Probing the nanoscale origin of strain and doping in graphene-hBN heterostructures

We use confocal Raman microscopy and a recently proposed vector analysis scheme to investigate the nanoscale origin of strain and carrier concentration in exfoliated graphene-hexagonal boron nitride (hBN) heterostructures on silicon dioxide (SiO₂). Two types of heterostructures are studied: graphene on SiO₂ partially covered by hBN, and graphene fully encapsulated between two hBN flakes. We extend the vector analysis method to produce separated spatial maps of the strain and doping variation across the heterostructures. This allows us to visualise and directly quantify the much-speculated effect of the environment on carrier concentration in graphene. Moreover, we demonstrate that variations in strain and carrier concentration in graphene arise from nanoscale features of the heterostructures such as fractures, folds and bubbles trapped between layers. For bubbles in hBN-encapsulated graphene, hydrostatic strain is shown to be greatest at bubble centres, whereas the maximum carrier concentration is localised at bubble edges. Raman spectroscopy is shown to be a non-invasive tool for probing strain and doping in graphene, which could prove useful for engineering of two-dimensional devices.
Fraunhofer response and supercurrent spin switching in black phosphorus with strain and disorder

We develop theory models for both ballistic and disordered superconducting monolayer black phosphorus devices in the presence of magnetic exchange field and stress. The ballistic case is studied through a microscopic Bogoliubov-de Gennes formalism, while for the disordered case we formulate a quasiclassical model. Utilizing the two models, we theoretically study the response of supercurrent to an externally applied magnetic field in two-dimensional black phosphorus Josephson junctions. Our results demonstrate that the response of the supercurrent to a perpendicular magnetic field in ballistic samples can deviate from the standard Fraunhofer interference pattern when the Fermi level and mechanical stress are varied. This finding suggests the combination of chemical potential and strain is an efficient external knob to control the current response in highly sensitive strain-effect transistors and superconducting quantum interference devices. We also study the supercurrent in a superconductor-ferromagnet-ferromagnet-superconductor junction where the magnetizations of the two adjacent magnetized regions are uniform with misaligned orientations. We show that the magnetization misalignment can control the excitation of harmonics higher than the first harmonic $\sin\varphi$ (in which $\varphi$ is the phase difference between the superconductors) in supercurrent and constitutes a full-spin-switching current element. Finally, we discuss possible experimental implementations of our findings. We foresee our models and discussions could provide guidelines to experimentalists in designing devices and future investigations.
Ballistic tracks in graphene nanoribbons

High quality graphene nanoribbons epitaxially grown on the sidewalls of silicon carbide (SiC) mesa structures stand as key building blocks for graphene-based nanoelectronics. Such ribbons display 1D single-channel ballistic transport at room temperature with exceptionally long mean free paths. Here, using spatially-resolved two-point probe (2PP) measurements, we selectively access and directly image a range of individual transport modes in sidewall ribbons. The signature of the
independently contacted channels is a sequence of quantised conductance plateaus for different probe positions. These
result from an interplay between edge magnetism and asymmetric terminations at opposite ribbon edges due to the
underlying SiC structure morphology. Our findings demonstrate a precise control of transport through multiple,
independent, ballistic tracks in graphene-based devices, opening intriguing path-ways for quantum information device
concepts.

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Organisations: Center for Nanostructured Graphene, Department of Micro- and Nanotechnology, Theoretical
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Contributors: Aprojanz, J., Power, S. R., Bampoulis, P., Roche, S., Jauho, A., Zandvliet, H. J. W., Tegenkamp, C.,
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- Scopus rating (2015): CiteScore 11.23 SJR 6.287 SNIP 2.86
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- Scopus rating (2013): CiteScore 9.85 SJR 6.206 SNIP 2.797
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- Web of Science (2012): Indexed yes
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Conductance quantization suppression in the quantum Hall regime

Conductance quantization is the quintessential feature of electronic transport in non-interacting mesoscopic systems. This phenomenon is observed in quasi one-dimensional conductors at zero magnetic field $B$, and the formation of edge states at finite magnetic fields results in wider conductance plateaus within the quantum Hall regime. Electrostatic interactions can change this picture qualitatively. At finite $B$, screening mechanisms in narrow, gated ballistic conductors are predicted to give rise to an increase in conductance and a suppression of quantization due to the appearance of additional conduction channels. Despite being a universal effect, this regime has proven experimentally elusive because of difficulties in realizing one-dimensional systems with sufficiently hard-walled, disorder-free confinement. Here, we experimentally demonstrate the suppression of conductance quantization within the quantum Hall regime for graphene nanoconstrictions with low edge roughness. Our findings may have profound impact on fundamental studies of quantum transport in finite-size, two-dimensional crystals with low disorder.

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Electron Waiting Times of a Cooper Pair Splitter

Electron waiting times are an important concept in the analysis of quantum transport in nanoscale conductors. Here we show that the statistics of electron waiting times can be used to characterize Cooper pair splitters that create spatially separated spin-entangled electrons. A short waiting time between electrons tunneling into different leads is associated with the fast emission of a split Cooper pair, while long waiting times are governed by the slow injection of Cooper pairs from a superconductor. Experimentally, the waiting time distributions can be measured using real-time single-electron detectors in the regime of slow tunneling, where conventional current measurements are demanding. Our work is important for understanding the fundamental transport processes in Cooper pair splitters and the predictions may be verified using current technology.

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BFI (2016): BFI-level 2
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Web of Science (2016): Impact factor 8.462
Probing nonlocal effects in metals with graphene plasmons

In this paper, we analyze the effects of nonlocality on the optical properties of a system consisting of a thin metallic film separated from a graphene sheet by a hexagonal boron nitride (hBN) layer. We show that nonlocal effects in the metal have a strong impact on the spectrum of the surface plasmon-polaritons on graphene. If the graphene sheet is nanostructured into a periodic grating, we show that the resulting extinction curves can be used to shed light on the importance of nonlocal effects in metals. Therefore graphene surface plasmons emerge as a tool for probing nonlocal effects in metallic nanostructures, including thin metallic films. As a byproduct of our study, we show that nonlocal effects may lead to smaller losses for the graphene plasmons than what is predicted by a local calculation. Finally, we demonstrate that such nonlocal effects can be very well mimicked using a local theory with an effective spacer thickness larger than its actual value.
Strain-engineered Majorana zero energy modes and $\phi_0$ Josephson state in black phosphorus

We develop a theory for strain control of Majorana zero energy modes and Josephson effect in black phosphorus (BP) devices proximity coupled to a superconductor. Employing realistic values for the band parameters subject to strain, we show that the strain closes the intrinsic band gap of BP, however the proximity effect from the superconductor reopens it and creates Dirac and Weyl nodes. Our results illustrate that Majorana zero energy flat bands connect the nodes within the band-inverted regime in which their associated density of states is localized at the edges of the device. In a ferromagnetically mediated Josephson configuration, the exchange field induces super-harmonics into the supercurrent phase relation in addition to a $\phi_0$ phase shift, corresponding to a spontaneous supercurrent, and strain offers an efficient tool to control these phenomena. We analyze the experimental implications of our findings, and show that they can pave the way for creating a rich platform for studying two-dimensional Dirac and Weyl superconductivity.
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Classification of DNA nucleotides with transverse tunneling currents

It has been theoretically suggested and experimentally demonstrated that fast and low-cost sequencing of DNA, RNA, and peptide molecules might be achieved by passing such molecules between electrodes embedded in a nanochannel. The experimental realization of this scheme faces major challenges, however. In realistic liquid environments, typical currents in tunneling devices are of the order of picoamps. This corresponds to only six electrons per microsecond, and this number affects the integration time required to do current measurements in real experiments. This limits the speed of sequencing, though current fluctuations due to Brownian motion of the molecule average out during the required integration time. Moreover, data acquisition equipment introduces noise, and electronic filters create correlations in time-series data. We discuss how these effects must be included in the analysis of, e.g., the assignment of specific nucleobases to current signals. As the signals from different molecules overlap, unambiguous classification is impossible with a single measurement. We argue that the assignment of molecules to a signal is a standard pattern classification problem and calculation of the error rates is straightforward. The ideas presented here can be extended to other sequencing approaches of current interest.

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Organisations: Center for Nanostructured Graphene, Department of Micro- and Nanotechnology, University of California at San Diego
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Disorder-induced localised gating in graphene

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Contributors: Aktor, T., Jauho, A., Power, S.
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Electron trajectories and magnetotransport in nanopatterned graphene under commensurability conditions

Commensurability oscillations in the magnetotransport of periodically patterned systems, emerging from the interplay of cyclotron orbit and pattern periodicity, are a benchmark of mesoscopic physics in electron gas systems. Exploiting similar effects in two-dimensional materials would allow exceptional control of electron behavior, but it is hindered by the requirement to maintain ballistic transport over large length scales. Recent experiments have overcome this obstacle and observed distinct magnetoresistance commensurability peaks for perforated graphene sheets (antidot lattices). Interpreting the exact mechanisms behind these peaks is of key importance, particularly in graphene, where a range of regimes are accessible by varying the electron density. In this work, a fully atomistic, device-based simulation of magnetoresistance experiments allows us to analyze both the resistance peaks and the current flow at commensurability conditions. Magnetoresistance spectra are found in excellent agreement with experiment, but we show that a semiclassical analysis, in terms of simple skipping or pinned orbits, is insufficient to fully describe the corresponding electron trajectories. Instead, a generalized mechanism in terms of states bound to individual antidots, or to groups of antidots, is required. Commensurability features are shown to arise when scattering between such states is enhanced. The emergence and suppression of commensurability peaks is explored for different antidot sizes, magnetic field strengths, and electron densities. The insights gained from our study will guide the design and optimization of future experiments with nanostructured graphene.
Nanostructured graphene for spintronics
Zigzag edges of the honeycomb structure of graphene exhibit magnetic polarization, making them attractive as building blocks for spintronic devices. Here, we show that devices with zigzag-edged triangular antidots perform essential spintronic functionalities, such as spatial spin splitting or spin filtering of unpolarized incoming currents. Near-perfect performance can be obtained with optimized structures. The device performance is robust against substantial disorder. The gate-voltage dependence of transverse resistance is qualitatively different for spin-polarized and spin-unpolarized devices, and can be used as a diagnostic tool. Importantly, the suggested devices are feasible within current technologies.

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Plasmons in Dimensionally Mismatched Coulomb Coupled Graphene Systems

We calculate the plasmon dispersion relation for Coulomb coupled metallic armchair graphene nanoribbons and doped monolayer graphene. The crossing of the plasmon curves, which occurs for uncoupled 1D and 2D systems, is split by the interlayer Coulomb coupling into a lower and an upper plasmon branch. The upper branch exhibits an unusual behavior with end points at finite q. Accordingly, the structure factor shows either a single or a double peak behavior, depending on the plasmon wavelength. The new plasmon structure is relevant to recent experiments, its properties can be controlled by varying the system parameters and be used in plasmonic applications.
Quantum Corrections in Nanoplasmonics: Shape, Scale, and Material

The classical treatment of plasmonics is insufficient at the nanometer-scale due to quantum mechanical surface phenomena. Here, an extension of the classical paradigm is reported which rigorously remedies this deficiency through the incorporation of first-principles surface response functions—the Feibelman d parameters—in general geometries. Several analytical results for the leading-order plasmonic quantum corrections are obtained in a first-principles setting; particularly, a clear separation of the roles of shape, scale, and material is established. The utility of the formalism is illustrated by the derivation of a modified sum rule for complementary structures, a rigorous reformulation of Kreibig's phenomenological damping prescription, and an account of the small-scale resonance shifting of simple and noble metal nanostructures.
Spin-Caloritronic Batteries
The thermoelectric performance of a topological energy converter is analyzed. The H-shaped device is based on a combination of transverse topological effects involving the spin: the inverse spin Hall effect and the spin Nernst effect. The device can convert a temperature drop in one arm into an electric power output in the other arm. Analytical expressions for the output voltage, the figure of merit (ZT), and energy-converting efficiency are reported. We show that the output voltage and the ZT can be tuned by the geometry of the device and the physical properties of the material. Importantly, contrary to a conventional thermoelectric device, here a low electric conductivity may, in fact, enhance the ZT value, thereby opening a path to strategies in optimizing the figure of merit.
Strong Plasmon-Phonon Splitting and Hybridization in 2D Materials Revealed through a Self-Energy Approach

We reveal new aspects of the interaction between plasmons and phonons in 2D materials that go beyond a mere shift and increase in plasmon width due to coupling to either intrinsic vibrational modes of the material or phonons in a supporting substrate. More precisely, we predict strong plasmon splitting due to this coupling, resulting in a characteristic avoided crossing scheme. We base our results on a computationally efficient approach consisting in including many-body interactions through the electron self-energy. We specify this formalism for a description of plasmons based upon a tight-binding electron Hamiltonian combined with the random-phase approximation. This approach is valid provided vertex corrections can be neglected, as is the case in conventional plasmon-supporting metals and Dirac-Fermion systems. We illustrate our method by evaluating plasmonic spectra of doped graphene nanotriangles with varied size, where we predict remarkable peak splittings and other radical modifications in the spectra due to plasmon interactions with intrinsic optical phonons. Our method is equally applicable to other 2D materials and provides a simple approach for investigating coupling of plasmons to phonons, excitons, and other excitations in hybrid thin nanostructures.

General information

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Organisations: Department of Photonics Engineering, Center for Nanostructured Graphene, Structured Electromagnetic Materials, Department of Micro- and Nanotechnology, Department of Physics, Theoretical Atomic-scale Physics, Theoretical Nanotechnology, Barcelona Institute of Science and Technology
Contributors: Settnes, M., Saavedra, J. R. M., Thygesen, K. S., Jauho, A., Garcia de Abajo, F. J., Mortensen, N. A.
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Pages: 2908-2915
Symmetry-forbidden intervalley scattering by atomic defects in monolayer transition-metal dichalcogenides

Intervalley scattering by atomic defects in monolayer transition metal dichalcogenides (TDMs; MX$_2$) presents a serious obstacle for applications exploiting their unique valley-contrasting properties. Here, we show that the symmetry of the atomic defects can give rise to an unconventional protection mechanism against intervalley scattering in monolayer TMDs. The predicted defect-dependent selection rules for intervalley scattering can be verified via Fourier transform scanning tunneling spectroscopy (FT-STS), and provide a unique identification of, e.g., atomic vacancy defects (M vs X). Our findings are consistent with the absence of the K K' intervalley FT-STS peak in recent experiments.

General information
State: Published
Organisations: Center for Nanostructured Graphene, Department of Micro- and Nanotechnology, Theoretical Nanotechnology, University of Minnesota
Contributors: Kaasbjerg, K., Martiny, J. H. J., Low, T., Jauho, A.
Number of pages: 6
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Peer-reviewed: Yes

Publication information
Thermoelectrics in Coulomb-coupled quantum dots: Cotunneling and energy-dependent lead couplings

We study thermoelectric effects in Coulomb-coupled quantum-dot (CCQD) systems beyond lowest-order tunneling processes and the often applied wide-band approximation. To this end, we present a master-equation (ME) approach based on a perturbative T-matrix calculation of the charge and heat tunneling rates and transport currents. Applying the method to transport through a noninteracting single-level QD, we demonstrate excellent agreement with the Landauer-Büttiker theory when higher-order (cotunneling) processes are included in the ME. Next, we study the effect of cotunneling and energy-dependent lead couplings on the heat currents in a system of two CCQDs. We find that cotunneling processes (i) can dominate the off-resonant heat currents at low temperature and bias compared to the interdot interaction, and (ii) give rise to a pronounced reduction of the cooling power achievable with the recently demonstrated Maxwell's demon cooling mechanism. Furthermore, we demonstrate that the cooling power can be boosted significantly by carefully engineering the energy dependence of the lead couplings to filter out undesired transport processes. Our findings emphasize the importance of higher-order cotunneling processes as well as engineered energy-dependent lead couplings in the optimization of the thermoelectric performance of CCQD systems.
Despite of its many wonderful properties, pristine graphene has one major drawback: it does not have a band gap, which complicates its applications in electronic devices. Many routes have been suggested to overcome this difficulty, such as cutting graphene into nanoribbons, using chemical methods, or making regular nanopercorations, also known antidot lattices. Theoretically, all these ideas lead to a reasonable band gap, but realizing them in the lab is very difficult because all fabrication steps induce disorder or other nonidealities, with potentially disastrous consequences for the intended device operation. In this talk I elaborate these ideas and review the state-of-the-art both from the theoretical and the experimental points of view. I also introduce two new ideas: (1) triangular antidots, and (2) nanobubbles formed in
graphene. Both of these nanostructuring methods are predicted to yield novel transport signatures, which could form the basis of new types of devices. Our simulations show that it may be possible to generate very high quality spin- and/or valley polarized currents with these structures – something that has not yet been achieved in the lab. Importantly, our simulations involve millions of atoms which is necessary in order to address structures feasible in the lab.

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Contributors: Jauho, A.
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10.1109/NUSOD.2017.8009965
Source: PublicationPreSubmission
Source-ID: 140536953
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**All-graphene edge contacts: Electrical resistance of graphene T-junctions**
Using ab-initio methods we investigate the possibility of three-terminal graphene "T-junction" devices and show that these all-graphene edge contacts are energetically feasible when the 1D interface itself is free from foreign atoms. We examine the energetics of various junction structures as a function of the atomic scale geometry. Three-terminal equilibrium Green's functions are used to determine the transmission spectrum and contact resistance of the system. We find that the most symmetric structures have a significant binding energy, and we determine the contact resistances in the junction to be in the range of 1-10 kΩμm which is comparable to the best contact resistance reported for edge-contacted graphene-metal contacts. We conclude that conducting all-carbon T-junctions should be feasible.

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Contributors: Jacobsen, K. W., Falkenberg, J. T., Papior, N. R., Bøggild, P., Jauho, A., Brandbyge, M.
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Scopus rating (2016): CiteScore 6.49 SJR 2.091 SNIP 1.648
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 6.53 SJR 1.988 SNIP 1.71
Correlated Coulomb drag in capacitively coupled quantum-dot structures

We study theoretically Coulomb drag in capacitively coupled quantum dots (CQDs) -- a bias-driven dot coupled to an unbiased dot where transport is due to Coulomb mediated energy transfer drag. To this end, we introduce a master-equation approach which accounts for higher-order tunneling (cotunneling) processes as well as energy-dependent lead couplings, and identify a mesoscopic Coulomb drag mechanism driven by nonlocal multi-electron cotunneling processes. Our theory establishes the conditions for a nonzero drag as well as the direction of the drag current in terms of microscopic system parameters. Interestingly, the direction of the drag current is not determined by the drive current, but...
by an interplay between the energy-dependent lead couplings. Studying the drag mechanism in a graphene-based CQD heterostructure, we show that the predictions of our theory are consistent with recent experiments on Coulomb drag in CQD systems.
Electronic transport in graphene nanoribbons with sublattice-asymmetric doping

Recent experimental findings and theoretical predictions suggest that nitrogen-doped CVD-grown graphene may give rise to electronic band gaps due to impurity distributions which favor segregation on a single sublattice. Here, we demonstrate theoretically that such distributions lead to more complex behavior in the presence of edges, where geometry determines whether electrons in the sample view the impurities as a gap-opening average potential or as scatterers. Zigzag edges give rise to the latter case, and remove the electronic band gaps predicted in extended graphene samples. We predict that such behavior will give rise to leakage near grain boundaries with a similar geometry or in zigzag-edged etched devices. Furthermore, we examine the formation of one-dimensional metallic channels at interfaces between different sublattice domains, which should be observable experimentally and offer intriguing waveguiding possibilities.

General information
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Organisations: Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Theoretical Nanotechnology
Contributors: Aktor, T., Jauho, A., Power, S.
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
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Electronic versions:
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10.1103/physrevb.93.035446
Electron Interference in Ballistic Graphene Nanoconstrictions

We realize nanometer size constrictions in ballistic graphene nanoribbons grown on sidewalls of SiC mesa structures. The high quality of our devices allows the observation of a number of electronic quantum interference phenomena. The transmissions of Fabry-Perot-like resonances are probed by in situ transport measurements at various temperatures. The energies of the resonances are determined by the size of the constrictions, which can be controlled precisely using STM lithography. The temperature and size dependence of the measured conductances are in quantitative agreement with tight-binding calculations. The fact that these interference effects are visible even at room temperature makes the reported devices attractive as building blocks for future carbon based electronics.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Structured Electromagnetic Materials, Theoretical Nanotechnology, Leibniz University of Hannover
Contributors: Baringhaus, J., Settnes, M., Aprojanz, J., Power, S., Jauho, A., Tegenkamp, C.
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BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Graphene Nanobubbles as Valley Filters and Beam Splitters

The energy band structure of graphene has two inequivalent valleys at the K and K' points of the Brillouin zone. The possibility to manipulate this valley degree of freedom defines the field of valleytronics, the valley analogue of spintronics. A key requirement for valleytronic devices is the ability to break the valley degeneracy by filtering and spatially splitting valleys to generate valley polarized currents. Here, we suggest a way to obtain valley polarization using strain-induced inhomogeneous pseudomagnetic fields (PMFs) that act oppositely on the two valleys. Notably, the suggested method does not involve external magnetic fields, or magnetic materials, unlike previous proposals. In our proposal the strain is due to experimentally feasible nanobubbles, whose associated PMFs lead to different real space trajectories for K and K' electrons, thus allowing the two valleys to be addressed individually. In this way, graphene nanobubbles can be exploited in both valley filtering and valley splitting devices, and our simulations reveal that a number of different functionalities are possible depending on the deformation field.
Organisations: Department of Photonics Engineering, Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Structured Electromagnetic Materials, Theoretical Nanotechnology, Theoretical Nanoelectronics
Contributors: Settnes, M., Power, S., Brandbyge, M., Jauho, A.
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
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BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Magnetic edge states and magnetotransport in graphene antidot barriers

Magnetic fields are often used for characterizing transport in nanoscale materials. Recent magnetotransport experiments have demonstrated that ballistic transport is possible in graphene antidot lattices (GALs). These experiments have inspired the present theoretical study of GALs in a perpendicular magnetic field. We calculate magnetotransport through graphene antidot barriers (GABs), which are finite rows of antidots arranged periodically in a pristine graphene sheet, using a tight-binding model and the Landauer-Buttiker formula. We show that GABs behave as ideal Dirac mass barriers for antidots smaller than the magnetic length and demonstrate the presence of magnetic edge states, which are localized states on the periphery of the antidots due to successive reflections on the antidot edge in the presence of a magnetic field. We show that these states are robust against variations in lattice configuration and antidot edge chirality. Moreover, we calculate the transmittance of disordered GABs and find that magnetic edge states survive a moderate degree of disorder. Due to the long phase-coherence length in graphene and the robustness of these states, we expect magnetic edge states to be observable in experiments as well.
Plasma wave instabilities in nonequilibrium graphene

We study two-stream instabilities in a nonequilibrium system in which a stream of electrons is injected into doped graphene. As with equivalent nonequilibrium parabolic band systems, we find that the graphene systems can support unstable charge-density waves whose amplitudes grow with time. We determine the range of wave vectors $\mathbf{q}$ that are unstable, and their growth rates. We find no instability for waves with wave vectors parallel or perpendicular to the direction of the injected carriers. We find that, within the small-wave-vector approximation, the angle between $\mathbf{q}$ and the direction of the injected electrons that maximizes the growth rate increases with increasing $|\mathbf{q}|$. We compare the range and strength of the instability in graphene to that of two- and three-dimensional parabolic band systems.
Pseudomagnetic fields and triaxial strain in graphene

Pseudomagnetic fields, which can result from nonuniform strain distributions, have received much attention in graphene systems due to the possibility of mimicking real magnetic fields with magnitudes of greater than 100 T. We examine systems with such strains confined to finite regions ("pseudomagnetic dots") and provide a transparent explanation for the characteristic sublattice polarization occurring in the presence of a pseudomagnetic field. In particular, we focus on a triaxial strain leading to a constant field in the central region of the dot. This field causes the formation of pseudo-Landau levels, where the zeroth order level shows significant differences compared to the corresponding level in a real magnetic field. Analytic arguments based on the Dirac model are employed to predict the sublattice and valley dependencies of the density of states in these systems. Numerical tight-binding calculations of single pseudomagnetic dots in extended graphene sheets confirm these predictions, and are also used to study the effect of rotating the strain direction with respect to the underlying graphene lattice, and varying the size of the pseudomagnetic dot.

