— [2]Instituto de Ciencia de Materiales de Madrid, Spain

We analyze the single particle states at the edges of graphene quantum dots of arbitrary shapes. By combining analytical and numerical arguments, we show that localized edge states, distinct from extended ones, exist in dots of all dimensions. The number of these states is proportional to the circumference of the dot measured in lattice constants. Perturbations breaking electron-hole symmetry shift the edge states away from zero energy but do not change their total amount.

15 min. break

HL 7.6 Mon 11:45 H18

Graphene: Relativistic transport in a nearly perfect quantum liquid — •Lars Fritz[1], Markus Mueller[2], Joerg Schmalian[3], and Subir Sachdev[4] — [1]Universitaet zu Koeln, Institut fuer theoretische Physik, Zuelpicher Strasse 77, 50937 Koeln — [2]The Abdus Salam International Centre for Theoretical Physics, Strada Costiera 11, 34151 Trieste, Italy — [3]Department of Physics and Astronomy Iowa State University Ames, Iowa 50011, USA — [4]Harvard University, 17 Oxford Street, Cambridge, MA 02138, USA

Electrons and holes in clean, charge-neutral graphene behave like a strongly coupled relativistic liquid. The thermo-electric transport properties of the interacting Dirac quasiparticles are rather special, being constrained by an emergent Lorentz covariance at hydrodynamic frequency scales. At small carrier density and high temperatures, graphene exhibits signatures of a quantum critical system with an inelastic scattering rate set only by temperature, a conductivity with a nearly universal value, solely due to electron-hole friction, and a very low viscosity. In this regime one finds pronounced deviations from standard Fermi liquid behavior. These results, obtained by Boltzmann transport theory at weak electron-electron coupling, are fully consistent with the predictions of relativistic hydrodynamics.

HL 7.7 Mon 12:00 H18

Hyperfine interaction and electron-spin decoherence in graphene and carbon nanotube quantum dots — •Jan Fischer[1], Bjoern Trauzettel[2], and Daniel Loss[1] — [1]Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel, Switzerland — [2]Institute of Theoretical Physics and Astrophysics, University of Würzburg, D-97074 Würzburg, Germany

We analytically calculate the nuclear-spin interactions of a single electron confined to a carbon nanotube or graphene quantum dot [1]. While the conduction-band states in graphene are p-type, the accordant states in a carbon nanotube are sp-hybridized due to curvature. This leads to an interesting interplay between isotropic and anisotropic hyperfine interactions. By using only analytical methods, we are able to show how the interaction strength depends on important physical parameters, such as curvature and isotope abundances. We show that for the investigated carbon structures, the ^{13}C hyperfine coupling strength is less than 1 μeV, and that the associated electron-spin decoherence time can be expected to be several tens of microseconds or longer, depending on the abundance of spin-carrying ^{13}C nuclei. Furthermore, we find that the hyperfine-induced Knight shift is highly anisotropic, both in graphene and in nanotubes of arbitrary chirality.

[1] J. Fischer, B. Trauzettel, D. Loss, Phys. Rev. B 80, 155401 (2009)

HL 7.8 Mon 12:15 H18

Spin transport in graphene with inhomogeneous spin-orbit coupling — •Dario Bercioux[1] and Alessandro De Martino[2] — [1]Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität, D-79104 Freiburg, Germany — [2]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln, Germany

Recent theoretical [1] and experimental [2] works have shown that spin-orbit couplings in graphene can play a relevant role. Motivated by these results, we address the problem of spin transport in graphene through spin-orbit nanostructures, *i.e.* regions of inhomogeneous spin-orbit coupling on the nanometer scale. In analogy with the case of usual two-dimensional electron gases, we discuss the phenomenon of spin-double refraction [3,4] and its consequences on the spin polarization. In particular we study the transmission properties of a single- and a double-interface between a normal region and a region with finite spin-orbit coupling, and analyze the polarization properties of these systems. In addition, for the case of the single interface, we consider the formation of bound states localized at the interface, analogous to the states occuring at the edges of graphene in the weak topological insulator regime discussed by Kane and Mele [5].

[1] D. Huertas-Hernando, *et al.*, Phys. Rev. Lett. **103**, 146801 (2009).
[2] A. Varykhalov, *et al.*, Phys. Rev. Lett. **101**, 157601 (2008).
[3] V. M. Ramaglia, *et al.*, Eur. Phys. J. B **36**, 365 (2003).
[4] V. M. Ramaglia, *et al.*, J. Phys.: Condens. Matter **16**, 9143 (2004).
[5] C. L. Kane and E. J. Mele, Phys. Rev. Lett. **95**, 226801 (2005).

HL 7.9 Mon 12:30 H18

Edge effects in quantum transport and quasiparticle spectra of graphene nanostructures — •Jürgen Wurm[1,2], Klaus Richter[1], and Inanç Adagideli[2] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg — [2]Faculty of Engineering and Natural Sciences, Sabancı University, Orhanlı - Tuzla, 34956, Turkey

In this work, we focus on the spectral and transport properties of graphene nanostructures. In recent work, we studied the effects of edges on the transport and spectral properties of graphene quantum dots, as well as on the conductance of graphene nanoribbons numerically [1,2]. Some edges can lead to effective time reversal symmetry breaking, others are effective intervalley scatterers. In this work, we develop a theory that is capable of handling such effects in graphene nanostructures. We do this in two steps. First, we derive an exact expression for the Green function of a graphene flake, where each term in this expansion corresponds to the specific number of times the quasiparticle hits the edge. Second, we use the Green function to calculate: (i) the spectra for closed systems and (ii) the conductance of open systems. In particular, we focus on phase coherent effects, such as the weak localization correction to the average conductance, and the universal conductance fluctuations. Moreover, we show how the size of these effects depends on the edges.

[1] J. Wurm et al., Phys. Rev. Lett. **102**, 056806 (2009)
[2] J. Wurm et al., New J. Phys. **11**, 095022 (2009)

HL 7.10 Mon 12:45 H18

Charge transport in disordered superconductor-graphene junctions — •Georgo Metalidis[1], Dmitry Golubev[2], and Gerd Schön[1] — [1]Institut für Theoretische Festkörperphysik, Karlsruher Institut für Technologie, D-76131 Karlsruhe, Germany — [2]Institut für Nanotechnologie, Karlsruher Institut für Technologie, D-76021 Karlsruhe, Germany

We consider the charge transport through superconductor-graphene tunnel junctions, including the effect of disorder. Coherent scattering on elastic impurities in the graphene layer can give rise to multiple reflections at the graphene-superconductor interface, and can thereby increase the probability of Andreev reflection, leading to an enhancement of the subgap conductance above its classical value. Although the phenomenon is known already from heterostructures involving normal metals, we have studied how graphenes peculiar dispersion relation influences the effect.

HL 8: Organic Electronics and Photovoltaics I (Joint Session with DS/CPP/O)

Time: Monday 10:15–12:30 Location: H8

HL 8.1 Mon 10:15 H8

Colour tuneable light-emitting transistor — •Eva J. Feldmeier, Christian Melzer, and Heinz von Seggern — Electronic Materials Department, Institute of Materials Science Technische Universität Darmstadt, Petersenstraße 23, 64287 Darmstadt, Germany

In recent years the interest in ambipolar organic light-emitting field-effect transistors has increased steadily as the devices combine switching behaviour of transistors with light emission. Usually, small molecules and polymers with a band gap in the visible spectral range serve as semiconducting materials. Mandatory remain balanced injection and transport properties for both charge carrier types to provide full control of the spatial position of the recombination zone of electrons