1- arXiv:1504.03181

Title: **Magnetic and superconducting phase diagram of the half-Heusler topological semimetal HoPdBi**

Authors: A.M. Nikitin, Y. Pan, X. Mao, R. Jehee, G. K. Araizi, Y. K. Huang, C. Paulsen, S. C. Wu, B. H. Yan, A. de Visser

Abstract: We report a study of the magnetic and electronic properties of the non-centrosymmetric half-Heusler antiferromagnet HoPdBi (TN = 2.0 K). Magnetotransport measurements show HoPdBi has a semimetallic behaviour with a carrier concentration n = 3.7×1018 cm−3 extracted from the Shubnikov-de Haas effect. The magnetic phase diagram in the field-temperature plane has been determined by transport, magnetization and thermal expansion measurements: magnetic order is suppressed at BM ∼ 3.6 T for T → 0. Superconductivity with Tc ∼ 1.9 K is found in the antiferromagnetic phase. Ac-susceptibility measurements provide solid evidence for bulk superconductivity below Tc = 0.75 K with a screening signal close to a volume fraction of 100 %. The upper critical field shows an unusual linear temperature variation with Bc2(T → 0) = 1.1 T. We also report electronic structure calculations that classify HoPdBi as a new topological semimetal, with a non-trivial band inversion of 0.25 eV.

2- arXiv:1504.03123

Title: **How the vortex lattice of a superconductor becomes disordered: a study by scanning tunneling spectroscopy**

Authors: M. Zehetmayer

Abstract: Order-disorder transitions take place in many physical systems, but observing them in detail in real materials is difficult. In two- or quasi-two-dimensional systems, the transition has been studied by computer simulations and experimentally in electron sheets, dusty plasmas, colloidal and other systems. Here I show the different stages of defect formation in the vortex lattice of a superconductor while it undergoes an order-disorder transition by presenting real-space images of the lattice from scanning tunneling spectroscopy. When the system evolves from the ordered to the disordered state, the predominant kind of defect changes from dislocation pairs to single dislocations, and finally to defect clusters forming grain boundaries. Correlation functions indicate a hexatic-like state preceding the disordered state. The transition in the microscopic vortex distribution is mirrored by the well-known spectacular second peak effect observed in the macroscopic current density of the superconductor.

3- arXiv:1504.04233

Title: **Topological states in a microscopic model of interacting fermions**

Authors: N. Lang, H. P. Büchler

Abstract: We present a microscopic model of interacting fermions where the ground state degeneracy is topologically protected. The model is based on a double-wire setup with local interactions in a particle number conserving setting. A compelling property of this model is the exact solvability for its ground states and low energy excitations. We demonstrate the appearance of topologically protected edge states and derive their braiding properties on a microscopic level. We find the non-abelian statistics of Ising anyons, which can be interpreted as Majorana-like edge states.

4- arXiv:1504.04230

Title: **Localized Majorana-like modes in a number conserving setting: An exactly solvable model**

Authors: F. Iemini, L. Mazza, D. Rossini, S. Diehl, R. Fazio

Abstract: In this letter we present, in a number conserving framework, a model of interacting fermions in a two-wire geometry supporting non-local zero-energy Majorana-like edge excitations. The model has an exactly solvable line, on varying the density of fermions, described by a topologically non-trivial ground state wave-function. Away from the exactly solvable line we study the system by means of the numerical density matrix renormalization group. We characterize its topological properties, establish the presence of a gap in its single particle spectrum while the Hamiltonian is gapless, and compute the correlations between the edge modes as well as the superfluid correlations. The topological phase covers a sizeable portion of the phase diagram, the solvable line being one of its boundaries.

5- arXiv:1504.03837

Title: **Time-dependent simulation and analytical modelling of electronic Mach-Zehnder interferometry with edge-states wave packets**

Authors: A. Beggi, P. Bordone, F. Buscemi, A. Bertoni

Abstract: We study the effect of the spatial localization of carriers on the interference pattern of electronic Mach-Zehnder interferometers based on Landau edge-states transport. The exact carrier dynamics is obtained by solving numerically the time-dependent Schroedinger equation with a suitable 2D potential profile reproducing the interferometer design. An external magnetic field, driving the system to the quantum Hall regime with filling factor one, is also included. The injected carriers are represented by a superposition of edge states and their interference pattern reproduces the results of Y. Ji et al. [Nature 422, 415 (2003)]. By tuning the system towards different regimes, we find two novel features in the transmission spectra, both related to carrier localization, namely a damping of the Aharonov-Bohm oscillations with increasing difference in the arms length, and an increased mean transmission that we trace to the energy-dependent transmittance of quantum point contacts. Finally, we present an analytical model, also accounting for the finite spatial dispersion of the carriers, able to reproduce the above effects.

6- arXiv:1504.03286

Title: **Proximity superconductivity in ballistic graphene, from Fabry-Perot oscillations to random Andreev states in magnetic field**

Authors: M. Ben Shalom, M. J. Zhu, V. I. Fal'ko, A. Mishchenko, A. V. Kretinin, K. S. Novoselov, C. R. Woods, K. Watanabe, T. Taniguchi, A. K. Geim, J. R. Prance

Abstract: Graphene-based Josephson junctions have attracted significant interest as a novel system to study the proximity effect due to graphene's unique electronic spectrum and the possibility to tune junction properties by gate voltage. Here we describe graphene junctions with the mean free path of several micrometers, low contact resistance and large supercurrents. Such devices exhibit pronounced Fabry-Perot oscillations not only in the normal-state resistance but also in the critical current. The proximity effect is mostly suppressed in magnetic fields of <10 mT, showing the conventional Fraunhofer pattern. Unexpectedly, some proximity survives even in fields as high as 1 T. Superconducting states randomly appear and disappear as a function of field and carrier concentration, and each of them exhibits a supercurrent carrying capacity close to the universal limit of eD/h where D is the superconducting gap, e the electron charge and h Planck's constant. We attribute the high-field Josephson effect to individual Andreev bound states that persist near graphene edges. Our work reveals new proximity regimes that can be controlled by quantum confinement and cyclotron motion.

7- arXiv:1504.03898

Title: **Theory of spin-relaxation in bilayer graphene: resonant scattering by magnetic impurities**

Authors: D. Kochan, S. Irmer, M. Gmitra, J. Fabian

Abstract: We propose that the observed spin-relaxation in bilayer graphene is due to resonant scattering by magnetic impurities. We analyze a resonant scattering model due to adatoms on both dimer and non-dimer sites, finding that only the former give narrow resonances at the charge neutrality point. Opposite to single-layer graphene, the measured spin-relaxation rate in graphene bilayer increases with carrier density. Although it has been commonly argued that a different mechanism must be at play for the two structures, our model explains this behavior rather naturally in terms of different broadening scales for the same underlying resonant processes. Not only our results---using robust and first-principles inspired parameters---agree with experiment, they also predict an experimentally testable sharp decrease of the spin-relaxation rate at high carrier densities.