General information
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Contributors: Settnes, M., Power, S., Jauho, A.
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Peer-reviewed: Yes
Quantum transport in graphene in presence of strain-induced pseudo-Landau levels

We report on mesoscopic transport fingerprints in disordered graphene caused by strain-field induced pseudomagnetic Landau levels (pLLs). Efficient numerical real space calculations of the Kubo formula are performed for an ordered network of nanobubbles in graphene, creating pseudomagnetic fields up to several hundreds of Tesla, values inaccessible by real magnetic fields. Strain-induced pLLs yield enhanced scattering effects across the energy spectrum resulting in lower mean free path and enhanced localization effects. In the vicinity of the zeroth order pLL, we demonstrate an anomalous transport regime, where the mean free paths increases with disorder. We attribute this puzzling behavior to the low-energy sub-lattice polarization induced by the zeroth order pLL, which is unique to pseudomagnetic fields preserving time-reversal symmetry. These results, combined with the experimental feasibility of reversible deformation fields, open the way to tailor a metal-insulator transition driven by pseudomagnetic fields.
Robust band gap and half-metallicity in graphene with triangular perforations

Ideal graphene antidot lattices are predicted to show promising band gap behavior (i.e., $E_G \approx 500$ meV) under carefully specified conditions. However, for the structures studied so far this behavior is critically dependent on superlattice geometry and is not robust against experimentally realistic disorders. Here we study a rectangular array of triangular antidots with zigzag edge geometries and show that their band gap behavior qualitatively differs from the standard behavior which is exhibited, e.g., by rectangular arrays of armchair-edged triangles. In the spin unpolarized case, zigzag-edged antidots give rise to large band gaps compared to armchair-edged antidots, irrespective of the rules which govern the existence of gaps in armchair-edged antidot lattices. In addition the zigzag-edged antidots appear more robust than armchair-edged antidots in the presence of geometrical disorder. The inclusion of spin polarization within a mean-field Hubbard approach gives rise to a large overall magnetic moment at each antidot due to the sublattice imbalance imposed by the triangular geometry. Half-metallic behavior arises from the formation of spin-split dispersive states near the Fermi energy, reducing the band gaps compared to the unpolarized case. This behavior is also found to be robust in the presence of disorder. Our results highlight the possibilities of using triangular perforations in graphene to open electronic band gaps in systems with experimentally realistic levels of disorder, and furthermore, of exploiting the strong spin dependence of the system for spintronic applications.

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Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Bubbles in graphene: a computational study

Strain-induced deformations in graphene are predicted to give rise to large pseudomagnetic fields. We examine theoretically the case of gas-inflated bubbles to determine whether signatures of such fields are present in the local density of states. Sharp-edged bubbles are found to induce Friedel-type oscillations which can envelope pseudo-Landau level features in certain regions of the bubble. However, bubbles which minimise interference effects are also unsuitable for pseudo-Landau level formation due to more spatially varying field profiles.
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Organisations: Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Theoretical Nanotechnology, Theoretical Nanoelectronics
Contributors: Settnes, M., Power, S., Lin, J., Petersen, D. H., Jauho, A.
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  BFI (2017): BFI-level 1
  Scopus rating (2017): CiteScore 0.48 SJR 0.241 SNIP 0.447
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Original language: English
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Electron polarization function and plasmons in metallic armchair graphene nanoribbons

Plasmon excitations in metallic armchair graphene nanoribbons are investigated using the random phase approximation. An exact analytical expression for the polarization function of Dirac fermions is obtained, valid for arbitrary temperature and doping. We find that at finite temperatures, due to the phase space redistribution among inter-band and intra-band electronic transitions in the conduction and valence bands, the full polarization function becomes independent of temperature and position of the chemical potential. It is shown that for a given width of nanoribbon there exists a single plasmon mode whose energy dispersion is determined by the graphene's fine structure constant. In the case of two Coulomb-coupled nanoribbons, this plasmon splits into in-phase and out-of-phase plasmon modes with splitting energy determined by the inter-ribbon spacing.
From Classical to Quantum Plasmonics in Three and Two Dimensions

This thesis presents theoretical results for the description and understanding of plasmons in three- and two-dimensional platforms, with a special emphasis on the evolution from classical to nonclassical behavior as the optical and structural length scales are reduced towards the intrinsic scales of the electronic plasma. The content is divided into two parts and split by dimensionality. First, following a general introduction to the topic of plasmonics in three dimensions, we review the fundamental shortcomings of the conventional classical approach, finding its limitations to fall in four categories. We center our efforts on the deficiencies originating in the disregard of nonlocality, and explore its inclusion by means of a hydrodynamic model, which accounts to lowest order for the momentum-dispersion of the dielectric response. Concretely, we apply the hydrodynamic framework to the half-space, thin film, and spherical geometries. In the latter case, we extend the understanding of hydrodynamics beyond the dipolar regime, by contrasting optical probes of far- and near-field character. For short probe-to-surface separations, we establish that near- and far-field measurements provide significantly dissimilar weighting of spectral features, with particular importance to the excitation of multipole plasmons. Moreover, for these multipole plasmons, we find a hydrodynamic shift which increases with multipole order. This shift removes the singular classical pile-up of multipoles near the planar surface plasmon frequency. Complementing these considerations, we present results arising from an experimental collaboration, in which, using electron energy-loss spectroscopy, the impact of higher-order multipoles are identified in embedded silver nanoparticles with radii down to 4 nm. Finally, in recognizing the limitations of the hydrodynamic model, we propose the outline of an extension of the Feibelman-parameter approach to arbitrary geometries. Formally, this extension achieves a simultaneous first-order account of spill-out, nonlocality, and Landau damping, by instating a natural division between electronic and optical aspects. Our treatment of two-dimensional plasmonics centers on the platform of graphene. After a short review of graphene’s intrinsic electronic and optical properties, we introduce and explicate the main characteristic features of graphene plasmonics. We tabulate and discuss the resonance conditions and properties for the extended sheet, half-sheet, ribbon, disk, and regular polygons. In addition, we consider the existence of graphene plasmons in the non-planar geometry of a coated nanosphere. Proceeding to a consideration of effects beyond the conventional approach, we present first an adaptation of the hydrodynamic model to graphene. Next, we review the recently introduced tight-binding approach to the quantum
plasmonic response of graphene nanostructures. We demonstrate how this frequency-domain method finds an equivalent implementation in the time-domain. Using this method and a related Dirac equation approach, we investigate the role of edge states in graphene, finding significant differences between the plasmonic properties of armchair- and non-armchair-terminated nanostructures. Lastly, we discuss the influence of a nonlinear Kerr interaction on the plasmons supported by a graphene nanoribbon, finding redshifting behavior relative to the linear case. We offer a straightforward and general perturbative understanding of this prediction, which depends only on the plasmon's spatial inhomogeneity and geometry-averaged field intensity.

**General information**
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Organisations: Department of Photonics Engineering, Center for Nanostructured Graphene, Structured Electromagnetic Materials, Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Christensen, T., Mortensen, N. A., Wubs, M., Jauho, A.
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**Graphene nanoribbons with sublattice asymmetric doping**

**General information**
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Organisations: Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Theoretical Nanotechnology
Contributors: Aktor, T., Jauho, A., Power, S. R.
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**Graphene on graphene antidot lattices: Electronic and transport properties**

Graphene bilayer systems are known to exhibit a band gap when the layer symmetry is broken by applying a perpendicular electric field. The resulting band structure resembles that of a conventional semiconductor with a parabolic dispersion. Here, we introduce a bilayer graphene heterostructure, where single-layer graphene is placed on top of another layer of graphene with a regular lattice of antidots. We dub this class of graphene systems GOAL: graphene on graphene antidot lattice. By varying the structure geometry, band-structure engineering can be performed to obtain linearly dispersing bands (with a high concomitant mobility), which nevertheless can be made gapped with a perpendicular field. We analyze the electronic structure and transport properties of various types of GOALs, and draw general conclusions about their properties to aid their design in experiments.

**General information**
State: Published
Organisations: Center for Nanostructured Graphene, Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Gregersen, S. S., Pedersen, J. G., Power, S., Jauho, A.
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Kerr nonlinearity and plasmonic bistability in graphene nanoribbons
We theoretically examine the role of Kerr nonlinearities for graphene plasmonics in nanostructures, specifically in nanoribbons. The nonlinear Kerr interaction is included semiclassically in the intraband approximation. The resulting electromagnetic problem is solved numerically by self-consistent iteration with linear steps using a real-space discretization. We derive a simple approximation for the resonance shifts in general graphene nanostructures, and obtain excellent agreement with numerics for moderately high field strengths. Near plasmonic resonances the nonlinearities are strongly enhanced due to field enhancement, and the total nonlinearity is significantly affected by the field inhomogeneity of the plasmonic excitation. Finally, we discuss the emergence of a plasmonic bistability which exists for energies red-shifted relative to the linear resonance. Our results offer insights into the role of nonlinear interaction in nanostructured graphene and pave the way for experimental investigation.
Localized plasmons in graphene-coated nanospheres

We present an analytical derivation of the electromagnetic response of a spherical object coated by a conductive film, here exemplified by a graphene coating. Applying the framework of Mie-Lorenz theory augmented to account for a conductive boundary condition, we derive the multipole scattering coefficients, modified essentially through the inclusion of an additive correction in numerator and denominator. By reductionist means, starting from the retarded response, we offer simple results in the quasistatic regime by analyzing the multipolar polarizability and associated dispersion equation for the localized plasmons. We consider graphene coatings of both dielectric and conducting spheres, where the graphene coating in the former case introduces the plasmons and in the latter case modifies in interesting ways the existing ones. Finally, we discuss our analytical results in the context of extinction cross section and local density of states. Recent demonstrations of fabricated spherical graphene nanostructures make our study directly relevant to experiments.

General information
State: Published
Organisations: Center for Nanostructured Graphene, Department of Photonics Engineering, Structured Electromagnetic Materials, Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Christensen, T., Jauho, A., Wubs, M., Mortensen, N. A.
Patched Green's function techniques for two-dimensional systems: Electronic behavior of bubbles and perforations in graphene

We present a numerically efficient technique to evaluate the Green's function for extended two-dimensional systems without relying on periodic boundary conditions. Different regions of interest, or "patches," are connected using self-energy terms which encode the information of the extended parts of the system. The calculation scheme uses a combination of analytic expressions for the Green's function of infinite pristine systems and an adaptive recursive Green's function technique for the patches. The method allows for an efficient calculation of both local electronic and transport properties, as well as the inclusion of multiple probes in arbitrary geometries embedded in extended samples. We apply the patched Green's function method to evaluate the local densities of states and transmission properties of graphene systems with two kinds of deviations from the pristine structure: bubbles and perforations with characteristic dimensions of the order of 10-25 nm, i.e., including hundreds of thousands of atoms. The strain field induced by a bubble is treated beyond an effective Dirac model, and we demonstrate the existence of both Friedel-type oscillations arising from the edges of the bubble, as well as pseudo-Landau levels related to the pseudomagnetic field induced by the nonuniform strain. Second, we compute the transport properties of a large perforation with atomic positions extracted from a transmission electron microscope image and show that current vortices may form near the zigzag segments of the perforation.
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Plasmonic eigenmodes in individual and bow-tie graphene nanotriangles
In classical electrodynamics, nanostructured graphene is commonly modeled by the computationally demanding problem of a three-dimensional conducting film of atomic-scale thickness. Here, we propose an efficient alternative two-dimensional electrostatic approach where all calculation procedures are restricted to the graphene sheet. Furthermore, to explore possible quantum effects, we perform tight-binding calculations, adopting a random-phase approximation. We investigate multiple plasmon modes in 20 nm equilateral triangles of graphene, treating the optical response classically as well as quantum mechanically. Compared to the classical plasmonic spectrum which is "blind" to the edge termination, we find that the quantum plasmon frequencies exhibit blueshifts in the case of armchair edge termination of the underlying atomic lattice, while redshifts are found for zigzag edges. Furthermore, we find spectral features in the zigzag case which are associated with electronic edge states not present for armchair termination. Merging pairs of triangles into dimers, plasmon hybridization leads to energy splitting that appears strongest in classical calculations while splitting is lower for armchair edges and even more reduced for zigzag edges. Our various results illustrate a surprising phenomenon: Even 20 nm large graphene structures clearly exhibit quantum plasmonic features due to atomic-scale details in the edge termination.

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Scopus rating (2012): CiteScore 2.44 SJR 1.531 SNIP 0.962
The thesis concerns the development of theoretical and computational methods for multiprobe systems and their application to nanostructured graphene. Recent experimental advances emphasize the usefulness of multi-probe techniques when analyzing the electrical properties of nanoscale samples. The multi-probe setup, however, is conceptually different from the standard calculation setups which either disregard the effects of the probes altogether or use probes connected at the edge of a finite device region. In the multi-probe setup, on the other hand, the device region is infinite and extends all around the local probes. This necessitates a reformulation of the conventional calculation methods allowing for the description of non-periodic structures embedded within infinite samples.

The two-dimensional material graphene, is a highly interesting system for multi-probe characterization as graphene is purely surface and exhibits a wide range of highly intriguing electronic properties. Using a dual probe setup, we demonstrate the application of the developed formalism to a number of different graphene-based systems. The conductance between the two probes in either scanning or spectroscopy mode, shows quantum interference patterns around impurities or crystalline edges. These interferences can be used to reveal important information about the scattering processes taking place. The thesis furthermore discusses nanostructuring such as perforations or local gating. We show how single states or modes and their interplay gives rise to resonances in the dual probe conductance and can be associated with vortex-like current patterns either guiding or suppressing the current.

We further address the effect of strain in graphene when subjected to mechanical deformations giving rise to so-called pseudomagnetic fields. Here we investigate strained graphene bubbles ("pseudomagnetic dots") directly from tight binding, effectively going beyond the Dirac approximation. In this way, we study the local density of states of different pseudomagnetic dots in real space and show Friedel-type oscillations caused by the finite size of the dots, sublattice polarization and Landau quantization. Additionally, we use the dual probe conductance to demonstrate the current guiding ability of the pseudomagnetic fields leading to preferential scattering directions responsible for the observed pseudomagnetic focusing and anti-focusing effects.

**General information**

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Organisations: Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Theoretical Nanotechnology, Nanocarbon
Contributors: Settnes, M., Power, S., Petersen, D. H., Jauho, A.
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Research output: Research › Ph.D. thesis – Annual report year: 2015

**Thermally Driven Pure Spin and Valley Currents via the Anomalous Nernst Effect in Monolayer Group-VI Dichalcogenides**

The spin and valley-dependent anomalous Nernst effects are analyzed for monolayer MoS2 and other group-VI dichalcogenides. We find that pure spin and valley currents can be generated perpendicular to the applied thermal gradient in the plane of these two-dimensional materials. This effect provides a versatile platform for applications of spin caloritronics. A spin current purity factor is introduced to quantify this effect. When time reversal symmetry is violated, e.g., two-dimensional materials on an insulating magnetic substrate, a dip-peak feature appears for the total Nernst coefficient.
For the dip state it is found that carriers with only one spin and from one valley are driven by the temperature gradient.

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**Organisations:** Department of Micro- and Nanotechnology, Theoretical Nanotechnology, Center for Nanostructured Graphene, Chinese Academy of Sciences

**Contributors:** Yu, X., Zhu, Z., Su, G., Jauho, A.

**Number of pages:** 5

**Publication date:** 2015

**Peer-reviewed:** Yes
Classical and quantum plasmonics in graphene nanodisks: Role of edge states

Edge states are ubiquitous for many condensed matter systems with multicomponent wave functions. For example, edge states play a crucial role in transport in zigzag graphene nanoribbons. Here, we report microscopic calculations of quantum plasmonics in doped graphene nanodisks with zigzag edges. We express the nanodisk conductivity $\sigma(\omega)$ as a sum of the conventional bulk conductivity $\sigma_B(\omega)$, and a novel term $\sigma_E(\omega)$, corresponding to a coupling between the edge and bulk states. We show that the edge states give rise to a redshift and broadening of the plasmon resonance, and that they often significantly impact the absorption efficiency. We further develop simplified models, incorporating nonlocal response within a hydrodynamical approach, which allow a semiquantitative description of plasmonics in the ultrasmall size regime. Furthermore, we show that the effect of hydrodynamic and edge-conductivity corrections scale identically, approximately with the inverse of the disk radius, highlighting their equitable importance. However, the polarization dependence is only given by fully microscopic models. The approach developed here should have many applications in other systems supporting edge states.

General information
State: Published
Organisations: Center for Nanostructured Graphene, Department of Photonics Engineering, Structured Electromagnetic Materials, Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Christensen, T., Wang, W., Jauho, A., Wubs, M., Mortensen, N. A.
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Issue number: 24
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Dual-probe spectroscopic fingerprints of defects in graphene

Recent advances in experimental techniques emphasize the usefulness of multiple scanning probe techniques when analyzing nanoscale samples. Here, we analyze theoretically dual-probe setups with probe separations in the nanometer range, i.e., in a regime where quantum coherence effects can be observed at low temperatures. In a dual-probe setup the electrons are injected at one probe and collected at the other. The measured conductance reflects the local transport properties on the nanoscale, thereby yielding information complementary to that obtained with a standard one-probe setup (the local density of states). In this work we develop a real-space Green's function method to compute the conductance. This requires an extension of the standard calculation schemes, which typically address a finite sample between the probes. In contrast, the developed method makes no assumption of the sample size (e.g., an extended graphene sheet). Applying this method, we study the transport anisotropies in pristine graphene sheets, and analyze the spectroscopic fingerprints arising from quantum interference around single-site defects, such as vacancies and adatoms. Furthermore, we demonstrate that the dual-probe setup is a useful tool for characterizing the electronic transport properties of extended defects or designed nanostructures. In particular, we show that nanoscale perforations, or antidots, in a graphene sheet display Fano-type resonances with a strong dependence on the edge geometry of the perforation.
Electronic transport in disordered graphene antidot lattice devices

Nanostructuring of graphene is in part motivated by the requirement to open a gap in the electronic band structure. In particular, a periodically perforated graphene sheet in the form of an antidot lattice may have such a gap. Such systems have been investigated with a view towards application in transistor or waveguiding devices. The desired properties have been predicted for atomically precise systems, but fabrication methods will introduce significant levels of disorder in the shape, position and edge configurations of individual antidots. We calculate the electronic transport properties of a wide range of finite graphene antidot devices to determine the effect of such disorders on their performance. Modest geometric disorder is seen to have a detrimental effect on devices containing small, tightly packed antidots, which have optimal performance in pristine lattices. Larger antidots display a range of effects which strongly depend on their edge geometry. Antidot systems with armchair edges are seen to have a far more robust transport gap than those composed from zigzag or mixed edge antidots. The role of disorder in waveguide geometries is slightly different and can enhance performance by extending the energy range over which waveguiding behavior is observed.
Nonlocal Response of Metallic Nanospheres Probed by Light, Electrons, and Atoms

Inspired by recent measurements on individual metallic nanospheres that cannot be explained with traditional classical electrodynamics, we theoretically investigate the effects of nonlocal response by metallic nanospheres in three distinct settings: atomic spontaneous emission, electron energy loss spectroscopy, and light scattering. These constitute two near-field and one far-field measurements, with zero-, one-, and two-dimensional excitation sources, respectively. We search for the clearest signatures of hydrodynamic pressure waves in nanospheres. We employ a linearized hydrodynamic model, and Mie–Lorenz theory is applied for each case. Nonlocal response shows its mark in all three configurations, but for the two near-field measurements, we predict especially pronounced nonlocal effects that are not exhibited in far-field measurements. Associated with every multipole order is not only a single blueshifted surface plasmon but also an infinite series of bulk plasmons that have no counterpart in a local-response approximation. We show that these increasingly blueshifted multipole plasmons become spectrally more prominent at shorter probe-to-surface separations and for decreasing nanosphere radii. For selected metals, we predict hydrodynamic multipolar plasmons to be measurable on single nanospheres.
Optical bistability of graphene in the terahertz range

We use an exact solution of the relaxation-time Boltzmann equation in a uniform ac electric field to describe the nonlinear optical response of graphene in the terahertz (THz) range. The cases of monolayer, bilayer, and ABA-stacked trilayer graphene are considered, and the monolayer species is shown to be the most appropriate one to exploit the nonlinear free electron response. We find that a single layer of graphene shows optical bistability in the THz range, within the electromagnetic power range attainable in practice. The current associated with the third harmonic generation is also computed.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology, Center for Nanostructured Graphene, University of Minho
Contributors: Peres, N. M. R., Bludov, Y. V., Santos, J. E., Jauho, A., Vasilevskiy, M. I.
Number of pages: 9
We analyze theoretically charge transport in Coulomb coupled graphene waveguides (GWGs). The GWGs are defined using antidot lattices, and the lateral geometry bypasses many technological challenges of earlier designs. The drag resistivity $\rho_D$, which is a measure of the many-particle interactions between the GWGs, is computed for a range of temperatures and waveguide separations. It is demonstrated that for $T>0.1T_F$ the drag is significantly enhanced due to plasmons, and that in the low-temperature regime a complicated behavior may occur. In the weak coupling regime the dependence of drag on the interwaveguide separation $d$ follows $\rho_D\sim d^{-n}$, where $n=6$. 

