. This induces a gate-controlled singlet-triplet splitting which, with an appropriate superconductor geometry, remains large for dot separations within the superconducting coherence length. Furthermore, we show that when two double-dot singlet-triplet qubits are tunnel coupled to a superconductor with finite charging energy, crossed Andreev reflection enables a strong two-qubit coupling over distances much larger than the coherence length.

**Self-Organization of Atoms along a Nanophotonic Waveguide**
*D. E. Chang, J. I. Cirac, and H. J. Kimble*, Phys. Rev. Lett. 110, 113606 (2013)
Atoms coupled to nanophotonic interfaces represent an exciting frontier for the investigation of quantum light-matter interactions. While most work has considered the interaction between statically positioned atoms and light, here we demonstrate that a wealth of phenomena can arise from the self-consistent interaction between atomic internal states, optical scattering, and atomic forces. We consider in detail the case of atoms coupled to a one-dimensional nanophotonic waveguide and show that this interplay gives rise to the self-organization of atomic positions along the waveguide, which can be probed through distinct characteristics in the reflection and transmission spectra.