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Contributors: Shylau, A. A., Jauho, A.
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Web of Science (2017): Impact factor 3.813
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Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Theoretical analysis of a dual-probe scanning tunneling microscope setup on graphene

Experimental advances allow for the inclusion of multiple probes to measure the transport properties of a sample surface. We develop a theory of dual-probe scanning tunneling microscopy using a Green's function formalism, and apply it to graphene. Sampling the local conduction properties at finite length scales yields real space conductance maps which show anisotropy for pristine graphene systems and quantum interference effects in the presence of isolated impurities. Spectral signatures in the Fourier transforms of real space conductance maps include characteristics that can be related to different scattering processes. We compute the conductance maps of graphene systems with different edge geometries.
Acoustic phonon limited mobility in two-dimensional semiconductors: Deformation potential and piezoelectric scattering in monolayer MoS$_2$ from first principles

We theoretically study the acoustic phonon limited mobility in n-doped two-dimensional MoS$_2$ for temperatures T<100 K and high carrier densities using the Boltzmann equation and first-principles calculations of the acoustic electron-phonon (el-ph) interaction. In combination with a continuum elastic model, analytic expressions and the coupling strengths for the deformation potential and piezoelectric interactions are established. We furthermore show that the deformation potential interaction has contributions from both normal and umklapp processes and that the latter contribution is only weakly affected by carrier screening. Consequently, the calculated mobilities show a transition from a high-temperature $\mu\sim T^{-1}$ behavior to a stronger $\mu\sim T^{-4}$ behavior in the low-temperature Bloch-Grüneisen regime characteristic of unscreened deformation potential scattering. Intrinsvc mobilities in excess of 105 cm$^2$ V$^{-1}$ s$^{-1}$ are predicted at T<10 K and high carrier densities (n\gtrsim 10^{11} cm$^{-2}$). At 100 K, the mobility does not exceed $\sim 7\times 10^3$ cm$^2$ V$^{-1}$ s$^{-1}$. Our findings provide new and important understanding of the acoustic el-ph interaction and its screening by free carriers, and is of high relevance for the understanding of acoustic phonon-limited mobilities in general.
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Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
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BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
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Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
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Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.012 SNIP 1.103
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.184 SNIP 1.179
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.856 SNIP 1.841
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.132 SNIP 1.727
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.84 SNIP 1.603
Web of Science (2000): Indexed yes
Blueshift of the surface plasmon resonance in silver nanoparticles studied with EELS

We study the surface plasmon (SP) resonance energy of isolated spherical Ag nanoparticles dispersed on a silicon nitride substrate in the diameter range 3.5–26 nm with monochromated electron energy-loss spectroscopy. A significant blueshift of the SP resonance energy of 0.5 eV is measured when the particle size decreases from 26 down to 3.5 nm. We interpret the observed blueshift using three models for a metallic sphere embedded in homogeneous background material: a classical Drude model with a homogeneous electron density profile in the metal, a semiclassical model corrected for an inhomogeneous electron density associated with quantum confinement, and a semiclassical nonlocal hydrodynamic description of the electron density. We find that the latter two models provide a qualitative explanation for the observed blueshift, but the theoretical predictions show smaller blueshifts than observed experimentally.

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Electronic and transport properties of kinked graphene

Local curvature, or bending, of a graphene sheet is known to increase the chemical reactivity presenting an opportunity for templated chemical functionalisation. Using first-principles calculations based on density functional theory (DFT), we investigate the reaction barrier reduction for the adsorption of atomic hydrogen at linear bends in graphene. We find a significant barrier lowering (≈15%) for realistic radii of curvature (≈20 Å) and that adsorption along the linear bend leads to a stable linear kink. We compute the electronic transport properties of individual and multiple kink lines, and demonstrate how these act as efficient barriers for electron transport. In particular, two parallel kink lines form a graphene pseudo-nanoribbon structure with a semimetallic/semiconducting electronic structure closely related to the corresponding isolated ribbons; the ribbon band gap translates into a transport gap for electronic transport across the kink lines. We finally consider pseudo-ribbon-based heterostructures and propose that such structures present a novel approach for band gap engineering in nanostructured graphene.

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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 2.86 SJR 1.138 SNIP 1.026
Web of Science (2016): Impact factor 3.127
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BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.05 SJR 1.001 SNIP 0.944
Web of Science (2015): Impact factor 2.778
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.67 SJR 1.163 SNIP 1.038
Web of Science (2014): Impact factor 2.67
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Scopus rating (2013): CiteScore 2.56 SJR 1.268 SNIP 1.057
Web of Science (2013): Impact factor 2.332
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 2.01 SJR 1.036 SNIP 1.004
Web of Science (2012): Impact factor 2.374
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
Scopus rating (2011): SJR 0.398 SNIP 0.469
Web of Science (2011): Impact factor 0.789
Regular nanoscale perforations in graphene (graphene antidot lattices, GALs) are known to lead to a gap in the energy spectrum, thereby paving a possible way towards many applications. This theoretical prediction relies on a perfect placement of identical perforations, a situation not likely to occur in the laboratory. Here, we present a systematic study of the effects of disorder in GALs. We consider both geometric and chemical disorder, and evaluate the density of states as well as the optical conductivity of disordered GALs. The theoretical method is based on an efficient algorithm for solving the time-dependent Schrödinger equation in a tight-binding representation of the graphene sheet [Yuan et al., Phys. Rev. B 82, 115448 (2010)], which allows us to consider GALs consisting of 6400 × 6400 carbon atoms. The central conclusion for all kinds of disorder is that the gaps found for pristine GALs do survive at a considerable amount of disorder, but disappear for very strong disorder. Geometric disorder is more detrimental to gap formation than chemical disorder. The optical conductivity shows a low-energy tail below the pristine GAL band gap due to disorder-introduced transitions.
We study the fundamental limit on single-photon indistinguishability imposed by decoherence due to phonon interactions in semiconductor quantum dot-cavity quantum electrodynamics systems. Employing an exact diagonalization approach we find large differences compared to standard methods. An important finding is that short-time non-Markovian effects limit the maximal attainable indistinguishability. The results are explained using a polariton picture that yields valuable insight into the phonon-induced dephasing dynamics.
Nonlocal response in plasmonic waveguiding with extreme light confinement

We present a novel wave equation for linearized plasmonic response, obtained by combining the coupled real-space differential equations for the electric field and current density. Nonlocal dynamics are fully accounted for, and the formulation is very well suited for numerical implementation, allowing us to study waveguides with subnanometer cross-sections exhibiting extreme light confinement. We show that groove and wedge waveguides have a fundamental lower limit in their mode confinement, only captured by the nonlocal theory. The limitation translates into an upper limit for the corresponding Purcell factors, and thus has important implications for quantum plasmonics.

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Contributors: Toscano, G., Raza, S., Yan, W., Jeppesen, C., Xiao, S., Wubs, M., Jauho, A., Bozhevolnyi, S. I., Mortensen, N. A.
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Refractive-Index Sensing with Ultrathin Plasmonic Nanotubes

We study the refractive-index sensing properties of plasmonic nanotubes with a dielectric core and ultrathin metal shell. The few nanometer thin metal shell is described by both the usual Drude model and the nonlocal hydrodynamic model to investigate the effects of nonlocality. We derive an analytical expression for the extinction cross section and show how sensing of the refractive index of the surrounding medium and the figure of merit are affected by the shape and size of the nanotubes. Comparison with other localized surface plasmon resonance sensors reveals that the nanotube exhibits superior sensitivity and comparable figure of merit.
Screening and collective modes in disordered graphene antidot lattices

The excitation spectrum and the collective modes of graphene antidot lattices (GALs) are studied in the context of a π-band tight-binding model. The dynamical polarizability and dielectric function are calculated within the random-phase approximation. The effect of different kinds of disorder, such as geometric and chemical disorder, are included in our calculations. We highlight the main differences of GALs with respect to single-layer graphene (SLG). Our results show that, in addition to the well-understood bulk plasmon in doped samples, interband plasmons appear in GALs. We further show that the static screening properties of undoped and doped GALs quantitatively differ from SLG.

General information

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Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology, Center for Nanostructured Graphene, Radboud University Nijmegen, Research Center Jülich GmbH, Complutense University
Contributors: Yuan, S., Jin, F., Roldan, R., Jauho, A., Katsnelson, M. I.
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Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Fundamental properties of devices for quantum information technology

This thesis reports a theoretical investigation of the influence of the electron-phonon interaction on semiconductor cavity quantum electrodynamical systems, specifically a quantum dot coupled to an optical microcavity. We develop a theoretical description of the decay dynamics of the quantum dot interacting with the cavity and the phonons. It is shown that the presence of the phonon interaction, fundamentally changes the spontaneous emission decay behavior of the quantum dot. Especially in the regime where the quantum dot-cavity spectral detuning is significantly larger than any linewidth of the system, the effect of the phonon interaction is very pronounced. A simple approximate analytical expression for the quantum dot decay rate is derived, which predicts a strong asymmetry with respect to the quantum dot-cavity detuning at low temperatures, and allows for a clear interpretation of the physics.

Furthermore, a study of the indistinguishability of single photons emitted from the coupled quantum dot-cavity system is performed, with special emphasis on non-Markovian decoherence due to the phonon interaction. We show that common theoretical approaches fail to predict the degree of indistinguishability, on both a qualitative and quantitative level, for experimentally relevant parameters regimes. The important role of non-Markovian effects in the short-time regime, where virtual processes dominate the decoherence of the quantum dot-cavity system, is emphasized. Importantly, our investigations lead to a maximum achievable degree of indistinguishability, a prediction which eludes common approaches.

Are there novel resonances in nanoplasmonic structures due to nonlocal response?

In tiny metallic nanostructures, quantum confinement and nonlocal response change the collective plasmonic behaviour with resulting important consequences for e.g. field-enhancement and extinction cross sections. Here we report on nonlocal resonances in the hydrodynamical Drude model for plasmonic nanostructures that have no counterpart in the local-response Drude model. Even though there are no additional resonances in the visible due to nonlocal response, plasmonic field enhancements are affected by nonlocal response. We present both analytical results for simple geometries and our numerical implementation for arbitrary geometries, and address computational issues related to the several length scales involved.
Dynamical polarizability of graphene irradiated by circularly polarized ac electric fields

We examine the low-energy physics of graphene in the presence of a circularly polarized electric field in the terahertz regime. Specifically, we derive a general expression for the dynamical polarizability of graphene irradiated by an ac electric field. Several approximations are developed that allow one to develop a semi-analytical theory for the weak-field regime. The ac field changes qualitatively the single- and many-electron excitations of graphene: Undoped samples may exhibit collective excitations (in contrast to the equilibrium situation), and the properties of the excitations in doped...
graphene are strongly influenced by the ac field. We also show that the intensity of the external field is the critical control parameter for the stability of these excitations.

**General information**

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Organisations: Department of Micro- and Nanotechnology, Theory Section, Theoretical Nanotechnology Group, Center for Nanostructured Graphene, Complutense University  
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Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04  
Web of Science (2017): Impact factor 3.813  
Web of Science (2017): Indexed yes  
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151  
Web of Science (2016): Impact factor 3.836  
Web of Science (2016): Indexed yes  
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13  
Web of Science (2015): Impact factor 3.718  
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Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316  
Web of Science (2014): Impact factor 3.736  
Web of Science (2014): Indexed yes  
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326  
Web of Science (2013): Impact factor 3.664  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378  
Web of Science (2012): Impact factor 3.767  
ISI indexed (2012): ISI indexed yes  
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Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423  
Web of Science (2011): Impact factor 3.691  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
Scopus rating (2010): SJR 3.318 SNIP 1.447  
Web of Science (2010): Impact factor 3.774  
Web of Science (2010): Indexed yes  
Web of Science (2009): Indexed yes  
Scopus rating (2008): SJR 2.923 SNIP 1.516  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 2.892 SNIP 1.588  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 2.62 SNIP 1.468
Electronic transport in graphene-based structures: An effective cross-section approach

We show that transport in low-dimensional carbon structures with finite concentrations of scatterers can be modeled by utilizing scaling theory and effective cross sections. Our results are based on large-scale numerical simulations of carbon nanotubes and graphene nanoribbons, using a tight-binding model with parameters obtained from first-principles electronic structure calculations. As shown by a comprehensive statistical analysis, the scattering cross sections can be used to estimate the conductance of a quasi-one-dimensional system both in the Ohmic and localized regimes. They can be computed with good accuracy from the transmission functions of single defects, greatly reducing the computational cost and paving the way toward using first-principles methods to evaluate the conductance of mesoscopic systems, consisting of millions of atoms.

General information

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Organisations: Department of Micro- and Nanotechnology, Aalto University
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Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
A common strategy to compensate for losses in optical nanostructures is to add gain material in the system. By exploiting slow-light effects it is expected that the gain may be enhanced beyond its bulk value. Here we show that this route cannot be followed uncritically: inclusion of gain inevitably modifies the underlying dispersion law, and thereby may degrade the slow-light properties underlying the device operation and the anticipated gain enhancement itself. This degradation is...
generic; we demonstrate it for three different systems of current interest (coupled-resonator optical waveguides, Bragg stacks, and photonic crystal waveguides). Nevertheless, a small amount of added gain may be beneficial.

**General information**
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Organisations: Department of Photonics Engineering, Structured Electromagnetic Materials, Department of Mechanical Engineering, Solid Mechanics, Department of Micro- and Nanotechnology, Theory Section, Quantum and Laser Photonics, Center for Nanostructured Graphene
Contributors: Grgic, J., Ott, J. R., Wang, F., Sigmund, O., Jauho, A., Merk, J., Mortensen, N. A.
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BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
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Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
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Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 2
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ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
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Web of Science (2009): Indexed yes
Fundamental limitations to gain enhancement in slow-light photonic structures

We present a non-perturbative analysis of light-matter interaction in active photonic crystal waveguides in the slow-light regime. Inclusion of gain is shown to modify the underlying dispersion law, thereby degrading the slow-light enhancement.

Microscopic theory of phonon-induced effects on semiconductor quantum dot decay dynamics in cavity QED

We investigate the influence of the electron-phonon interaction on the decay dynamics of a quantum dot coupled to an optical microcavity. We show that the electron-phonon interaction has important consequences on the dynamics, especially when the quantum dot and cavity are tuned out of resonance, in which case the phonons may add or remove...
energy leading to an effective nonresonant coupling between quantum dot and cavity. The system is investigated using two different theoretical approaches: (i) a second-order expansion in the bare phonon coupling constant, and (ii) an expansion in a polaron-photon coupling constant, arising from the polaron transformation which allows an accurate description at high temperatures. In the low-temperature regime, we find excellent agreement between the two approaches. An extensive study of the quantum dot decay dynamics is performed, where important parameter dependencies are covered. We find that in general the electron-phonon interaction gives rise to a greatly increased bandwidth of the coupling between quantum dot and cavity. At low temperature, an asymmetry in the quantum dot decay rate is observed, leading to a faster decay when the quantum dot has a larger energy than to the cavity. We explain this as due to the absence of phonon absorption processes. Furthermore, we derive approximate analytical expressions for the quantum dot decay rate, applicable when the cavity can be adiabatically eliminated. The expressions lead to a clear interpretation of the physics and emphasize the important role played by the effective phonon density, describing the availability of phonons for scattering, in quantum dot decay dynamics. Based on the analytical expressions, we present the parameter regimes where phonon effects are expected to be important. Also, we include all technical developments in appendixes.
We study the effect of nonlocal optical response on the optical properties of metallic nanowires, by numerically implementing the hydrodynamical Drude model for arbitrary nanowire geometries. We first demonstrate the accuracy of our frequency-domain finite-element implementation by benchmarking it in a wide frequency range against analytical results for the extinction cross section of a cylindrical plasmonic nanowire. Our main results concern more complex geometries, namely cylindrical and bow-tie nanowire dimers that can strongly enhance optical fields. For both types of dimers we find that nonlocal response can strongly affect both the field enhancement in between the dimers and their respective extinction cross sections. In particular, we give examples of blueshifted maximal field enhancements near hybridized plasmonic dimer resonances that are still large but nearly two times smaller than in the usual local-response description. For the same geometry at a fixed frequency, the field enhancement and cross section can also be significantly more enhanced in the nonlocal-response model.
Nanoplasmonics beyond Ohm's law

In tiny metallic nanostructures, quantum confinement and nonlocal response change the collective plasmonic behavior with important consequences for e.g. field-enhancement and extinction cross sections. We report on our most recent developments of a real-space formulation of an equation-of-motion that goes beyond the common local-response approximation and use of Ohm's law as the central constitutive equation. The electron gas is treated within a semi-classical hydrodynamic model with the emergence of a new intrinsic length scale. We briefly review the new governing wave equations and give examples of applying the nonlocal framework to calculation of extinction cross sections and field enhancement in isolated particles, dimers, and corrugated surfaces.

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Contributors: Mortensen, N. A., Toscano, G., Raza, S., Stenger, N., Yan, W., Jauho, A., Xiao, S., Wubs, M.
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Nanoplasmonics beyond Ohm's law

In tiny metallic nanostructures, quantum confinement and nonlocal response change the collective plasmonic behavior with important consequences for e.g. field-enhancement and extinction cross sections. We report on our most recent developments of a real-space formulation of an equation-of-motion that goes beyond the common local-response approximation and use of Ohm's law as the central constitutive equation. The electron gas is treated within a semi-
classical hydrodynamic model with the emergence of a new intrinsic length scale. We briefly review the new governing wave equations and give examples of applying the nonlocal framework to calculation of extinction cross sections and field enhancement in isolated particles, dimers, and corrugated surfaces.
Nanoplasmonics beyond the refractive index

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Single-photon indistinguishability: influence of phonons
Recent years have demonstrated that the interaction with phonons plays an important role in semiconductor based cavity QED systems [2], consisting of a quantum dot (QD) coupled to a single cavity mode [Fig. 1(a)], where the phonon interaction is the main decoherence mechanism. Avoiding decoherence effects is important in linear optical quantum computing [1], where a device emitting fully coherent indistinguishable single photons on demand, is the essential ingredient.

In this contribution we present a numerically exact simulation of the effect of phonons on the degree of indistinguishability of photons emitted from a solid-state cavity QED system. Our model rigorously describes non-Markovian effects to all orders in the phonon coupling constant, being based on an exact diagonalization procedure accounting for the time evolution of one-time and two-time photon correlation functions. We compare to standard approaches for treating the phonon interaction, namely the Markovian Lindblad formalism and the long-time limit of the non-Markovian time-convolution-less (TCL) approach, and find large quantitative and qualitative differences [3].

Figures 1(b) and (c) show the calculated indistinguishability as a function of the QD-cavity coupling strength for light emitted from the QD and the cavity, respectively, for all the employed methods. Both the Lindblad and TCL theories deviate significantly from our exact results, where, importantly, the exact results predict a pronounced maximum in the degree of indistinguishability, absent in the approximate theories. The maximum arises due to virtual processes in the highly non-Markovian short-time regime, which dominate the decoherence for small QD-cavity coupling, and phonon-mediated real transitions between the upper and lower polariton branches in the long-time regime, dominating the decoherence for large QD-cavity coupling. Our method captures the physics of the regime of small and as well as large QD-cavity coupling, both corresponding to experimentally relevant situations. Importantly, the commonly used Lindblad formalism fails completely in describing the variations of the indistinguishability predicted by the two other models.

General information
State: Published
Organisations: Department of Photonics Engineering, Quantum and Laser Photonics, Department of Micro- and Nanotechnology, Theoretical Nanotechnology, University of Copenhagen
Contributors: Nielsen, P. K., Lodahl, P., Jauho, A., Mørk, J.
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Slow light enhancement and limitations in periodic media
Properties of periodic dielectric media have attracted a big interest in the last two decades due to numerous exciting physical phenomena that cannot occur in homogeneous media. Due to their strong dispersive properties, the speed of light can be significantly slowed down in periodic structures. When light velocity is much smaller than the speed of light in a vacuum, we describe this phenomena as slow light. In this thesis, we analyze important properties of slow light enhancement and limitations in periodic structures. We analyze quantitatively and qualitatively different technologies and significant structures with numerical and analytical methods. By analyzing different structures, we show very general properties for limitation and enhancement in the slow light regime.

Inherent imperfections of fabricated structures such as a material loss and structural disorder have a strong influence on slowly propagating light. By means of perturbative analysis, we address the effect of small imperfections in periodic structures. From our analysis, we find very universal behavior in a slow light regime for all periodic structures. Even if losses are very small the dispersion is severely affected in the vicinity of the band edge. The minimum attainable group velocity will depend on the amount of imperfections. Since imperfections are inherited as part of any periodic structure it is necessary to take them into account when we are interested in slow light applications. Slowly propagating light gives rise to longer interaction time in the periodic media. Due to this reason, weak light-matter interaction is enhanced. The enhancement due to slow light has been studied for loss and gain. By introducing gain/loss, dispersive properties, in the slow light region, are severely influenced. The minimum attainable group velocity is strongly dependent on the amount of introduced loss/gain that will result in limitation of enhancement. Therefore, small amounts of gain/loss will provide great enhancement. While for a large amount of gain/loss slow, light is heavily jeopardized, hence no enhancement will occur.

Surface-enhanced Raman spectroscopy: nonlocal limitations
Giant field enhancement and field singularities are a natural consequence of the commonly employed local-response framework. We show that a more general nonlocal treatment of the plasmonic response leads to new and possibly fundamental limitations on field enhancement with important consequences for our understanding of surface-enhanced Raman spectroscopy (SERS). The intrinsic length scale of the electron gas serves to smear out assumed field singularities, leaving the SERS enhancement factor finite, even for geometries with infinitely sharp features. For silver nanogroove structures, mimicked by periodic arrays of half-cylinders (up to 120 nm in radius), we find no enhancement factors exceeding 10 orders of magnitude (10^{10}).
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.89 SJR 1.79 SNIP 1.597
Web of Science (2017): Impact factor 3.589
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.769 SNIP 1.549
Web of Science (2016): Impact factor 3.416
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.53 SJR 2.013 SNIP 1.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.86 SJR 2.429 SNIP 1.997
Web of Science (2014): Impact factor 3.292
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Scopus rating (2013): CiteScore 3.95 SJR 2.441 SNIP 2.058
Web of Science (2013): Impact factor 3.179
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.52 SJR 2.577 SNIP 1.92
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BFI (2009): BFI-level 1
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Web of Science (2009): Indexed yes
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Scopus rating (2008): SJR 3.354 SNIP 2.384
Web of Science (2008): Indexed yes
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Scopus rating (2006): SJR 3.126 SNIP 2.319
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.245 SNIP 2.451
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.523 SNIP 2.726
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.725 SNIP 2.626
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 3.571 SNIP 2.415
Thermoelectric properties of disordered graphene antidot devices

Clar Sextet Analysis of Triangular, Rectangular, and Honeycomb Graphene Antidot Lattices

Pristine graphene is a semimetal and thus does not have a band gap. By making a nanometer scale periodic array of holes in the graphene sheet a band gap may form; the size of the gap is controllable by adjusting the parameters of the lattice. The hole diameter, hole geometry, lattice geometry, and the separation of the holes are parameters that all play an important role in determining the size of the band gap, which, for technological applications, should be at least of the order of tenths of an eV. We investigate four different hole configurations: the rectangular, the triangular, the rotated triangular, and the honeycomb lattice. It is found that the lattice geometry plays a crucial role for size of the band gap the triangular arrangement displays always a stable gap, while for the other types only particular hole separations lead to a large gap. This observation is explained using, Clear sextet theory, and we find that a sufficient condition for a large gap is that the number of sextets exceeds one-third of the total number of hexagons in the unit cell. Furthermore we investigate, nonisosceles triangular structures to probe the sensitivity of the gap in triangular lattices to small changes in geometry.
Clar sextets in square graphene antidot lattices
A periodic array of holes transforms graphene from a semimetal into a semiconductor with a band gap tuneable by varying the parameters of the lattice. In earlier work only hexagonal lattices have been treated. Using atomistic models we here investigate the size of the band gap of a square lattice, as the parameters of the lattice, that is, the width and height of the unit cell as well as the hole diameter, are varied. It is found that the size of the gap has a very intricate dependence on the width and height of the unit cell, and that even the smallest changes can cause large fluctuations in the gap. These findings are interpreted with the aid of Clar sextet theory and it is found that only when the number of Clar sextets exceeds
one third of the total number of hexagons in the unit cell a large band gap is found.

**General information**

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  - Web of Science (2017): Impact factor 2.399  
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  - Scopus rating (2016): CiteScore 2.01 SJR 0.557 SNIP 0.836  
  - Web of Science (2016): Impact factor 2.221  
  - BFI (2015): BFI-level 1  
  - Scopus rating (2015): CiteScore 1.87 SJR 0.601 SNIP 0.848  
  - Web of Science (2015): Impact factor 1.904  
  - BFI (2014): BFI-level 1  
  - Scopus rating (2014): CiteScore 1.99 SJR 0.684 SNIP 0.864  
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  - Scopus rating (2013): CiteScore 1.66 SJR 0.683 SNIP 0.78  
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  - ISI indexed (2013): ISI indexed yes  
  - BFI (2012): BFI-level 1  
  - Scopus rating (2012): CiteScore 1.62 SJR 0.717 SNIP 0.88  
  - Web of Science (2012): Impact factor 1.522  
  - ISI indexed (2012): ISI indexed yes  
  - BFI (2011): BFI-level 1  
  - Scopus rating (2011): CiteScore 1.33 SJR 0.694 SNIP 0.788  
  - Web of Science (2011): Impact factor 1.532  
  - ISI indexed (2011): ISI indexed yes  
  - Web of Science (2011): Indexed yes  
  - BFI (2010): BFI-level 1  
  - Scopus rating (2010): SJR 0.766 SNIP 0.751  
  - Web of Science (2010): Impact factor 1.304  
  - Web of Science (2010): Indexed yes  
  - BFI (2009): BFI-level 1  
  - Scopus rating (2009): SJR 0.697 SNIP 0.548  
  - BFI (2008): BFI-level 1  
  - Scopus rating (2008): SJR 0.701 SNIP 0.633  
  - Web of Science (2008): Indexed yes  
  - Scopus rating (2007): SJR 0.637 SNIP 0.546
Electron transport in edge-disordered graphene nanoribbons

Ab initio methods are used to study the spin-resolved transport properties of graphene nanoribbons (GNRs) that have both chemical and structural edge disorder. Oxygen edge adsorbates on ideal and protruded ribbons are chosen as representative examples, with the protrusions forming the smallest possible structural disorder consistent with the edge geometry. The impact of the oxygen adsorbate dominates the transport properties of armchair nanoribbons. For zigzag nanoribbons, the transmission properties are markedly affected by the protrusion alone, leading to spin-polarized transport and a smaller perturbation from the oxygen adsorbate. Armchair nanoribbons also exhibit, as a function of their width and the threefold family structure, a repeating pattern related to the existence of the spin polarization and to the variation in the width of the band gap.

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Organisations: Department of Micro- and Nanotechnology, Aalto University, University of York, Nokia Research Center
Contributors: Saloriutta, K., Hancock, Y., Karkkainen, A., Karkkainen, L., Puska, M. J., Jauho, A.
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Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
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Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Field enhancement at metallic interfaces due to quantum confinement

We point out an apparently overlooked consequence of the boundary conditions obeyed by the electric displacement vector at air-metal interfaces: the continuity of the normal component combined with the quantum mechanical penetration of the electron gas in the air implies the existence of a surface on which the dielectric function vanishes. This, in turn, leads to an enhancement of the normal component of the total electric field. We study this effect for a planar metal surface, with the inhomogeneous electron density accounted for by a Jellium model. We also illustrate the effect for equilateral triangular nanoislands via numerical solutions of the appropriate Maxwell equations, and show that the field enhancement is several orders of magnitude larger than what the conventional theory predicts. (C) 2011 Society of Photo-Optical Instrumentation Engineers (SPIE). [DOI: 10.1117/1.3574159]
Role of the light-matter coupling strength on non-Markovian phonon effects in semiconductor cavity QED

Semiconductor cavity quantum electrodynamical (CQED) devices are believed to be important components for future quantum information technologies. Being composed of a single quantum dot (QD) embedded in a cavity, semiconductor CQED systems resemble atomic CQED systems. However, recent experiments [1] have demonstrated that the physics of such all-solid-state systems is much richer than their atomic counterparts. In the regime of small detuning between the QD and cavity resonance, interactions with acoustical phonons are considered [2] to be the most important effect of the solid-state environment. Phonons introduce pure dephasing and other renormalization phenomena [3], which are inherently non-Markovian in nature.

Thermoelectric properties of finite graphene antidot lattices

We present calculations of the electronic and thermal transport properties of graphene antidot lattices with a finite length along the transport direction. The calculations are based on the π-tight-binding model and the Brenner potential. We show that both electronic and thermal transport properties converge fast toward the bulk limit with increasing length of the lattice: only a few repetitions (=6) of the fundamental unit cell are required to recover the electronic band gap of the infinite lattice as a transport gap for the finite lattice. We investigate how different antidot shapes and sizes affect the thermoelectric properties. The resulting thermoelectric figure of merit, ZT, can exceed 0.25, and it is highly sensitive to the atomic arrangement of the antidot edges. Specifically, hexagonal holes with pure armchair edges lead to an order-of-magnitude larger ZT as compared to pure zigzag edges. We explain this behavior as a consequence of the localization of states, which predominantly occurs for zigzag edges, and of an increased splitting of the electronic minibands, which reduces the power factor $S^2G_e$ ($S$ is the Seebeck coefficient and $G_e$ is the electric conductance).
Unusual resonances in nanoplasmonic structures due to nonlocal response

We study the nonlocal response of a confined electron gas within the hydrodynamical Drude model. We address the question as to whether plasmonic nanostructures exhibit nonlocal resonances that have no counterpart in the local-response Drude model. Avoiding the usual quasistatic approximation, we find that such resonances do indeed occur, but only above the plasma frequency. Thus the recently found nonlocal resonances at optical frequencies for very small structures, obtained within quasistatic approximation, are unphysical. As a specific example we consider nanosized metallic cylinders, for which extinction cross sections and field distributions can be calculated analytically.
We review recent results on electronic and thermal transport in two different quasi one-dimensional systems: Silicon nanowires (SiNW) and atomic gold chains. For SiNW's we compute the ballistic electronic and thermal transport properties on equal footing, allowing us to make quantitative predictions for the thermoelectric properties, while for the atomic gold chains we evaluate microscopically the damping of the vibrations, due to the coupling of the chain atoms to the modes in the bulk contacts. Both approaches are based on the combination of density-functional theory, and nonequilibrium Green's functions.

Ab initio vibrations in nonequilibrium nanowires

We review recent results on electronic and thermal transport in two different quasi one-dimensional systems: Silicon nanowires (SiNW) and atomic gold chains. For SiNW's we compute the ballistic electronic and thermal transport properties on equal footing, allowing us to make quantitative predictions for the thermoelectric properties, while for the atomic gold chains we evaluate microscopically the damping of the vibrations, due to the coupling of the chain atoms to the modes in the bulk contacts. Both approaches are based on the combination of density-functional theory, and nonequilibrium Green's functions.

General information

State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanoelectronics Group, Theory Section, Technical University of Denmark
Contributors: Jauho, A., Engelund, M., Markussen, T., Brandbyge, M.
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Analysis of optical properties of strained semiconductor quantum dots for electromagnetically induced transparency

Using multiband k* p theory we study the size and geometry dependence on the slow light properties of conical semiconductor quantum dots. We find the V-type scheme for electromagnetically induced transparency (EIT) to be most favorable, and identify an optimal height and size for efficient EIT operation. In case of the ladder scheme, the existence of additional dipole allowed intraband transitions along with an almost equidistant energy level spacing adds additional decay pathways, which significantly impairs the EIT effect. We further study the influence of strain and band mixing comparing four different k* p band structure models. In addition to the separation of the heavy and light holes due to the biaxial strain...
component, we observe a general reduction in the transition strengths due to energy crossings in the valence bands caused by strain and band mixing effects. We furthermore find a non-trivial quantum dot size dependence of the dipole moments directly related to the biaxial strain component. Due to the separation of the heavy and light holes the optical transition strengths between the lower conduction and upper most valence-band states computed using one-band model and eight-band model show general qualitative agreement, with exceptions relevant for EIT operation.

**Atomic carbon chains as spin-transmitters: An ab initio transport study**

An atomic carbon chain joining two graphene flakes was recently realized in a ground-breaking experiment by Jin et al. (Phys. Rev. Lett., 102 (2009) 205501). We present ab initio results for the electron transport properties of such chains and demonstrate complete spin-polarization of the transmission in large energy ranges. The effect is due to the spin-polarized zig-zag edge terminating each graphene flake causing a spin-splitting of the graphene π(z) bands, and the chain states. Transmission occurs when the graphene p-states resonate with similar states in the strongly hybridized edges and chain. This effect should in general hold for any p-conjugated molecules bridging the zig-zag edges of graphene electrodes. The polarization of the transmission can be controlled by chemically or mechanically modifying the molecule, or by applying an electrical gate.
Counting statistics of transport through Coulomb blockade nanostructures: High-order cumulants and non-Markovian effects

Recent experimental progress has made it possible to detect in real-time single electrons tunneling through Coulomb blockade nanostructures, thereby allowing for precise measurements of the statistical distribution of the number of transferred charges, the so-called full counting statistics. These experimental advances call for a solid theoretical platform for equally accurate calculations of distribution functions and their cumulants. Here we develop a general framework for calculating zero-frequency current cumulants of arbitrary orders for transport through nanostructures with strong Coulomb interactions. Our recursive method can treat systems with many states as well as non-Markovian dynamics. We illustrate our approach with three examples of current experimental relevance: bunching transport through a two-level quantum dot, transport through a nanoelectromechanical system with dynamical Franck-Condon blockade, and transport through coherently coupled quantum dots embedded in a dissipative environment. We discuss properties of high-order cumulants as well as possible subtleties associated with non-Markovian dynamics.

General information
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Organisations: Department of Micro- and Nanotechnology, Harvard University, Charles University, University of Genoa
Contributors: Flindt, C., Novotny, T., Braggio, A., Jauho, A.
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Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
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Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
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Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
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ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Influence of confining potentials on the exchange coupling in double quantum dots

We report simple expressions for the exchange coupling in double quantum dots calculated within the Heitler-London and the Hund-Mulliken approximations using four different confining potentials. At large interdot distances and at large magnetic fields, the exchange coupling does not depend significantly on the details of the potentials. In contrast, at low fields and short distances, different behaviors of the exchange coupling can be attributed to particular features of the potentials. Our results may be useful as guidelines in numerical studies and in the modeling of experiments.

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Organisations: Structured Electromagnetic Materials, Department of Photonics Engineering, Department of Micro- and Nanotechnology, Harvard University
Contributors: Pedersen, J. G., Flindt, C., Jauho, A., Mortensen, A.
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BFI (2018): BFI-level 1
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Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Localized Edge Vibrations and Edge Reconstruction by Joule Heating in Graphene Nanostructures

Control of the edge topology of graphene nanostructures is critical to graphene-based electronics. A means of producing atomically smooth zigzag edges using electronic current has recently been demonstrated in experiments [Jia et al., Science 323, 1701 (2009)]. We develop a microscopic theory for current-induced edge reconstruction using density functional theory. Our calculations provide evidence for localized vibrations at edge interfaces involving unpassivated armchair edges. We demonstrate that these vibrations couple to the current, estimate their excitation by Joule heating, and argue that they are the likely cause of the reconstructions observed in the experiments.

General information
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Organisations: Department of Micro- and Nanotechnology, Theoretical Nanoelectronics Group, Theory Section
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Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
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Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
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ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
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Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
Non-markovian effects in semiconductor cavity QED: Role of phonon-mediated processes

We show theoretically that the non-Markovian nature of the carrier-phonon interaction influences the dynamical properties of a semiconductor cavity QED system considerably, leading to asymmetries with respect to detuning in carrier lifetimes. This pronounced phonon effect originates from the polaritonic quasi-particle nature of the carrier-photon system interacting with the phonon reservoir.

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Non-markovian model of photon-assisted dephasing by electron-phonon interactions in a coupled quantum-dot-cavity system

We investigate the influence of electron-phonon interactions on the dynamical properties of a quantum-dot-cavity QED system. We show that non-Markovian effects in the phonon reservoir lead to strong changes in the dynamics, arising from photon-assisted dephasing processes, not present in Markovian treatments. A pronounced consequence is the emergence of a phonon induced spectral asymmetry when detuning the cavity from the quantum-dot resonance. The asymmetry can only be explained when considering the polaritonic quasiparticle nature of the quantum-dot-cavity system. Furthermore, a temperature induced reduction of the light-matter coupling strength is found to be relevant in interpreting experimental data, especially in the strong coupling regime.

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Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
We study the importance of taking the nonlocal optical response of metals into account for accurate determination of optical properties of nanoplasmonic structures. Here we focus on the computational physics aspects of this problem, and in particular we report on the nonlocal-response package that we wrote for state-of-the-art numerical software, enabling us to take into account the nonlocal material response of metals for any arbitrarily shaped nanoplasmonic structures, without much numerical overhead as compared to the standard local response. Our method is a frequency-domain method, and hence it is sensitive to possible narrow resonances that may arise due to strong electronic quantum confinement in the metal. This feature allows us to accurately determine which geometries are strongly affected by nonlocal response, for example regarding applications based on electric field enhancement properties for which metal nanostructures are widely used.
Scattering cross section of metal catalyst atoms in silicon nanowires

A common technique to fabricate silicon nanowires is to use metal particles (e.g., Au, Ag, Cu, Al) to catalyze the growth reaction. As a consequence, the fabricated nanowires contain small concentrations of these metals as impurities. In this work we investigate the effect of the metallic impurities on the electronic transport properties of silicon nanowires. The computational method is based on ab initio density functional theory together with nonequilibrium Green's functions. From the computed transmission functions we extract a scattering cross section to characterize the scattering strength of the different metal atoms. We find that Au, Ag, and Cu impurities have very similar scattering cross sections, while Al differs from the rest. Impurities located in the center of the wires scatter significantly more than impurities close to or at the surface. The results for nanowires are compared with bulk Si scattering calculations and good agreement is found. This agreement shows that the scattering results for the ultrathin nanowires (which are computationally feasible) are not dominated by finite size or surface effects, and indicate that the results can be extended to larger and experimentally more relevant wires.

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Contributors: Markussen, T., Rurali, R., Cartoixa, X., Jauho, A., Brandbyge, M.
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Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
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Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
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Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
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Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
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Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Slow-light enhanced absorption in a hollow-core fiber

Light traversing a hollow-core photonic band-gap fiber may experience multiple reflections and thereby a slow-down and enhanced optical path length. This offers a technologically interesting way of increasing the optical absorption of an otherwise weakly absorbing material which can infiltrate the fibre. However, in contrast to structures with a refractive index that varies along the propagation direction, like Bragg stacks, the translationally invariant structures studied here feature an intrinsic trade-off between light slow-down and filling fraction that limits the net absorption enhancement. We quantify the degree of absorption enhancement that can be achieved and its dependence on key material parameters. By treating the absorption and index on equal footing, we demonstrate the existence of an absorption-induced saturation of the group index that itself limits the maximum absorption enhancement that can be achieved.
Atomistic theory for the damping of vibrational modes in monoatomic gold chains

We develop a computational method for evaluating the damping of vibrational modes in monatomic metallic chains suspended between bulk crystals under external strain. The damping is due to the coupling between the chain and contact modes and the phonons in the bulk substrates. The geometry of the atoms forming the contact is taken into account. The dynamical matrix is computed with density-functional theory in the atomic chain and the contacts using finite atomic displacements while an empirical method is employed for the bulk substrate. As a specific example, we present results for the experimentally realized case of gold chains in two different crystallographic directions. The range of the computed damping rates confirms the estimates obtained by fits to experimental data [T. Frederiksen et al., Phys. Rev. B 75, 205413 (2007)]. Our method indicates that an order-of-magnitude variation in the harmonic damping is possible even for relatively small changes in the strain. Such detailed insight is necessary for a quantitative analysis of damping in metallic atomic chains and in explaining the rich phenomenology seen in the experiments.

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Contributors: Engelund, M., Brandbyge, M., Jauho, A.
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Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
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Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
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Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.012 SNIP 1.103
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.184 SNIP 1.179
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.856 SNIP 1.841
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.132 SNIP 1.727
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Comparison of electromagnetically induced transparency schemes in semiconductor quantum dot structures: Impact of many-body interactions

We investigate the impact of many-body interactions on group-velocity slowdown achieved via electromagnetically induced transparency in quantum dots using three different coupling-probe schemes (ladder, V, and Lambda, respectively). We find that for all schemes many-body interactions have an important impact on the slow light properties. In the case of the Lambda and V schemes, the minimum required coupling power to achieve slow light is significantly reduced by many-body interactions. V type schemes are found to be generally preferable due to a favorable redistribution of carriers in energy space.

General information
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Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
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 Corrections to the density-functional theory electronic spectrum: Copper phthalocyanine
A method for improving the electronic spectrum of standard Density-Functional Theory (DFT) calculations (i.e., LDA or GGA approximations) is presented, and its application is discussed for the case of the copper phthalocyanine (CuPc) molecule. The method is based on a treatment of exchange and correlation in a many-body Hamiltonian, and it leads to easy-to-evaluate corrections to the DFT eigenvalues. Self-interaction is largely corrected, so that the modified energy levels do not suffer from spurious crossings, as often encountered for CuPc in DFT, and they remedy the standard underestimation of the gap. As a specific example we study the sequence and position of the CuPc molecular orbitals, which are wrongly calculated by standard DFT, and show that they are correctly reproduced after our corrections are included. The suggested method is fast and simple and, while not as accurate as hybrid or semiempirical functionals for molecular levels, it can be easily applied to any local-orbital DFT approach, improving on several important limitations of standard DFT methods.

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Contributors: Vazquez, H., Jelinek, P., Brandbyge, M., Jauho, A., Flores, F.
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Density functional study of graphene antidot lattices: Roles of geometrical relaxation and spin

Graphene sheets with regular perforations, dubbed as antidot lattices, have theoretically been predicted to have a number of interesting properties. Their recent experimental realization with lattice constants below 100 nanometers stresses the urgency of a thorough understanding of their electronic properties. In this work, we perform calculations of the band structure for various hydrogen-passivated hole geometries using both spin-polarized density functional theory (DFT) and DFT based tight-binding (DFTB) and address the importance of relaxation of the structures using either method or a combination thereof. We find from DFT that all structures investigated have band gaps ranging from 0.2 to 1.5 eV. Band gap sizes and general trends are well captured by DFTB with band gaps agreeing within about 0.2 eV even for very small structures. A combination of the two methods is found to offer a good trade-off between computational cost and accuracy. Both methods predict nondegenerate midgap states for certain antidot hole symmetries. The inclusion of spin results in a spin-splitting of these states as well as magnetic moments obeying the Lieb theorem. The local-spin texture of both magnetic and nonmagnetic symmetries is addressed.
Electron and phonon transport in silicon nanowires: Atomistic approach to thermoelectric properties

We compute both electron and phonon transmissions in thin disordered silicon nanowires (SiNWs). Our atomistic approach is based on tight-binding and empirical potential descriptions of the electronic and phononic systems, respectively. Surface disorder is modeled by introducing surface silicon vacancies. It is shown that the average phonon and electron transmissions through long SiNWs containing many vacancies can be accurately estimated from the scattering properties of the isolated vacancies using a recently proposed averaging method [Markussen et al., Phys. Rev. Lett. 99, 076803 (2007)]. We apply this averaging method to surface disordered SiNWs in the diameter range of 1–3 nm to compute the thermoelectric figure of merit ZT. It is found that the phonon transmission is affected more by the vacancies than the electronic transmission leading to an increased thermoelectric performance of disordered wires, in qualitative agreement with recent experiments. The largest ZT>3 is found in strongly disordered 111-oriented wires with a diameter of 2 nm.

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Contributors: Markussen, T., Jauho, A., Brandbyge, M.
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Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
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Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
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Web of Science (2014): Indexed yes
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Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Electronic properties of graphene antidot lattices

Graphene antidot lattices constitute a novel class of nano-engineered graphene devices with controllable electronic and optical properties. An antidot lattice consists of a periodic array of holes that causes a band gap to open up around the Fermi level, turning graphene from a semimetal into a semiconductor. We calculate the electronic band structure of graphene antidot lattices using three numerical approaches with different levels of computational complexity, efficiency and accuracy. Fast finite-element solutions of the Dirac equation capture qualitative features of the band structure, while full tight-binding calculations and density functional theory (DFT) are necessary for more reliable predictions of the band structure. We compare the three computational approaches and investigate the role of hydrogen passivation within our DFT scheme.
Electronic transport properties of fullerene functionalized carbon nanotubes: Ab initio and tight-binding calculations

Fullerene functionalized carbon nanotubes-NanoBuds-form a novel class of hybrid carbon materials, which possesses many advantageous properties as compared to the pristine components. Here, we report a theoretical study of the electronic transport properties of these compounds. We use both ab initio techniques and tight-binding calculations to illustrate these materials' transmission properties and give physical arguments to interpret the numerical results. Specifically, above the Fermi energy we find a strong reduction in electron transmission due to localized states in certain regions of the structure while below the Fermi energy all considered structures exhibit a high-transmission energy band with a geometry-dependent width.

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Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Optical properties and optimization of electromagnetically induced transparency in strained InAs/GaAs quantum dot structures
Using multiband k center dot p theory we study the size and geometry dependence on the slow light properties of conical semiconductor quantum dots. We find the V-type scheme for electromagnetically induced transparency (EIT) to be most favorable and identify an optimal height and size for efficient EIT operation. In case of the ladder scheme, the existence of additional dipole allowed intraband transitions along with an almost equidistant energy-level spacing adds additional decay pathways, which significantly impairs the EIT effect. We further study the influence of strain and band mixing comparing four different k center dot p band-structure models. In addition to the separation of the heavy and light holes due to the biaxial-strain component, we observe a general reduction in the transition strengths due to energy crossings in the valence bands caused by strain and band-mixing effects. We furthermore find a nontrivial quantum dot size dependence of the dipole moments directly related to the biaxial-strain component. Due to the separation of the heavy and light holes the optical transition strengths between the lower conduction and upper most valence-band states computed using one-band model and eight-band model show general qualitative agreement, with exceptions relevant for EIT operation.
Optical response and excitons in gapped graphene

Graphene can be rendered semiconducting via energy gaps introduced in a variety of ways, e.g., coupling to substrates, electrical biasing, or nanostructuring. To describe and compare different realizations of gapped graphene we propose a simple two-band model in which a "mass" term is responsible for the gap. The optical conductivity predicted for this model is obtained as a simple closed-form expression. In addition, analytical estimates for the binding energy of excitons are derived and the impact of excitons on the optical response is analyzed.

General information
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Organisations: Department of Micro- and Nanotechnology, Aalborg University
Contributors: Pedersen, T. G., Jauho, A., Pedersen, K.
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Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
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Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
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ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
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ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
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Web of Science (2011): Impact factor 3.691
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Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.012 SNIP 1.103
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.184 SNIP 1.179
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.856 SNIP 1.841
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.132 SNIP 1.727
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.84 SNIP 1.603
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 2.789 SNIP 1.541
Prospects and limits of nanostructures for surface-enhanced raman spectroscopy

General information
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Organisations: Structured Electromagnetic Materials, Department of Photonics Engineering, Department of Micro- and Nanotechnology
Contributors: Xiao, S., Mortensen, A., Jauho, A.
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Surface-Decorated Silicon Nanowires: A Route to High-ZT Thermoelectrics
Based on atomistic calculations of electron and phonon transport, we propose to use surface-decorated silicon nanowires for thermoelectric applications. Two examples of surface decorations are studied to illustrate the underlying ideas: nanotrees and alkyl functionalized silicon nanowires. For both systems we find (i) that the phonon conductance is significantly reduced compared to the electronic conductance leading to high thermoelectric figure of merit ZT, and (ii) for ultrathin wires, surface decoration leads to significantly better performance than surface disorder.

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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
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BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
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Web of Science (2014): Impact factor 7.512
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BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
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Thermal rectification in nonlinear quantum circuits
We present a theoretical study of radiative heat transport in nonlinear solid-state quantum circuits. We give a detailed account of heat rectification effects, i.e., the asymmetry of heat current with respect to a reversal of the thermal gradient, in a system consisting of two reservoirs at finite temperatures coupled through a nonlinear resonator. We suggest an experimentally feasible superconducting circuit employing the Josephson nonlinearity to realize a controllable low-temperature heat rectifier with a maximal asymmetry of the order of 10%. We also discover a parameter regime where the rectification changes sign as a function of temperature.
We present an ab initio study of spin-dependent transport in armchair carbon nanotubes with transition metal adsorbates: iron or vanadium. The method based on density functional theory and nonequilibrium Green's functions is used to compute the electronic structure and zero-bias conductance. The presence of the adsorbate causes scattering of electrons of mainly one spin type. The scattering is shown to be due to a coupling of the two armchair band states to the metal 3d orbitals with matching symmetry, giving rise to Fano antiresonances appearing as dips in the transmission function. The spin type (majority or minority) being scattered depends on the adsorbate and is explained in terms of d-state filling. We contrast the single-walled carbon nanotube results to the simpler case of the adsorbate on a flat graphene sheet with periodic boundary conditions and corresponding width in the zigzag direction, where the d-orbital selectivity is easily understood in terms of a simple tight-binding model.
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Web of Science (2002): Indexed yes
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Web of Science (2001): Indexed yes
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Scopus rating (1999): SJR 2.789 SNIP 1.541
Original language: English
Keywords: carbon nanotubes, vanadium, tight-binding calculations, density functional theory, electric admittance, spin polarised transport, adsorption, band structure, iron, ab initio calculations, Green's function methods
Electronic versions:
Joachim.pdf
DOIs:
10.1103/PhysRevB.78.195405
URLs:

Bibliographical note
Copyright (2008) American Physical Society
Source: orbit
Source-ID: 233892
Research output: Research - peer-review › Journal article – Annual report year: 2008

Analysis of quantum dot EIT based on 8-band k*p theory

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Department of Photonics Engineering, Quantum and Laser Photonics
Publication date: 2008
Peer-reviewed: Yes
Event: Poster session presented at 29th International Conference on the Physics of Semiconductors, Rio de Janeiro, Brazil.
Source: orbit
Source-ID: 228435
Research output: Research - peer-review › Poster – Annual report year: 2008

Comparison of EIT schemes in semiconductor quantum dots

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Quantum and Laser Photonics, Department of Photonics Engineering
Contributors: Houmark-Nielsen, J., Nielsen, T. R., Mørk, J., Jauho, A.
Publication date: 2008
Peer-reviewed: Yes
Event: Poster session presented at Slow and Fast Light (SL) 2008, Boston, United States.
Source: orbit
Source-ID: 228439
Research output: Research - peer-review › Poster – Annual report year: 2008

Counting statistics of non-markovian quantum stochastic processes
We derive a general expression for the cumulant generating function (CGF) of non-Markovian quantum stochastic transport processes. The long-time limit of the CGF is determined by a single dominating pole of the resolvent of the memory kernel from which we extract the zero-frequency cumulants of the current using a recursive scheme. The finite-frequency noise is expressed not only in terms of the resolvent, but also initial system-environment correlations. As an illustrative example we consider electron transport through a dissipative double quantum dot for which we study the effects of dissipation on the zero-frequency cumulants of high orders and the finite-frequency noise.

General information
State: Published
Designed defects in 2D antidot lattices for quantum information processing

We propose a new physical implementation of spin qubits for quantum information processing, namely defect states in antidot lattices defined in the two-dimensional electron gas (2DEG) at a semiconductor heterostructure. Calculations of the band structure of a periodic antidot lattice are presented. A point defect is created by removing a single antidot, and calculations show that localized states form within the defect, with an energy structure which is robust against thermal dephasing. The exchange coupling between two electrons residing in two tunnel-coupled defect states is calculated numerically. We find results reminiscent of double quantum dot structures, indicating that the suggested structure is a feasible physical implementation of spin qubits.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Pages: 1075-1077
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Physica E: Low-Dimensional Systems and Nanostructures
Volume: 40
Issue number: 5
ISSN (Print): 1386-9477
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.33 SJR 0.595 SNIP 0.873
Original language: English
Keywords: antidot lattices, quantum computing, EP2DS-17, exchange coupling
DOIs:
10.1016/j.physe.2007.08.016
Source: orbit
Source-ID: 221921
Research output: Research - peer-review › Journal article – Annual report year: 2008
Graphene antidot lattices: Designed defects and spin qubits
Antidot lattices, defined on a two-dimensional electron gas at a semiconductor heterostructure, are a well-studied class of man-made structures with intriguing physical properties. We point out that a closely related system, graphene sheets with regularly spaced holes (“antidots”), should display similar phenomenology, but within a much more favorable energy scale, a consequence of the Dirac fermion nature of the states around the Fermi level. Further, by leaving out some of the holes one can create defect states, or pairs of coupled defect states, which can function as hosts for electron spin qubits. We present a detailed study of the energetics of periodic graphene antidot lattices, analyze the level structure of a single defect, calculate the exchange coupling between a pair of spin qubits, and identify possible avenues for further developments.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Structured Electromagnetic Materials
Contributors: Pedersen, T., Flindt, C., Pedersen, J. G., Mortensen, A., Jauho, A., Pedersen, K.
Pages: 136804
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 100
Issue number: 13
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Heat Conductance is Strongly Anisotropic for Pristine Silicon Nanowires

We compute atomistically the heat conductance for ultrathin pristine silicon nanowires (SiNWs) with diameters ranging from 1 to 5 nm. The room temperature thermal conductance is found to be highly anisotropic: wires oriented along the 110 direction have 50–75% larger conductance than wires oriented along the 100 and 111 directions. We show that the anisotropies can be qualitatively understood and reproduced from the bulk phonon band structure. Ab initio density functional theory (DFT) is used to study the thinnest wires, but becomes computationally prohibitive for larger diameters, where we instead use the Tersoff empirical potential model (TEP). For the smallest wires, the thermal conductances obtained from DFT and TEP calculations agree within 10%. The presented results could be relevant for future phonon-engineering of nanowire devices.
Influence of many-particle interactions on slow light phenomena in quantum dots

We investigate the impact of many-particle interactions on group-velocity slowdown achieved via Electromagnetically Induced Transparency (EIT) in quantum dots. Using a ladder scheme we find in the steady-state an increase in maximum slow-down as compared to the non-interacting case, which can be attributed to Coulomb interaction effects. The necessary pump power at which maximum slow down is obtained EIT remains, however.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Quantum and Laser Photonics, Department of Photonics Engineering
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Journal of Physics - Conference Series
Volume: 107
Article number: 012005
ISSN (Print): 1742-6588
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.48 SJR 0.241 SNIP 0.447
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.45 SJR 0.24 SNIP 0.401
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.35 SJR 0.252 SNIP 0.374
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.32 SJR 0.264 SNIP 0.352
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.25 SJR 0.245 SNIP 0.293
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.33 SJR 0.293 SNIP 0.387
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.43 SJR 0.293 SNIP 0.356
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.288 SNIP 0.351
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.259 SNIP 0.346
Influence of many-particle interactions on slow-light phenomena in quantum dots

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2008

Host publication information
Title of host publication: Journal of Physics: Conference Series
Publisher: IOP Publishing
Source: orbit
Source-ID: 233758
Research output: Research - peer-review \ Article in proceedings – Annual report year: 2008

Mesoscopic photon heat transistor
We show that the heat transport between two bodies, mediated by electromagnetic fluctuations, can be controlled with an intermediate quantum circuit-leading to the device concept of a mesoscopic photon heat transistor (MPHT). Our theoretical analysis is based on a novel Meir-Wingreen-Landauer-type of conductance formula, which gives the photonic heat current through an arbitrary circuit element coupled to two dissipative reservoirs at finite temperatures. As an illustration we present an exact solution for the case when the intermediate circuit can be described as an electromagnetic resonator. We discuss in detail how the MPHT can be implemented experimentally in terms of a flux-controlled SQUID circuit.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Ojanen, T., Jauho, A.
Pages: 155902
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Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 100
Issue number: 15
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Keywords: QUANTUM, THERMAL CONDUCTANCE
Electronic versions:
Teemu.pdf
Modeling Transport in Ultrathin Si Nanowires: Charged versus Neutral Impurities

Abstract: At room temperature dopants in semiconducting nanowires are ionized. We show that the long-range electrostatic potential due to charged dopants has a dramatic impact on the transport properties in ultrathin wires and can virtually block minority carriers. Our quantitative estimates of this effect are obtained by computing the electronic transmission through wires with either charged or neutral P and B dopants. The dopant potential is obtained from density functional theory (DFT) calculations. Contrary to the neutral case, the transmission through charged dopants cannot be converged within a supercell-based DFT scheme, because the system size implied by the long-ranged electrostatic potential becomes computationally unmanagable. We overcome this problem by modifying the DFT potential with finite element calculations. We find that the minority scattering is increased by a factor of 1000, while majority transmission is within 50% of the neutral dopant results.
Nanostructure design for surface-enhanced Raman spectroscopy - prospects and limits

Surface-enhanced Raman spectroscopy (SERS) allows single-molecule detection due to the strong field localization occurring at sharp bends or kinks of the metal-vacuum interface. An important question concerns the limits of the signal enhancement that can be achieved via a judicious design of the surface. By using a specific example of a technologically realizable nanopatterned surface, we demonstrate that while very high enhancement factors ($\sim 10^{12}$) can be found for an ideal surface, these are unlikely to be achieved in laboratory samples, because even a minute, inevitable rounding-off strongly suppresses the enhancement, as well as shifts the optimal frequency. Our simulations indicate that the geometric enhancement factors are unlikely to exceed $\sim 10^8$ for real samples, and that it is necessary to consider the geometric uncertainty to reliably predict the frequency for maximum enhancement.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Structured Electromagnetic Materials, Department of Photonics Engineering
Contributors: Xiao, S., Mortensen, N. A., Jauho, A.
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Journal of the European Optical Society - Rapid Publications
Volume: 3
Article number: 08022
ISSN (Print): 1990-2573
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
Optical properties of graphene antidot lattices

Undoped graphene is semimetallic and thus not suitable for many electronic and optoelectronic applications requiring gapped semiconductor materials. However, a periodic array of holes (antidot lattice) renders graphene semiconductor with a controllable band gap. Using atomistic modeling, we demonstrate that this artificial nanomaterial is a dipole-allowed direct-gap semiconductor with a very pronounced optical-absorption edge. Hence, optical infrared spectroscopy should be an ideal probe of the electronic structure. To address realistic experimental situations, we include effects due to disorder and the presence of a substrate in the analysis.
General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Structured Electromagnetic Materials
Contributors: Pedersen, T. G., Flindt, C., Pedersen, J. G., Jauho, A., Mortensen, A., Pedersen, K.
Pages: 245431
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Physical Review B Condensed Matter
Volume: 77
Issue number: 24
ISSN (Print): 0163-1829
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Spin-polarized current and shot noise in the presence of spin flip in a quantum dot via nonequilibrium Green's functions

Using nonequilibrium Green's functions we calculate the spin-polarized current and shot noise in a ferromagnet-quantum-dot-ferromagnet system. Both parallel (P) and antiparallel (AP) magnetic configurations are considered. Coulomb interaction and coherent spin flip (similar to a transverse magnetic field) are taken into account within the dot. We find that the interplay between Coulomb interaction and spin accumulation in the dot can result in a bias-dependent current polarization \( p \). In particular, \( p \) can be suppressed in the P alignment and enhanced in the AP case depending on the bias voltage. The coherent spin flip can also result in a switch of the current polarization from the emitter to the collector lead. Interestingly, for a particular set of parameters it is possible to have a polarized current in the collector and an unpolarized current in the emitter lead. We also found a suppression of the Fano factor to values well below 0.5.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: De Souza, F., Jauho, A., Egues, J.
Pages: 155303
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Physical Review B Condensed Matter
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Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Spin qubits in antidot lattices

We suggest and study designed defects in an otherwise periodic potential modulation of a two-dimensional electron gas as an alternative approach to electron spin based quantum information processing in the solid-state using conventional gate-defined quantum dots. We calculate the band structure and density of states for a periodic potential modulation, referred to as an antidot lattice, and find that localized states appear when designed defects are introduced in the lattice. Such defect states may form the building blocks for quantum computing in a large antidot lattice, allowing for coherent electron transport between distant defect states in the lattice, and for a tunnel coupling of neighboring defect states with corresponding electrostatically controllable exchange coupling between different electron spins.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Pages: 045325
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Physical Review B Condensed Matter
Volume: 77
Issue number: 4
ISSN (Print): 0163-1829
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Transport in Silicon Nanowires: Role of Radial Dopant Profile

We consider the electronic transport properties of phosphorus (P) doped silicon nanowires (SiNWs). By combining ab initio density functional theory (DFT) calculations with a recursive Green’s function method, we calculate the conductance distribution of up to 200 nm long SiNWs with different distributions of P dopant impurities. We find that the radial distribution of the dopants influences the conductance properties significantly: surface doped wires have longer mean-free paths and smaller sample-to-sample fluctuations in the cross-over from ballistic to diffusive transport. These findings can be quantitatively predicted in terms of the scattering properties of the single dopant atoms, implying that relatively simple calculations are sufficient in practical device modeling.

General information
State: Published
Organisations: Theoretical Nanoelectronics Group, Theory Section, Department of Micro- and Nanotechnology
Contributors: Markussen, T., Rurali, R., Jauho, A., Brandbyge, M.
Pages: 324-327
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Journal of Computational Electronics
Volume: 7
Issue number: 3
ISSN (Print): 1569-8025
Failure of standard approximations of the exchange coupling in nanostructures

We calculate the exchange coupling for a double dot system using a numerically exact technique based on finite-element methods and an expansion in two-dimensional Gaussians. Specifically, we evaluate the exchange coupling both for a quasi-one- and a two-dimensional system, also including an applied magnetic field. Our numerical results provide a stringent test of standard approximation schemes e.g., Heitler-London, Hund- Mulliken, Hubbard, and they show that the standard methods do not have reliable predictive power even for simple model systems. Their value in modeling more realistic quantum-dot structures is thus cast in serious doubt.
General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology, Optofluidics Theory and Simulation
Contributors: Pedersen, J. G., Flindt, C., Mortensen, A., Jauho, A.
Pages: 125323
Publication date: 2007
Peer-reviewed: Yes

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Journal: Physical Review B Condensed Matter
Volume: 76
Issue number: 12
ISSN (Print): 0163-1829
Ratings:
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Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Inelastic transport theory from first principles: Methodology and application to nanoscale devices

We describe a first-principles method for calculating electronic structure, vibrational modes and frequencies, electron-phonon couplings, and inelastic electron transport properties of an atomic-scale device bridging two metallic contacts under nonequilibrium conditions. The method extends the density-functional codes SIESTA and TRANSIESTA that use atomic basis sets. The inelastic conductance characteristics are calculated using the nonequilibrium Green's function formalism, and the electron-phonon interaction is addressed with perturbation theory up to the level of the self-consistent Born approximation. While these calculations often are computationally demanding, we show how they can be approximated by a simple and efficient lowest order expansion. Our method also addresses effects of energy dissipation and local heating of the junction via detailed calculations of the power flow. We demonstrate the developed procedures by considering inelastic transport through atomic gold wires of various lengths, thereby extending the results presented in Frederiksen et al. Phys. Rev. Lett. 93, 256601 2004. To illustrate that the method applies more generally to molecular devices, we also calculate the inelastic current through different hydrocarbon molecules between gold electrodes. Both for the wires and the molecules our theory is in quantitative agreement with experiments, and characterizes the system-specific mode selectivity and local heating.
Influence of Coulomb interactions on quantum coherence in quantum dots

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology, Nanophotonics, Department of Photonics Engineering
Publication date: 2007
Peer-reviewed: Yes
Event: Poster session presented at Physics-based mathematical models of low-dimensional semiconductor nanostructures: analysis and computation, Banff, Canada.
Source: orbit
Source-ID: 209851
Research output: Research - peer-review › Poster – Annual report year: 2007

Quantum dot as a spin-current diode: A master-equation approach
We report a study of spin-dependent transport in a system composed of a quantum dot coupled to a normal metal lead and a ferromagnetic lead NM-QD-FM. We use the master equation approach to calculate the spin-resolved currents in the presence of an external bias and an intradot Coulomb interaction. We find that for a range of positive external biases current flow from the normal metal to the ferromagnet the current polarization \( I^{↑} - I^{↓} / I^{↑} + I^{↓} \) is suppressed to zero, while for the corresponding negative biases current flow from the ferromagnet to the normal metal attains a relative maximum value. The system thus operates as a rectifier for spin-current polarization. This effect follows from an interplay between Coulomb interaction and nonequilibrium spin accumulation in the dot. In the parameter range considered, we also show that the above results can be obtained via nonequilibrium Green functions within a Hartree-Fock type approximation.

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Souza, F., Egues, J., Jauho, A.
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Publication date: 2007
Peer-reviewed: Yes

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BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.012 SNIP 1.103
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.184 SNIP 1.179
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.856 SNIP 1.841
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.132 SNIP 1.727
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.84 SNIP 1.603
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 2.789 SNIP 1.541
Original language: English
Keywords: SYSTEMS, DEVICES, MAGNETORESISTANCE, FERROMAGNETIC TUNNEL-JUNCTIONS, COMPUTATION, DEPENDENT TRANSPORT, LEADS, SPINTRONICS, COULOMB-BLOCKADE, DOUBLE-BARRIER JUNCTIONS
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Bibliographical note
Quantum information processing using designed defect states in 2D anti-dot lattices

We propose a new physical implementation of spin qubits for quantum information processing, namely defect states in antidot lattices defined in the two-dimensional electron gas at a semiconductor heterostructure. Calculations of the band structure of the periodic antidot lattice are presented. A point defect is created by removing a single antidot, and calculations show that localized states form that are to a high degree localized within the defect, with an energy structure which is robust against thermal dephasing. The exchange coupling between two electrons confined to two tunnel-coupled defect states is calculated numerically. We find results reminiscent of double quantum dot structures, indicating that the suggested structure is a feasible physical implementation of spin qubits.

Scaling theory put into practice: First-principles modeling of transport in doped silicon nanowires

We combine the ideas of scaling theory and universal conductance fluctuations with density-functional theory to analyze the conductance properties of doped silicon nanowires. Specifically, we study the crossover from ballistic to diffusive transport in boron or phosphorus doped Si nanowires by computing the mean free path, sample-averaged conductance $\langle h G \rangle$, and sample-to-sample variations $\text{std}_G$ as a function of energy, doping density, wire length, and the radial dopant profile. Our main findings are (i) the main trends can be predicted quantitatively based on the scattering properties of single dopants, (ii) the sample-to-sample fluctuations depend on energy but not on doping density, thereby displaying a degree of universality, and (iii) in the diffusive regime the analytical predictions of the Dorokhov-Mello-Pereyra-Kumar theory are in good agreement with our ab initio calculations.
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Transient charging and discharging of spin-polarized electrons in a quantum dot

We study spin-polarized transient transport in a quantum dot coupled to two ferromagnetic leads subjected to a rectangular bias voltage pulse. Time-dependent spin-resolved currents, occupations, spin accumulation, and tunneling magnetoresistance TMR are calculated using both nonequilibrium Green function and master equation techniques. Both parallel- and antiparallel-lead magnetization alignments are analyzed. Our main findings are a dynamical spin accumulation that changes sign in time, a short-lived pulse of spin polarized current in the emitter lead but not in the collector lead, and a dynamical TMR that develops negative values in the transient regime. We also observe that the intradot Coulomb interaction can enhance even further the negative values of the TMR.
Electronic transport through Si nanowires: Role of bulk and surface disorder

We calculate the resistance and mean free path in long metallic and semiconducting silicon nanowires (SiNW's) using two different numerical approaches: a real-space Kubo method and a recursive Green's-function method. We compare the two approaches and find that they are complementary: depending on the situation a preferable method can be identified. Several numerical results are presented to illustrate the relative merits of the two methods. Our calculations of relaxed atomic structures and their conductance properties are based on density functional theory without introducing adjustable parameters. Two specific models of disorder are considered: Unpassivated, surface reconstructed SiNW's are perturbed by random on-site (Anderson) disorder whereas defects in hydrogen passivated wires are introduced by randomly removed H atoms. The unpassivated wires are very sensitive to disorder in the surface whereas bulk disorder has almost no influence. For the passivated wires, the scattering by the hydrogen vacancies is strongly energy dependent and for relatively long SiNW's (L > 200 nm) the resistance changes from the Ohmic to the localization regime within a 0.1-eV shift of the Fermi energy. This high sensitivity might be used for sensor applications.
Modeling of inelastic effects in molecular electronics

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Jauho, A.
Pages: 313-323
Publication date: 2006

Host publication information
Title of host publication: Progress in Nonequilibrium Green's Functions III
Volume: 38
Source: orbit
Source-ID: 192745
Research output: Research - peer-review › Book chapter – Annual report year: 2006

Quantum information processing using designed defects in 2D antidot lattices

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology, Optofluidics Theory and Simulation
Contributors: Pedersen, J., Flindt, C., Mortensen, N. A., Jauho, A.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from ICPS28, Vienna, Austria, .
Source: orbit
Source-ID: 192719
Research output: Research › Conference abstract for conference – Annual report year: 2006

Current and Current Fluctuations in Quantum Shuttles
We review the properties of electron shuttles, i.e., nanoelectromechanical devices that transport electrons one by one by utilizing a combination of electronic and mechanical degrees of freedom. We focus on the extreme quantum limit, where the mechanical motion is quantized. We introduce the main theoretical tools needed for the analysis, e.g., generalized master equations and Wigner functions, and we outline the methods how the resulting large numerical problems can be handled. Illustrative results are given for current, noise, and full counting statistics for a number of model systems. Throughout the review we focus on the physics behind the various approximations, and some simple examples are given to illustrate the theoretical concepts. We also comment on the experimental situation. ©2005 American Institute of Physics

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Jauho, A., Flindt, C., Novotny, T., Donarini, A.
Pages: 100613
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Physics of Fluids
Volume: 17
Issue number: 10
ISSN (Print): 1070-6631
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.51 SJR 1.19 SNIP 1.278
Web of Science (2017): Impact factor 2.279
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.16 SJR 1.331 SNIP 1.356
Web of Science (2016): Impact factor 2.232
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.35 SNIP 1.282
Web of Science (2015): Impact factor 2.017
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.375 SNIP 1.414
Web of Science (2014): Impact factor 2.031
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.419 SNIP 1.471
Web of Science (2013): Impact factor 2.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.202 SNIP 1.44
Web of Science (2012): Impact factor 1.942
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.381 SNIP 1.485
Web of Science (2011): Impact factor 1.926
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.346 SNIP 1.38
Web of Science (2010): Impact factor 1.722
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.607 SNIP 1.359
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.738 SNIP 1.347
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.712 SNIP 1.352
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.943 SNIP 1.485
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.989 SNIP 1.557
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.99 SNIP 1.716
Scopus rating (2003): SJR 2.128 SNIP 1.576
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.447 SNIP 1.74
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.897 SNIP 1.616
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.441 SNIP 1.429
Current Noise Spectrum of a Quantum Shuttle

We present a method for calculating the full current noise spectrum $S(\omega)$ for the class of nano-electromechanical systems (NEMS) that can be described by a Markovian generalized master equation. As a specific example we apply the method to a quantum shuttle. The noise spectrum of the shuttle has peaks at integer multiples of the mechanical frequency, which is slightly renormalized. The renormalization explains a previously observed small deviation of the shuttle current compared to the expected value given by the product of the natural mechanical frequency and the electron charge. For a certain parameter range the quantum shuttle exhibits a coexistence regime, where the charges are transported by two different mechanisms: Shuttling and sequential tunneling. In our previous studies we showed that characteristic features in the zero-frequency noise could be quantitatively understood as a slow switching process between the two current channels, and the present study shows that this interpretation holds also qualitatively at finite frequency. (c) 2005 Elsevier B.V. All rights reserved.
First-principles theory of inelastic transport in atomic gold wires

**General information**

State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Frederiksen, T., Paulsson, M., Brandbyge, M., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Event: Poster session presented at 2nd meeting on Molecular Electronics, Grenoble, France.

**Source**

Source: orbit
Source-ID: 186117

Research output: Research - peer-review › Journal article – Annual report year: 2005

**DOI**

10.1016/j.physe.2005.05.040

**Original language**

English

**DOIs**

10.1016/j.physe.2005.05.040
Full Counting Statistics of NEMS

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Flindt, C., Novotny, T., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186132
Research output: Research › Poster – Annual report year: 2005

Full Counting Statistics of NEMS

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Flindt, C., Novotny, T., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Event: Poster session presented at Kilpisjärvi Spring School on Mesoscopic Physics for Graduate Students of Nordic Countries, Helsinki, Finland.
Source: orbit
Source-ID: 186138
Research output: Research › Poster – Annual report year: 2005

Inelastic Transport from First Principles

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Frederiksen, T., Brandbyge, M., Jauho, A.
**Inelastic Transport from First Principles**

**General information**
- **State**: Published
- **Organisations**: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
- **Contributors**: Frederiksen, T., Brandbyge, M., Jauho, A.
- **Publication date**: 2005
- **Peer-reviewed**: No
- **Event**: Poster session presented at NanoDay, Kgs. Lyngby, Denmark.
- **Source**: orbit

**Intershell resistance in multiwall carbon nanotubes: A Coulomb drag study**

We calculate the intershell resistance $R_{21}$ in a multiwall carbon nanotube as a function of temperature $T$ and Fermi level $\epsilon_F$ (e.g., a gate voltage), varying the chirality of the inner and outer tubes. This is done in a so-called Coulomb drag setup, where a current $I_{1}$ in one shell induces a voltage drop $V_{2}$ in another shell by the screened Coulomb interaction between the shells neglecting the intershell tunneling. We provide benchmark results for $R_{21} = V_2/I_{1}$ within the Fermi liquid theory using Boltzmann equations. The band structure gives rise to strongly chirality-dependent suppression effects for the Coulomb drag between different tubes due to selection rules combined with mismatching of wave vector and crystal angular momentum conservation near the Fermi level. This gives rise to orders of magnitude changes in $R_{21}$ and even the sign of $R_{21}$ can change depending on the chirality of the inner and outer tube and misalignment of inner and outer tube Fermi levels. However, for any tube combination, we predict a dip (or peak) in $R_{21}$ as a function of gate voltage, since $R_{21}$ vanishes at the electron-hole symmetry point. As a by-product, we classified all metallic tubes into either zigzaglike or armchairlike, which have two different nonzero crystal angular momenta $m(a)$, $M_b$ and only zero angular momentum, respectively.

**General information**
- **State**: Published
- **Organisations**: Department of Micro- and Nanotechnology, University of Copenhagen
- **Contributors**: Lunde, A. M., Flensborg, K., Jauho, A.
- **Pages**: 125408
- **Publication date**: 2005
- **Peer-reviewed**: Yes

**Publication information**
- **Journal**: Physical Review B Condensed Matter
- **Volume**: 71
- **Issue number**: 12
- **ISSN (Print)**: 0163-1829
- **Ratings**:
  - BFI (2019): BFI-level 1
  - Web of Science (2019): Indexed yes
  - BFI (2018): BFI-level 1
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 2
  - Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
  - Web of Science (2017): Impact factor 3.813
  - Web of Science (2017): Indexed yes
  - Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
  - Web of Science (2016): Impact factor 3.836
  - Web of Science (2016): Indexed yes
  - Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Modeling of Inelastic Transport in Molecular Electronics from First Principles

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186204
Research output: Research › Paper – Annual report year: 2005

Modeling of Transport Properties in Silicon Nanowires

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Markussen, T., Brandbyge, M., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Event: Poster session presented at 2nd meeting on Molecular Electronics, Grenoble, France.
Source: orbit
Source-ID: 186126
Research output: Research › Poster – Annual report year: 2005

Modeling of Transport Properties in Silicon Nanowires

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Markussen, T., Brandbyge, M., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186128
Research output: Research › Poster – Annual report year: 2005

Noise and bistabilities in quantum shuttles

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Flindt, C., Novotny, T., Jauho, A.
Publication date: 2005

Host publication information
Title of host publication: AIP Conf. Proc.
Volume: 780
Source: orbit
Source-ID: 182408
Research output: Research - peer-review › Article in proceedings – Annual report year: 2005

Non-equilibrium Transport Properties of Carbon Nanotube

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Fürst, J. A., Brandbyge, M., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Open Problems in Noise in NEMS

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Jauho, A., Donarini, A., Flindt, C., Novotny, T.
Pages: 56-63
Publication date: 2005

Host publication information
Title of host publication: Proceedings of UPoN-4, AIP Conf. Proc. 800
Source: orbit
Source-ID: 186121
Research output: Research › peer-review › Article in proceedings – Annual report year: 2005

Quantum Computing using Defects in 2D antidot Lattices

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology, Optofluidics Theory and Simulation
Contributors: Flindt, C., Mortensen, N. A., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186139
Research output: Research › Poster – Annual report year: 2005

Quantum Computing via Defect States in Two-dimenional anti-dot Lattices

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology, Optofluidics Theory and Simulation
Contributors: Flindt, C., Mortensen, N. A., Jauho, A.
Pages: 2515-2518
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Nano Letters
Volume: 5
Issue number: 12
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 13.07
Web of Science (2017): Impact factor 12.08
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 13.4
Web of Science (2016): Impact factor 12.712
Web of Science (2016): Indexed yes
Quantum Transport Calculations Using Wave Function Propagation and the Kubo Formula

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Markussen, T., Brandbyge, M., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186119
Research output: Research - peer-review › Journal article – Annual report year: 2005

Quantum Transport Calculations Using Wave Function Propagation and the Kubo Formula

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Markussen, T., Brandbyge, M., Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186129
Research output: Research › Poster – Annual report year: 2005
Quantum Transport Theories

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Jauho, A.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 186203
Research output: Research › Paper – Annual report year: 2005

Simple Models Sufficient for the Single Dot Quantum Shuttle

General information
State: Published
Organisations: Theoretical Nanotechnology, Department of Micro- and Nanotechnology
Contributors: Donarini, A., Novotny, T., Jauho, A.
Pages: 237
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: New Journal of Physics
Volume: 7
ISSN (Print): 1367-2630
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.28 SJR 1.653 SNIP 1.102
Web of Science (2017): Impact factor 3.579
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.97 SJR 2.183 SNIP 1.173
Web of Science (2016): Impact factor 3.786
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.8 SJR 2.33 SNIP 1.157
Web of Science (2015): Impact factor 3.57
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.89 SJR 2.917 SNIP 1.335
Web of Science (2014): Impact factor 3.558
Web of Science (2014): Indexed yes
Unsolved Problems of Noise and Fluctuations in Physics

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanotechnology
Contributors: Jauho, A.
Publication date: 2005
Peer-reviewed: No
Event: Paper presented at UPoN4-2005, Gallipoli, Italy
Source: orbit
Source-ID: 186118
Research output: Research - peer-review › Journal article – Annual report year: 2005

Original language: English

Coulomb drag in multiwall armchair carbon nanotubes
We calculate the transresistivity $\rho(21)$ between two concentric armchair nanotubes in a diffusive multiwall carbon nanotube as a function of temperature $T$ and Fermi level $\epsilon(F)$. We approximate the tight-binding band structure by two crossing bands with a linear dispersion near the Fermi surface. The cylindrical geometry of the nanotubes and the different parities of the Bloch states are accounted for in the evaluation of the effective Coulomb interaction between charges in the concentric nanotubes. We find a broad peak in $\rho(21)$ as a function of temperature at roughly $T \sim 0.4T(F)$. Further, we predict a peak in $\rho(21)$ as a function of $\epsilon(F)$, which can be studied experimentally by changing a gate voltage or by doping.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Lunde, A., Jauho, A.
Pages: 433-443
Publication date: 2004
Peer-reviewed: Yes

Publication information
Journal: Semiconductor Science and Technology
Volume: 19
Issue number: 4
ISSN (Print): 0268-1242
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.22 SJR 0.757 SNIP 1.003
Web of Science (2017): Impact factor 2.28
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.75 SJR 0.793 SNIP 1.02
Web of Science (2016): Impact factor 2.305
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 1.73 SJR 0.844 SNIP 1.12
Web of Science (2015): Impact factor 2.098
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 1.72 SJR 1.04 SNIP 1.128
Web of Science (2014): Impact factor 2.19
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 1.53 SJR 1.228 SNIP 1.168
Web of Science (2013): Impact factor 2.206
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 1.42 SJR 1.081 SNIP 1.012
Web of Science (2012): Impact factor 1.921
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.66 SJR 1.008 SNIP 1.069
Web of Science (2011): Impact factor 1.723
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.809 SNIP 0.864
Web of Science (2010): Impact factor 1.333
Current noise in a vibrating quantum dot array

We develop methods for calculating the zero-frequency noise for quantum shuttles, i.e., nanoelectromechanical devices where the mechanical motion is quantized. As a model system we consider a three-dot array, where the internal electronic coherence both complicates and enriches the physics. Two different formulations are presented: (i) quantum regression theorem and (ii) the counting variable approach. It is demonstrated, both analytically and numerically, that the two formulations yield identical results, when the conditions of their respective applicability are fulfilled. We describe the results of extensive numerical calculations for current and current noise (Fano factor), based on a solution of a Markovian generalized master equation. The results for the current and noise are further analyzed in terms of Wigner functions, which help to distinguish different transport regimes (in particular, shuttling versus cotunneling). In the case of weak interdot coupling, the electron transport proceeds via sequential tunneling between neighboring dots. A simple rate equation with the rates calculated analytically from the P(E) theory is developed and shown to agree with the full numerics.
Inelastic scattering and local heating in atomic gold wires

We present a method for including inelastic scattering in a first-principles density-functional computational scheme for molecular electronics. As an application, we study two geometries of four-atom gold wires corresponding to two different values of strain and present results for nonlinear differential conductance vs device bias. Our theory is in quantitative agreement with experimental results and explains the experimentally observed mode selectivity. We also identify the signatures of phonon heating.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Theoretical Nanoelectronics Group, Theory Section, Universite Toulouse III - Paul Sabatier
Contributors: Frederiksen, T., Brandbyge, M., Lorente, N., Jauho, A.
Pages: 256601
Publication date: 2004
Peer-reviewed: Yes

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Journal: Physical Review Letters
Volume: 93
Issue number: 25
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Modeling of inelastic transport in one-dimensional metallic atomic wires

Atomic-size conductors represent the ultimate limit of miniaturization, and understanding their properties is an important problem in the fields of nanoelectronics and molecular electronics. Quantum effects become important which leads to a physical behavior fundamentally different from macroscopic devices. A full description of the transport properties of atomic-size conductors therefore requires a quantum mechanical treatment of both the electronic and mechanical degrees of freedom. In this paper, we study a one-dimensional tight-binding model of the conducting electrons combined with a balls-and-springs model for the mechanical motion of the nuclei comprising the wire. We determine the vibrational modes and frequencies for the wires. The electronic Hamiltonian is expanded to lowest order in these normal modes.
Modeling of quantum nanomechanics

Microelectromechanical systems (MEMS) are approaching the nanoscale, which ultimately implies that the mechanical motion needs to be treated quantum mechanically. In recent years our group has developed theoretical methods to analyze the shuttle transition in the quantum regime (Novotny, 2004), focusing not only on the IV-curve, but also considering noise, which is an important diagnostic tool in unraveling the microscopic transport mechanisms. Our theoretical analysis is based on a numerical solution of a generalized master equation (GME) for the density matrix. This equation is obtained by tracing the Liouville equation over the bath degrees of freedom (i.e., the free fermions of the electronic contacts, and the damping of the mechanical degree of freedom due to a bosonic environment).

Quantum theory of shuttling instability in a movable quantum dot array

We study the shuttling instability in an array of three quantum dots the central one of which is movable. We extend the results by Armour and MacKinnon on this problem to a broader parameter regime. The results obtained by an efficient numerical method are interpreted directly using the Wigner distributions. We emphasize that the instability should be viewed as a crossover phenomenon rather than a clear-cut transition.
Shot noise of a quantum shuttle
We formulate a theory for shot noise in quantum nanoelectromechanical systems. As a specific example, the theory is applied to a quantum shuttle, and the zero-frequency noise, measured by the Fano factor $F$, is computed. $F$ reaches very low values ($F \approx 10^{-2}$) in the shuttling regime even in the quantum limit, confirming that shuttling is universally a low noise phenomenon. In approaching the semiclassical limit, the Fano factor shows a giant enhancement ($F \approx 10^2$) at the shuttling threshold, consistent with predictions based on phase-space representations of the density matrix.
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Electronic versions:
Andrea.pdf
DOIs:
10.1103/PhysRevLett.92.248302
URLs:

Bibliographical note
Source: orbit
Source-ID: 135435
Research output: Research - peer-review › Journal article – Annual report year: 2004

Shuttle Instabilities: Semiclassical Phase Analysis

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Donarini, A., Jauho, A.
Pages: 721-724
Publication date: 2004
Peer-reviewed: Yes

Publication information
Journal: Physica
Volume: E 22
Original language: English
Source: orbit
Source-ID: 135434
TMR Effect in a FM-QD-FM system

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Souza, F., Egues, J., Jauho, A.
Pages: 565-567
Publication date: 2004
Peer-reviewed: Yes

Publication information
Journal: Brazilian Journal of Physics
Volume: 34
ISSN (Print): 0103-9733
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.95 SJR 0.276 SNIP 0.6
Web of Science (2017): Impact factor 1.082
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.68 SJR 0.292 SNIP 0.345
Web of Science (2016): Impact factor 0.732
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.83 SJR 0.331 SNIP 0.51
Web of Science (2015): Impact factor 1.042
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.73 SJR 0.42 SNIP 0.526
Web of Science (2014): Impact factor 0.81
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.74 SJR 0.325 SNIP 0.639
Web of Science (2013): Impact factor 0.683
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.72 SJR 0.319 SNIP 0.626
Web of Science (2012): Impact factor 0.598
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.68 SJR 0.329 SNIP 0.521
Web of Science (2011): Impact factor 0.754
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.295 SNIP 0.36
Web of Science (2010): Impact factor 0.661
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.332 SNIP 0.361
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.385 SNIP 0.356
Scopus rating (2007): SJR 0.311 SNIP 0.381
Scopus rating (2006): SJR 0.316 SNIP 0.376
Quantum Shuttle in Phase Space

Abstract: We present a quantum theory of the shuttle instability in electronic transport through a nanostructure with a mechanical degree of freedom. A phase space formulation in terms of the Wigner function allows us to identify a crossover from the tunneling to the shuttling regime, thus extending the previously found classical results to the quantum domain. Further, a new dynamical regime is discovered, where the shuttling is driven exclusively by the quantum noise.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Novotny, T., Donarini, A., Jauho, A.
Pages: 256801
Publication date: 2003
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 90
Issue number: 25
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Virtual Photon Contribution to Frictional Drag in Double-layer Devices

Frictional drag between coupled two-dimensional charge systems is commonly viewed as a second order effect arising either from screened Coulomb interaction, or phonon exchange. We point out that for single-photon exchange the first order contribution does not have to vanish even at $T = 0$, and evaluate this contribution for simple models. (C) 2003 Elsevier Science B.V. All rights reserved.

General information
Coulomb drag in the mesoscopic regime

We present a theory for Coulomb drag between two mesoscopic systems which expresses the drag in terms of scattering matrices and wave functions. The formalism can be applied to both ballistic and disordered systems and the consequences can be studied either by numerical simulations or analytic means such as perturbation theory or random matrix theory. The physics of Coulomb drag in the mesoscopic regime is very different from Coulomb drag between extended electron systems. In the mesoscopic regime we in general find fluctuations of the drag comparable to the mean value. Examples are vanishing average drag for chaotic 2D-systems and dominating fluctuations of drag between quasi-ballistic wires with almost ideal transmission.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, University of Copenhagen
Contributors: Mortensen, N. A., Flensberg, K., Jauho, A.
Number of pages: 4
Pages: 177-180
Publication date: 2002
Peer-reviewed: Yes

Publication information
Journal: Physica scripta
Volume: T101
ISSN (Print): 0031-8949
Ratings: 
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.14
Web of Science (2017): Impact factor 1.902
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.84
Mesoscopic fluctuations of Coulomb drag between quasiballistic one-dimensional wires

Quasiballistic one-dimensional quantum wires are known to have a conductance of the order of $2e^2/h$, with small sample-to-sample fluctuations. We present a study of the transconductance $G_{12}$ of two Coulomb-coupled quasiballistic wires; i.e., we consider the Coulomb drag geometry. We show that the fluctuations in $G_{12}$ differ dramatically from those of the diagonal conductance $G_{ii}$: the fluctuations are large and can even exceed the mean value, thus implying a possible reversal of the induced drag current. We report extensive numerical simulations elucidating the fluctuations for both correlated and uncorrelated disorder. We also present analytic arguments, which fully account for the trends observed numerically.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Niels Bohr Institute
Contributors: Mortensen, A., Flensberg, K., Jauho, A.
Pages: 085317
Publication date: 2002
Peer-reviewed: Yes

Publication information
Journal: Physical Review B Condensed Matter
Volume: 65
Issue number: 8
ISSN (Print): 0163-1829

Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.012 SNIP 1.103
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.184 SNIP 1.179
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.856 SNIP 1.841
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.132 SNIP 1.727
Web of Science (2001): Indexed yes
Photon-mediated drag in double-layer electron gas

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Donarini, A., Ferarri, R., Jauho, A., Molin, L.
Publication date: 2002

Host publication information
Title of host publication: Proceedings of the 26th International Conference on the Physics of Semiconductors (ICPS-26)
Source: orbit
Source-ID: 59640
Research output: Research - peer-review › Article in proceedings – Annual report year: 2002

Proceedings of the 19th Semiconductor Meeting

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Birkedal, D., Jauho, A.
Number of pages: 242
Publication date: 2002

Publication information
Place of publication: Lyngby, Denmark
Publisher: Physica Scripta T101
ISBN (Print): 91-89621-07-7
Original language: English
Source: orbit
Source-ID: 61465
Research output: Research - peer-review › Book – Annual report year: 2002

Sign reversal of drag in bilayer systems with in-plane periodic potential modulation

We develop a theory for describing frictional drag in bilayer systems with in-plane periodic potential modulations, and use it to investigate the drag between bilayer systems in which one of the layers is modulated in one direction. At low temperatures, as the density of carriers in the modulated layer is changed, we show that it is possible for the transresistivity component in the direction of modulation to change its sign. We also give a physical explanation for this behavior.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, University of Copenhagen, University of Akron
Contributors: Alkauskas, A., Flensberg, K., Hu, B. Y., Jauho, A.
Pages: 201304
Publication date: 2002
Coulomb drag in coherent mesoscopic systems

We present a theory for Coulomb drag between two mesoscopic systems. Our formalism expresses the drag in terms of scattering matrices and wave functions, and its range of validity covers both ballistic and disordered systems. The consequences can be worked out either by analytic means, such as the random matrix theory, or by numerical simulations. We show that Coulomb drag is sensitive to localized states, which usual transport measurements do not probe. For chaotic 2D systems we find a vanishing average drag, with a nonzero variance. Disordered 1D wires show a finite drag, with a large variance, giving rise to a possible sign change of the induced current.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Niels Bohr Institute
Contributors: Mortensen, A., Flensberg, K., Jauho, A.
Pages: 1841-1844
Publication date: 2001
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 86
Issue number: 9
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes

Spin-dependent quantum shot noise

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: De Souza, F., Egues, J., Jauho, A.
Publication date: 2002

Host publication information
Title of host publication: Proceedings of the 26th International Conference on the Physics of Semiconductors (ICPS-26)
Source: orbit
Source-ID: 61339
Research output: Research - peer-review › Article in proceedings – Annual report year: 2002
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Coulomb drag in phase-coherent mesoscopic structures

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Mortensen, N. A., Flensberg, K., Jauho, A.
Publication date: 2001

Host publication information
Title of host publication: Proceedings of the 25th International Conference on the Physics of Semiconductors
Source: orbit
Source-ID: 61302
Research output: Research - peer-review › Article in proceedings – Annual report year: 2001

Dephasing in semiconductorsuperconductor structures by coupling to a voltage probe

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Mortensen, N. A., Jauho, A., Flensberg, K.
Pages: 67
Publication date: 2000
Peer-reviewed: Yes

Publication information
Journal: Superlattices and Microstructures
Volume: 28
ISSN (Print): 0749-6036
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.574 SNIP 0.925
Web of Science (2017): Impact factor 2.099
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.09 SJR 0.575 SNIP 0.973
Web of Science (2016): Impact factor 2.123
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.21 SJR 0.559 SNIP 0.962
Web of Science (2015): Impact factor 2.117
BFI (2014): BFI-level 1
Dephasing times in quantum dots due to elastic LO phonon-carrier collisions
Interpretation of experiments on quantum dot (QD) lasers presents a challenge: the phonon bottleneck, which should strongly suppress relaxation and dephasing of the discrete energy states, often seems to be inoperative. We suggest and develop a theory for an intrinsic mechanism for dephasing in QDs: second-order elastic interaction between quantum dot charge carriers and LO phonons. The calculated dephasing times are of the order of 200 fs at room temperature, consistent with experiments. The phonon bottleneck thus does not prevent significant room temperature dephasing.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Department of Photonics Engineering, Quantum and Laser Photonics, P. N. Lebedev Physical Institute, Tokyo University of Agriculture and Technology
Contributors: Uskov, A. V., Jauho, A., Tromborg, B., Mørk, J., Lang, R.
Pages: 1516-1519
Publication date: 2000
Peer-reviewed: Yes
Elastic LO-phonon scattering as an efficient mechanism of dephasing and homogeneous broadening in quantum dots

Transport in semiconductor superlattices: from quantum kinetics to THz-photon detectors
Andreev scattering and conductance enhancement in mesoscopic semiconductor-superconductor junction.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Mortensen, N. A., Jauho, A., Flensberg, K.
Pages: 120-121
Publication date: 1999

Host publication information
Title of host publication: Andreev scattering and conductance enhancement in mesoscopic semiconductor-superconductor junction.
Source: orbit
Source-ID: 173767
Research output: Research - peer-review › Article in proceedings – Annual report year: 1999

Angle dependence of Andreev scattering at semiconductor-superconductor interfaces

We study the angle dependence of the Andreev scattering at a semiconductor-superconductor interface, generalizing the one-dimensional theory of Blonder, Tinkham, and Klapwijk (BTK). An increase of the momentum parallel to the interface leads to suppression of the probability of Andreev reflection and increase of the probability of normal reflection. We show that in the presence of a Fermi velocity mismatch between the semiconductor and the superconductor the angles of incidence and transmission are related according to the well-known Snell's law in optics. As a consequence there is a critical angle of incidence above which only normal reflection exists. For two- and three-dimensional interfaces a lower excess current compared to ballistic transport with perpendicular incidence is found. Thus, the one-dimensional BTK model overestimates the barrier strength for two- and three-dimensional interfaces. [S0163-1829(99)01615-X].

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Dansk Fundamental Metrology A/S
Contributors: Mortensen, A., Flensberg, K., Jauho, A.
Pages: 10176-10182
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Physical Review B
Volume: 59
Issue number: 15
ISSN (Print): 2469-9950
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Original language: English

Keywords: METAL, TRANSITION, ENERGY, TINKHAM, REFLECTION, CURRENTS, BLONDER, BOUNDARIES, POINT-CONTACT

Electronic versions:
Niels.pdf

DOIs:
10.1103/PhysRevB.59.10176

URLs:

Bibliographical note
Conductance enhancement in quantum-point-contact semiconductor-superconductor devices

We present numerical calculations of the conductance of an interface between a phase-coherent two-dimensional electron gas and a superconductor with a quantum point contact in the normal region. Using a scattering matrix approach we reconsider the geometry of De Raedt, Michielsen, and Klapwijk [Phys. Rev. B 50, 631 (1994)] which was studied within the time-dependent Bogoliubov-de Gennes formalism. We find that the factor-of-2 enhancement of the conductance $G_{\text{NS}}$ compared to the normal state conductance $G_{\text{N}}$ for ideal interfaces may be suppressed for interfaces with a quantum point contact with only a few propagating modes. The suppression is found to depend strongly on the position of the Fermi level. We also study the suppression due to a barrier at the interface and find an anomalous behavior caused by quasiparticle interference. Finally, we consider the limit of sequential tunneling and find a suppression of the factor-of-2 enhancement which may explain the absence of conductance enhanced in experiments on metal-superconductor structures. [S0163-1829(99)07943-6].

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Leiden University, University of Copenhagen
Contributors: Mortensen, A., Jauho, A., Flensberg, K., Schomerus, H.
Pages: 13762-13769
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Physical Review B
Volume: 60
Issue number: 19
ISSN (Print): 2469-9950
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
Contact resistance of quantum tubes.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Mortensen, N. A., Johnsen, K., Jauho, A., Flensberg, K.
Pages: 351-361
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Superlattices and Microstructures
Volume: 26
Issue number: 6
ISSN (Print): 0749-6036
Ratings:
Current responsivity of semiconductor superlattice THz-photon detectors

The current responsivity of a semiconductor superlattice THz-photon detector is calculated using an equivalent circuit model which takes into account the finite matching efficiency between a detector antenna and the superlattice in the presence of parasitic losses. Calculations performed for currently available superlattice diodes show that both the magnitudes and the roll-off frequencies of the responsivity are strongly influenced by an excitation of hybrid plasma-Bloch oscillations which are found to be eigenmodes of the system in the THz-frequency band. The expected room temperature values of the responsivity (2–3 A/W in the 1–3 THz-frequency band) range up to several percents of the quantum efficiency e/[h-bar] omega of an ideal superconductor tunnel junction detector. Properly designed semiconductor superlattice detectors may thus demonstrate better room temperature THz-photon responsivity than conventional Schottky junction devices. ©1999 American Institute of Physics.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Technical University of Denmark
Contributors: Ignatov, A. A., Jauho, A.
Pages: 3643-3654
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Journal of Applied Physics
Volume: 85
Issue number: 7
ISSN (Print): 0021-8979
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.03 SJR 0.739 SNIP 0.953
Web of Science (2017): Impact factor 2.176
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.72 SJR 0.906 SNIP 0.977
Web of Science (2016): Impact factor 2.068
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.57 SJR 0.821 SNIP 0.996
Web of Science (2015): Impact factor 2.101
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.04 SJR 1.039 SNIP 1.197
Web of Science (2014): Impact factor 2.183
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.24 SJR 1.155 SNIP 1.286
Web of Science (2013): Impact factor 2.185
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.13 SJR 1.312 SNIP 1.291
Web of Science (2012): Impact factor 2.21
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Hot electrons in superlattices: quantum transport versus Boltzmann equation.

A self-consistent solution of the transport equation is presented for semiconductor superlattices within different approaches: (i) a full quantum transport model based on nonequilibrium Green functions, (ii) the semiclassical Boltzmann equation for electrons in a miniband, and (iii) Boltzmann equation for electrons in Wannier-Stark states. We find good quantitative agreement of the approximations (ii) and (iii) with (i) in their respective ranges of validity. (C) 1999 Elsevier Science B.V. All rights reserved.
Inelastic Quantum Transport in Superlattices: Success and Failure of the Boltzmann Equation

Electrical transport in semiconductor superlattices is studied within a fully self-consistent quantum transport model based on nonequilibrium Green functions, including phonon and impurity scattering. We compute both the drift-velocity-held relation and the momentum distribution function covering the whole held range from linear response to negative differential conductivity. The quantum results are compared with the respective results obtained from a Monte Carlo solution of the Boltzmann equation. Our analysis thus sets the limits of validity for the semiclassical theory in a nonlinear transport situation in the presence of inelastic scattering.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Friedrich-Alexander-Universität Erlangen-Nürnberg
Pages: 836-839
Publication date: 1999
Peer-reviewed: Yes

Publication Information
Journal: Physical Review Letters
Volume: 83
Issue number: 4
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Quasienergy Spectroscopy of Excitons
We theoretically study nonlinear optics of excitons under intense THz irradiation. In particular, the linear near-infrared absorption and resonantly enhanced nonlinear sideband generation are described. We predict a rich structure in the spectra which can be interpreted in terms of the quasienergy spectrum of the exciton, via a remarkably transparent expression for the susceptibility, and show that the effects of strongly avoided quasienergy crossings manifest themselves directly, both in the absorption and transmitted sidebands.
Resonant tunneling in a pulsed phonon field

We theoretically investigate resonant tunneling through a single level assisted by short LO phonon pulses. The analysis is based on the recently developed nonequilibrium linked-cluster expansion [P. Kral, Phys. Rev. B 56, 7293 (1997)], extended in this work to transient situations. The nonequilibrium spectral function for the resonance displays the formation and decay of the phonon sidebands on ultrashort time scales. The time-dependent tunneling current through the individual phonon satellites reflects this quasiparticle formation by oscillations, whose time scale is set by the frequency of the phonon field and its harmonics. These oscillations are washed out at elevated temperatures. [S0163-1829(99)04208-3].

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, University of Toronto
Contributors: Kral, P., Jauho, A.
Pages: 7656-7662
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Physical Review B
Volume: 59
Issue number: 11
ISSN (Print): 2469-9950
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.318 SNIP 1.447
Web of Science (2010): Impact factor 3.774
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 2.923 SNIP 1.516
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.892 SNIP 1.588
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.62 SNIP 1.468
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.126 SNIP 1.156
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.012 SNIP 1.103
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.184 SNIP 1.179
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.856 SNIP 1.841
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.132 SNIP 1.727
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.84 SNIP 1.603
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 2.789 SNIP 1.541
Simulations of interference effects in gated two-dimensional ballistic electron systems

We present detailed simulations addressing recent electronic interference experiments, where a metallic gate is used to locally modify the Fermi wavelength of the charge carriers. Our numerical calculations are based on a solution of the one-particle Schrödinger equation for a realistic model of the actual sample geometry, including a Poison equation-based determination of the potential due to the gate. The conductance is determined with the multiprobe Landauer-Buttiker formula, and in general we find conductance vs gate voltage characteristics, which closely resemble the experimental traces. A detailed examination based on quantum-mechanical streamlines suggests that the simple one-dimensional semiclassical model often used to describe the experiments has only a limited range of validity, and that certain "unexpected" periodicities should not be assigned any particular significance, they arise due to the complicated multiple scattering processes occurring in certain sample geometries.
Two color electro-optics in a semiconductor quantum well.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Johnsen, K., Jauho, A., Nordstrom, K., Allen, S.
Publication date: 1999
Unification of the three standard approaches to superlattice transport by nonequilibrium quantum theory.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Wacker, A., Jauho, A.
Publication date: 1999

Excitonic dynamical Franz-Keldysh effect.
The dynamical Franz-Keldysh effect is exposed by exploring near-band-gap absorption in the presence of intense THz electric fields. It bridges the gap between the de Franz-Keldysh effect and multiphoton absorption and competes with the THz ac Stark effect in shifting the energy of the excitonic resonance. A theoretical model which includes the strong THz field nonperturbatively via a nonequilibrium Green functions technique is able to describe the dynamical Franz-Keldysh effect in the presence of excitonic absorption.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, University of California, Japan Science and Technology Corporation, University of Tokyo
Pages: 457-460
Publication date: 1998
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 81
Issue number: 2
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Electronic versions:
Allen.pdf
DOIs:
10.1103/PhysRevLett.81.457
URLs:

Bibliographical note
Copyright (1998) by the American Physical Society.
Source: orbit
Source-ID: 170579
Research output: Research - peer-review > Journal article – Annual report year: 1998
Impact of interface roughness on perpendicular transport and domain formation in superlattices.
A microscopic calculation of the perpendicular current in doped multiple quantum wells is presented. Interface roughness is shown to affect the resonant transitions as well as to cause a nonresonant background current. The theoretical characteristics exhibit several branches due to the formation of electric field domains in quantitative agreement with experimental data. (C) 1998 Academic Press Limited.
Linear optical absorption spectra of mesoscopic structures in intense THz fields: Free-particle properties
We theoretically study the effect of THz radiation on the linear optical absorption spectra of semiconductor structures. A general theoretical framework, based on nonequilibrium Green functions, is formulated and applied to the calculation of linear optical absorption spectrum for several nonequilibrium mesoscopic structures. We show that a blueshift occurs and sidebands appear in bulklike structures, i.e., the dynamical Franz-Keldysh effect [A.-P. Jauho and K. Johnsen, Phys. Rev. Lett. 76, 4576 (1996)]. An analytic calculation leads to the prediction that in the case of superlattices distinct stable steps appear in the absorption spectrum when conditions for dynamical localization are met. [S0163-1829(95)03412-2].
Keywords: DYNAMIC LOCALIZATION, PHOTOEXCITED SEMICONDUCTORS, ELECTRIC-FIELDS, QUANTUM-WELLS, CARRIER DYNAMICS, SEMICONDUCTOR SUPERLATTICES, COHERENT, BLOCH OSCILLATIONS, MONTE-CARLO APPROACH, EMISSION

Electronic versions: Jauho.pdf

DOIs: 10.1103/PhysRevB.57.8860


Bibliographical note
Copyright (1998) by the American Physical Society.
Source: orbit
Source-ID: 170577
Research output: Research - peer-review ; Journal article – Annual report year: 1998
Microscopic theory of transconductivity.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Indiana University-Purdue, Dansk Fundamental Metrology A/S, Chalmers University of Technology
Contributors: Jauho, A., Bønsager, M., Flensberg, K., Hu, B. Y., Kinaret, J.
Pages: 87-90
Publication date: 1998
Peer-reviewed: Yes

Publication information
Journal: VLSI Design
Volume: 6
Issue number: 1-4
Original language: English
Source: orbit
Source-ID: 170540
Research output: Research - peer-review › Journal article – Annual report year: 1998

On the applicability of miniband transport in semiconductor superlattices.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Wacker, A., Jauho, A.
Pages: 66-69
Publication date: 1998

Host publication information
Title of host publication: On the applicability of miniband transport in semiconductor superlattices.
Source: orbit
Source-ID: 171113
Research output: Research › Article in proceedings – Annual report year: 1998

Photon side-bands in mesoscopics.
This paper reviews several applications of photonic side bands, used by Buttiker and Landauer (Phys. Rev. Lett. 49, 1739 (1982)) in their theory of traversal time in tunneling, in transport and optics of mesoscopic systems. Topics include generalizations of the transmission theory of transport to time-dependent situations, optics and transport of mesoscopic systems in THz electromagnetic fields, and phase-measurements of photon-assisted tunneling through a quantum dot. (C) 1998 Academic Press Limited.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Jauho, A.
Pages: 843-851
Publication date: 1998
Peer-reviewed: Yes

Publication information
Journal: Superlattices and Microstructures
Volume: 23
Issue number: 3-4
ISSN (Print): 0749-6036
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Quantum Transport: The Link between Standard Approaches in Superlattices

Theories describing electrical transport in semiconductor superlattices can essentially be divided in three disjoint categories: (i) transport in a miniband; (ii) hopping between Wannier-Stark ladders; and (iii) sequential tunneling. We
present a quantum transport model, based on nonequilibrium Green functions, which, in the appropriate limits, reproduces
the three conventional theories and describes the transport in the previously inaccessible region of the parameter space.

**General information**

State: Published  
Organisations: Department of Micro- and Nanotechnology  
Contributors: Wacker, A., Jauho, A.  
Pages: 369-372  
Publication date: 1998  
Peer-reviewed: Yes

**Publication information**  
Journal: Physical Review Letters  
Volume: 80  
Issue number: 2  
ISSN (Print): 0031-9007  
Ratings:  
BFI (2019): BFI-level 2  
Web of Science (2019): Indexed yes  
BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464  
Web of Science (2017): Impact factor 8.839  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61  
Web of Science (2016): Impact factor 8.462  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538  
Web of Science (2015): Impact factor 7.645  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71  
Web of Science (2014): Impact factor 7.512  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 6.45 SNIP 2.757  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 6.325 SNIP 2.947  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 2
Strong impact of impurity bands on domain formation in superlattices.
The formation of electric field domains in doped semiconductor superlattices is described within a microscopic model. Due to the presence of impurity bands in low-doped samples the current-voltage characteristic is essentially different compared to medium-doped samples. (C) 1998 Published by Elsevier Science B.V. All rights reserved.
Theory of phase-sensitive measurement of photon-assisted tunneling through a quantum dot

Recent double-slit interference experiments [Schuster et al., Nature (London) 385, 417 (1997)] have demonstrated the possibility of probing the phase of the complex transmission coefficient of a quantum dot via the Aharonov-Bohm effect. We propose an extension of these experiments: an ac voltage imposed on the side gate with the concomitant photonic sidebands leads to additional structure both in the amplitude and in the phase of the Aharonov-Bohm signal. Observation of these effects would be a definitive proof of coherent absorption and reemission of photons from the ac source. [S0163-1829(98)08736-0].
Frictional Coulomb drag in strong magnetic fields

A treatment of frictional Coulomb drag between two two-dimensional electron layers in a strong perpendicular magnetic field, within the independent electron picture, is presented. Assuming fully resolved Landau levels, the linear response theory expression for the transresistivity $\rho_{21}$ is evaluated using diagrammatic techniques. The transresistivity is given by an integral over energy and momentum transfer weighted by the product of the screened interlayer interaction and the phase space for scattering events. We demonstrate, by a numerical analysis of the transresistivity, that for well-resolved Landau levels the interplay between these two factors leads to characteristic features in both the magnetic field and the temperature dependence of $\rho_{21}$. Numerical results are compared with recent experiments.
Linear optical absorption in THz irradiated undoped semiconductor superlattices

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Johnsen, K., Jauho, A.
Pages: 55
Publication date: 1997
Peer-reviewed: Yes

Publication information
Journal: Phys. Status Solidi (b)
Volume: 205
Original language: English
Source: orbit
Source-ID: 169259
Research output: Research - peer-review › Journal article – Annual report year: 1997

Magnetic Fields and Phonons in Drag

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Bønsager, M. C., Flensberg, K., Hu, B. Y., Jauho, A., MacDonald, A. H.
Pages: 55
Publication date: 1997
Peer-reviewed: Yes

Publication information
Volume: 42
Original language: English
Source: orbit
Source-ID: 169270
Research output: Research - peer-review › Journal article – Annual report year: 1997
Microscopic modelling of perpendicular electronic transport in doped multiple quantum wells

We present a microscopic calculation of transport in strongly doped superlattices where domain formation is likely to occur. Our theoretical method is based on a current formula involving the spectral functions of the system, and thus allows, in principle, a systematic investigation of various interaction mechanisms. Taking into account impurity scattering and optical phonons we obtain a good quantitative agreement with existing experimental data from Helgesen and Finstad (J. Appl. Phys. 69, 2689, (1991)). Furthermore the calculated spectral functions indicate a significant increase of the average intersubband spacing compared to the bare level differences which might explain the experimental trend.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Wacker, A., Jauho, A.
Pages: 321-324
Publication date: 1997
Peer-reviewed: Yes

Publication information
Journal: Physica Scripta
Volume: T69
ISSN (Print): 0281-1847
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.14
Web of Science (2017): Impact factor 1.902
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.84
Web of Science (2016): Impact factor 1.28
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.64
Web of Science (2015): Impact factor 1.194
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.62
Web of Science (2014): Impact factor 1.126
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.61
Web of Science (2013): Impact factor 1.296
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.67
Web of Science (2012): Impact factor 1.032
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.85
Web of Science (2011): Impact factor 1.204
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Impact factor 0.985
Web of Science (2010): Indexed yes
Nonequilibrium absorption in semiconductors and the dynamical Franz-Keldysh effect

We theoretically study free electron light absorption for a sample which is placed in a strong, time-dependent uniform electric field. In the case of static fields one observes the Franz-Keldysh effect: finite absorption for photon energies below the band gap. We refer to this phenomenon as the Franz-Keldysh tail. Modulation of the spectra above the band gap is also found. These static effects are observed in both 3D, 2D and 1D systems. Our analysis, based on nonequilibrium Green function techniques, shows that an analogous effect takes place in time-dependent fields: the dynamical Franz-Keldysh effect. Specifically, we relate the nonequilibrium absorption coefficient to the generalized density of states and analyze how it is affected by an external harmonically oscillating electric field. The dynamical Franz-Keldysh tail should be experimentally observable in the THz regime in 1D, 2D and 3D systems. Modulation above the band gap is weak in the 3D case but considerable fine structure is predicted for 1D and 2D systems. A characteristic feature of the dynamical Franz-Keldysh effect is that the absorption edge will be shifted up by an amount corresponding to the average kinetic energy of an free electron placed in the oscillating external electric field.
Observation of Dynamical Franz-Keldysh Effect

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Johnsen, K., Johnsen, K., Allen, S. J., Jauho, A., Birnir, B., Kono, J., Noda, T., Akiyama, H., Sakaki, H.
Pages: 52-54
Publication date: 1997
Peer-reviewed: Yes

Publication information
Volume: 204
Original language: English
Source: orbit
Source-ID: 169258
Research output: Research - peer-review; Journal article – Annual report year: 1997

Optics of Excitons in THz irradiated Quantum Wells

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Johnsen, K., Jauho, A.
Pages: 553
Publication date: 1997
Peer-reviewed: Yes

Publication information
Possible THz gain in superlattices at a stable operation point

We demonstrate that semiconductor superlattices may provide gain at THz frequencies at an operation point which is stable against fluctuations at lower frequency. While an explicit experimental demonstration for the sample considered could not be achieved, the underlying principle of quantum response is quite general and may prove successful for differently designed superlattices.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Pages: 95-97
Publication date: 1997
Peer-reviewed: Yes

Publication information
Journal: IPPS physica status solidi (b)
Volume: 204
Issue number: 1
ISSN (Print): 0370-1972
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.67 SJR 0.602 SNIP 0.786
Web of Science (2017): Impact factor 1.729
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.53 SJR 0.96 SNIP 0.753
Web of Science (2016): Impact factor 1.674
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.43 SJR 0.665 SNIP 0.721
Web of Science (2015): Impact factor 1.522
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.53 SJR 0.805 SNIP 0.769
Web of Science (2014): Impact factor 1.469
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.53 SJR 0.831 SNIP 0.776
Web of Science (2013): Impact factor 1.605
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.39 SJR 0.897 SNIP 0.719
Web of Science (2012): Impact factor 1.489
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.34 SJR 0.931 SNIP 0.723
Web of Science (2011): Impact factor 1.316
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Sequential tunneling in doped superlattices: Fingerprints of impurity bands and photon-assisted tunneling

We report a combined theoretical and experimental study of electrical transport in weakly coupled doped superlattices. Our calculations exhibit negative differential conductivity at sufficiently high electric fields for all dopings. In low-doped samples the presence of impurity bands modifies the current-voltage characteristics substantially, and we find two different current peaks whose relative height changes with the electron temperature. These findings can explain the observation of different peaks in the current-voltage characteristics with and without external THz irradiation in low-doped samples. From our microscopic transport model we obtain quantitative agreement with the experimental current-voltage characteristics without using any fitting parameters. Both our experimental data and our theory show that absolute negative conductance persists over a wide range of frequencies of the free-electron laser source.
Transport in weakly-coupled superlattices: A quantitative approach for photon-assisted tunneling

Photon-assisted tunneling is studied in weakly-coupled semiconductor superlattices under THz irradiation. Using a microscopic transport model we find excellent quantitative agreement with experimental data for two different samples without using any fitting parameters.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Wacker, A., Jauho, A.
Pages: 73
Publication date: 1997
Peer-reviewed: Yes

Publication information
Journal: IPPS physica status solidi (b)
Volume: 204
Issue number: 1
ISSN (Print): 0370-1972
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.67 SJR 0.602 SNIP 0.786
Web of Science (2017): Impact factor 1.729
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.53 SJR 0.96 SNIP 0.753
Web of Science (2016): Impact factor 1.674
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.43 SJR 0.665 SNIP 0.721
Web of Science (2015): Impact factor 1.522
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.53 SJR 0.805 SNIP 0.769
Web of Science (2014): Impact factor 1.469
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.53 SJR 0.831 SNIP 0.776
Web of Science (2013): Impact factor 1.605
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.39 SJR 0.897 SNIP 0.719
Web of Science (2012): Impact factor 1.489
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Coulomb drag: a probe of electron interactions in coupled quantum wells

As semiconductor devices shrink in size and in dimensionality, interactions between charge carriers become more and more important. There is a simple physical reason behind this behavior: fewer carriers lead to less effective screening, and hence stronger effective interactions. A point in case are one-dimensional systems (quantum wires): there electron-electron interactions may lead to a behavior, which is qualitatively different from the standard Fermi liquid picture (Luttinger liquids). Electron-electron interactions also play a central role in the fractional quantum Hall effect, which displays an extremely rich physical behavior, and remains a very active area for research. Thus there is a clear need for a better understanding of electron-electron interactions in dimensionally reduced semiconductor structures. We have reviewed recent developments in the theory of Coulomb drag. Our calculations lead to several predictions of effects not yet seen experimentally: We conclude that Coulomb drag, in particular when combined with magnetic fields, is a very versatile tool for directly probing interparticle interactions in dimensionally restricted systems. A further line for research could be the study of quantum wires: there the interactions may lead to even more dramatic effects.

General information

State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Jauho, A.
Pages: 21-30
Publication date: 1996

Host publication information

Title of host publication: Proceedings of the International Semiconductor Conference
Volume: Volume 1
Dynamical Franz-Keldysh Effect

We introduce and analyze the properties of dynamical Franz-Keldysh effect, i.e., the change of density of states, or absorption spectra, of semiconductors under the influence of time-dependent electric fields. In the case of a harmonic time dependence, we predict the occurrence of significant fine structure, both below and above the zero-field band gap, which should be experimentally observable.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Jauho, A., Johnsen, K.
Pages: 4576-4579
Publication date: 1996
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 76
Issue number: 24
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 7.02 SJR 6.314 SNIP 2.905
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Keywords: FIELD
Electronic versions:
Jauho.pdf
DOIs:
10.1103/PhysRevLett.76.4576
URLs:
http://link.aps.org/doi/10.1103/PhysRevLett.76.4576

Bibliographical note
Source: orbit
Source-ID: 167101
Research output: Research - peer-review › Journal article – Annual report year: 1996

Frontiers in Nanoscale Science of Micron/Submicron Devices

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Kyiv National Taras Shevchenko University
Contributors: Jauho, A., Buzaneva, E.
Number of pages: 500
Magneto-Coulomb Drag: Interplay of Electron-Electron Interactions and Landau Quantization

We use the Kubo formalism to calculate the transresistivity $\rho(21)$ for carriers in coupled quantum wells in a large perpendicular magnetic field $B$. We find that $\rho(21)$ is enhanced by approximately 50-100 times over that of the $B = 0$ case in the interplateau regions of the integer quantum Hall effect. The presence of both electron-electron interactions and Landau quantization results in (i) a twin-peaked structure of $\rho(21)(B)$ in the interplateau regions at low temperatures and (ii) for the chemical potential at the center of a Landau level band, a peaked temperature dependence of $\rho(21)(T)/T^2$. 

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Indiana University-Purdue, Dansk Institut for Fundamental Metrologi
Contributors: Bønsager, M. C., Flensberg, K., Hu, B. Y., Jauho, A.
Pages: 1366-1369
Publication date: 1996
Peer-reviewed: Yes

Publication information
Journal: Physical Review Letters
Volume: 77
Issue number: 7
ISSN (Print): 0031-9007
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Impact factor 8.839
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Impact factor 8.462
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.76 SJR 4.656 SNIP 2.538
Web of Science (2015): Impact factor 7.645
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.62 SJR 5.232 SNIP 2.71
Web of Science (2014): Impact factor 7.512
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 7.46 SJR 5.675 SNIP 2.781
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 7.19 SJR 6.292 SNIP 2.867
ISI indexed (2012): ISI indexed yes
Nanostructuring of silicon by laser direct writing

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Contributors: Mullenborn, M., Jauho, A. (ed.)
Pages: 85-104
Publication date: 1996

Bibliographical note
Source: orbit
Source-ID: 166844
Research output: Research - peer-review › Journal article – Annual report year: 1996
**Quantum kinetics and optics of Semiconductors**

**General information**
State: Published  
Organisations: Department of Micro- and Nanotechnology, University of Frankfurt  
Contributors: Haug, H., Jauho, A.  
Number of pages: 350  
Publication date: 1996

**Publication information**
Place of publication: Berlin  
Publisher: Springer Verlag  
Original language: English  
Source: orbit  
Source-ID: 167972  
Research output: Research - peer-review › Book – Annual report year: 1996

**Theory of coherent time-dependent transport in one-dimensional multiband semiconductor super-lattices**

We present an analytical study of one-dimensional semiconductor superlattices in external electric fields, which may be time dependent. A number of general results for the (quasi)energies and eigenstates are derived. An equation of motion for the density matrix is obtained for a two-band model and the properties of the solutions are analyzed. An expression for the current is obtained. Finally, Zener tunneling in a two-band tight-binding model is considered. The present work gives the background and an extension of the theoretical framework underlying our recent Letter [J. Rotvig et al., Phys. Rev. Lett. 74, 1831 (1995)], where a set of numerical simulations was presented.

**General information**
State: Published  
Organisations: Department of Micro- and Nanotechnology  
Contributors: Rotvig, J., Smith, H., Jauho, A.  
Pages: 17691-17701  
Publication date: 1996  
Peer-reviewed: Yes

**Publication information**
Journal: Physical Review B Condensed Matter  
Volume: 54  
Issue number: 24  
ISSN (Print): 0163-1829  
Ratings:  
BFI (2019): BFI-level 1  
Web of Science (2019): Indexed yes  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04  
Web of Science (2017): Impact factor 3.813  
Web of Science (2017): Indexed yes  
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151  
Web of Science (2016): Impact factor 3.836  
Web of Science (2016): Indexed yes  
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13  
Web of Science (2015): Impact factor 3.718  
Web of Science (2015): Indexed yes  
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316  
Web of Science (2014): Impact factor 3.736
Bloch Oscillations, Zener Tunneling, and Wannier-Stark Ladders in the Time Domain

We present a time-domain analysis of carrier dynamics in a semiconductor superlattice with two minibands. Integration of the density-matrix equations of motion reveals a number of new features: (i) for certain values of the applied static electric field strong interminiband transitions occur; (ii) in static fields the complex time dependence of the density matrix displays a sequence of stable plateaus in the low field regime, and (iii) for harmonic fields the Fourier representation of the density matrix is shown to be intimately related to the quasienergy spectrum.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, University of Copenhagen
Contributors: Rotvig, J., Jauho, A., Smith, H.
Pages: 1831-1834
Linear-response theory of Coulomb drag in coupled electron systems

We report a fully microscopic theory for the transconductivity, or, equivalently, the momentum transfer rate, of Coulomb coupled electron systems. We use the Kubo linear-response formalism and our main formal result expresses the transconductivity in terms of two fluctuation diagrams, which are topologically related but not equivalent to the Aslamazov-Larkin diagrams known from superconductivity. Results reported elsewhere are shown to be special cases of our general expression; specifically, we recover the Boltzmann equation result in the semiclassical clean limit and the memory function results for dirty systems with constant impurity scattering rates. Furthermore, we show that for energy-dependent relaxation times, the final result is not expressible in terms of standard density-response functions. Other results include (i) at $T = 0$, the frequency dependence of the transfer rate is found to be proportional to $\Omega$ and $\Omega^2$ for frequencies below and above the impurity scattering rate, respectively, and (ii) the weak localization correction to the transconductivity is given by $\delta \sigma_{21}(WL) \propto \delta \sigma_{11}(WL) + \delta \sigma_{22}(WL)$.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Technical University of Denmark, NORDITA
Contributors: Flensberg, K., Hu, B. Y., Jauho, A., Kinaret, J. M.
Pages: 14761-14774
Publication date: 1995
Peer-reviewed: Yes

Publication information
Journal: Physical Review B
Volume: 52
Issue number: 20
ISSN (Print): 2469-9950
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Plasma instabilities in high electric fields

We analyze nonequilibrium screening with nonequilibrium Green function techniques. By employing the generalized Kadanoff-Baym ansatz to relate the correlation function to the nonequilibrium distribution function, the latter of which is assumed to be a shifted Maxwellian, an analytically tractable expression is derived for the nonequilibrium dielectric function $\varepsilon(K, \omega)$. For certain values of momenta $K$ and frequency $\omega$, $\text{Im} \varepsilon(K, \omega)$ becomes negative, implying a plasma instability. This new instability exists only for strong electric fields, underlining its nonequilibrium origin.
Time-dependent transport in interacting and noninteracting resonant-tunneling systems

We consider a mesoscopic region coupled to two leads under the influence of external time-dependent voltages. The time dependence is coupled to source and drain contacts, the gates controlling the tunnel-barrier heights, or to the gates that define the mesoscopic region. We derive, with the Keldysh nonequilibrium-Green-function technique, a formal expression for the fully nonlinear, time-dependent current through the system. The analysis admits arbitrary interactions in the mesoscopic region, but the leads are treated as noninteracting. For proportionate coupling to the leads, the time-averaged current is simply the integral between the chemical potentials of the time-averaged density of states, weighted by the coupling to the leads, in close analogy to the time-independent result of Meir and Wingreen [Phys. Rev. Lett. 68, 2512 (1992)]. Analytical and numerical results for the exactly solvable noninteracting resonant-tunneling system are presented. Due to the coherence between the leads and the resonant site, the current does not follow the driving signal adiabatically: a "ringing" current is found as a response to a voltage pulse, and a complex time dependence results in the case of harmonic driving voltages. We also establish a connection to recent linear-response calculations, and to earlier studies of electron-phonon scattering effects in resonant tunneling.
Volume: 50  
Issue number: 8  
ISSN (Print): 2469-9950  
Ratings:  
BFI (2019): BFI-level 1  
Web of Science (2019): Indexed yes  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04  
Web of Science (2017): Impact factor 3.813  
Web of Science (2017): Indexed yes  
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151  
Web of Science (2016): Impact factor 3.836  
Web of Science (2016): Indexed yes  
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13  
Web of Science (2015): Impact factor 3.718  
Web of Science (2015): Indexed yes  
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316  
Web of Science (2014): Impact factor 3.736  
Web of Science (2014): Indexed yes  
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326  
Web of Science (2013): Impact factor 3.664  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378  
Web of Science (2012): Impact factor 3.767  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423  
Web of Science (2011): Impact factor 3.691  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
Scopus rating (2010): SJR 3.318 SNIP 1.447  
Web of Science (2010): Impact factor 3.774  
Web of Science (2010): Indexed yes  
Web of Science (2009): Indexed yes  
Scopus rating (2008): SJR 2.923 SNIP 1.516  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 2.892 SNIP 1.588  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 2.62 SNIP 1.468  
Web of Science (2006): Indexed yes  
Scopus rating (2005): SJR 2.126 SNIP 1.156  
Web of Science (2005): Indexed yes  
Scopus rating (2004): SJR 2.012 SNIP 1.103  
Web of Science (2004): Indexed yes  
Scopus rating (2003): SJR 2.184 SNIP 1.179  
Web of Science (2003): Indexed yes  
Scopus rating (2002): SJR 2.856 SNIP 1.841  
Web of Science (2002): Indexed yes  
Scopus rating (2001): SJR 3.132 SNIP 1.727  
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.84 SNIP 1.603
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 2.789 SNIP 1.541
Original language: English
Keywords: DIODES, TRAVERSAL TIME, CONDUCTANCE, QUANTUM TRANSPORT, BARRIER, METALS, INELASTIC-SCATTERING, HETEROSTRUCTURES, IMPURITY, EQUATIONS
Electronic versions:
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DOIs:
10.1103/PhysRevB.50.5528
URLs:

Bibliographical note
Copyright (1994) by the American Physical Society.
Source: orbit
Source-ID: 251844
Research output: Research - peer-review › Journal article – Annual report year: 1994

Projects:

**Spin-valley physics and quantum transport in 2D materials**
Handberg Juul Martiny, J., PhD Student, Department of Physics
Jauho, A., Main Supervisor, Center for Nanostructured Graphene
Kaasbjerg, K., Supervisor, Department of Physics
Thygesen, K. S., Supervisor, Department of Physics
Samfinansieret - Andet
01/02/2017 → 31/01/2020
Award relations: Spin-valley physics and quantum transport in 2D materials
Project: PhD

**Opto-elektroniske komponenter baseret på kvante-strukturer**
Berg, T. W., PhD Student, Department of Photonics Engineering
Mørk, J., Main Supervisor, Department of Photonics Engineering
Birkedal, D., Supervisor, Department of Micro- and Nanotechnology
Tromborg, B., Supervisor, Department of Photonics Engineering
Jauho, A., Examiner, Department of Physics
Willatzen, M., Examiner, Department of Photonics Engineering
DTU-lønnet stipendie
15/10/2000 → 06/09/2004
Award relations: Opto-elektroniske komponenter baseret på kvante-strukturer
Project: PhD

**Quantum transport and thermoelectric effects in nanostructures and two-dimensional materials**
Walldorf, N., PhD Student, Department of Physics
Jauho, A., Main Supervisor, Center for Nanostructured Graphene
Kaasbjerg, K., Supervisor, Department of Physics
Samfinansieret - Andet
01/09/2016 → 31/08/2020
Award relations: Quantum transport and thermoelectric effects in nanostructures and two-dimensional materials
Project: PhD

**Novel Two-dimensional Plasmonic Materials in Curved and Engineered Geometries**
Dias Gonçalves, P. A., PhD Student, Department of Photonics Engineering
Mortensen, N. A., Main Supervisor, DTU Danchip
Jauho, A., Supervisor, Center for Nanostructured Graphene
Peres, N. M. R., Supervisor
Grundforskningsfonden
01/06/2016 → 31/05/2019
Award relations: Novel Two-dimensional Plasmonic Materials in Curved and Engineered Geometries
Project: PhD
**Theoretical Investigators of transport properties of ballistic graphene devices**

Calogero, G., PhD Student, Department of Micro- and Nanotechnology
Brandbyge, M., Main Supervisor, Department of Physics
Bøggild, P., Supervisor, Center for Nanostructured Graphene
Jauho, A., Examiner, Center for Nanostructured Graphene
Cuniberti, G., Examiner
Santos, E. J. G., Examiner
Papior, N. R., Supervisor, Theoretical Nanoelectronics
Forskningsrådsfinansiering
15/12/2015 → 14/12/2018

Award relations: Theoretical Investigators of transport properties of ballistic graphene devices
Project: PhD

**Bridging first principles modelling with nanodevice TCAD simulations**

Palsgaard, M. L. N., PhD Student, Department of Applied Mathematics and Computer Science
Brandbyge, M., Main Supervisor, Department of Physics
Gunst, T., Supervisor, Department of Micro- and Nanotechnology
Markussen, T., Supervisor, Department of Physics
Jauho, A., Examiner, Center for Nanostructured Graphene
Pedersen, T. G., Examiner
Rideau, D., Examiner
Palsgaard, M. L. N., PhD Student, Department of Applied Mathematics and Computer Science
Brandbyge, M., Main Supervisor, Department of Physics
Gunst, T., Supervisor, Department of Micro- and Nanotechnology
Markussen, T., Supervisor, Department of Physics
Jauho, A., Examiner, Center for Nanostructured Graphene
Pedersen, T. G., Examiner
Rideau, D., Examiner
Industrial PhD
01/09/2015 → 07/11/2018

Award relations: Bridging first principles modelling with nanodevice TCAD simulations
Project: PhD

**Nanostructuring of two-dimensional materials using disorder**

Aktor, T., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Center for Nanostructured Graphene
Schiøtz, J., Examiner, Department of Physics
Fehske, H., Examiner
Wacker, A., Examiner
Fehske, H., Examiner
Wacker, A., Examiner
Samfinansieret - Andet
01/05/2015 → 07/11/2018

Award relations: Nanostructuring of two-dimensional materials using disorder
Project: PhD

**Single-photon quantum information technology**

Taherkhani, M., PhD Student, Department of Photonics Engineering
Gregersen, N., Main Supervisor, Department of Photonics Engineering
Mark, J., Supervisor, Department of Photonics Engineering
Jauho, A., Examiner, Center for Nanostructured Graphene
Marquardt, O., Examiner
Zinner, N. T., Examiner
McCutcheon, D., Supervisor, Department of Photonics Engineering
Marquardt, O., Examiner
Zinner, N. T., Examiner
Forskningsrådsfinansiering
15/05/2015 → 05/09/2018

Award relations: Single-photon quantum information technology
Project: PhD

**Quantum Hall effects in nanostructured graphene**

Jauho, A., Main Supervisor, Theoretical Nanotechnology
Power, S., Supervisor, Department of Micro- and Nanotechnology
Willatzen, M., Examiner, Department of Photonics Engineering
Ferreira, M., Examiner
Harju, A., Examiner
Ferreira, M., Examiner
Harju, A., Examiner
Samfinansieret - Andet
01/04/2014 → 14/06/2017
Award relations: Quantum Hall effects in nanostructured graphene
Project: PhD

Slow light enhancement and limitations in periodic media
Grgic, J., PhD Student, Department of Photonics Engineering
Mortensen, N. A., Main Supervisor, Department of Photonics Engineering
Jauho, A., Supervisor, Department of Micro- and Nanotechnology
Mark, J., Supervisor, Department of Photonics Engineering
Laurynenka, A., Examiner, Department of Photonics Engineering
De Rossi, A., Examiner
Willatzen, M., Examiner, Department of Photonics Engineering
Eksternt finansieret virksomhed
01/01/2009 → 19/04/2012
Award relations: Slow light enhancement and limitations in periodic media
Project: PhD

Teori for Quantum Devices
Johnsen, K., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Physics
Jacobsen, K. W., Examiner, Department of Physics
Smith, H., Examiner
Mic-Finansieret-SU
01/09/1995 → 10/08/1999
Award relations: Teori for Quantum Devices
Project: PhD

Optical switching in poled glass
Jacobsen, R. S., PhD Student, Department of Photonics Engineering
Svalgaard, M., Main Supervisor, Department of Photonics Engineering
Fage-Pedersen, J., Supervisor, Department of Photonics Engineering
Kristensen, M., Supervisor, Department of Micro- and Nanotechnology
Jauho, A., Examiner, Department of Physics
Bozhevolnyi, S. I., Examiner, Department of Micro- and Nanotechnology
Kashyap, R., Examiner
DTU, Samfinansiering
15/03/2002 → 04/11/2005
Award relations: Optical switching in poled glass
Project: PhD

Spin-polariseret transport i halvledere
Jensen, A., PhD Student, Department of Physics
Mørup, S., Main Supervisor, Department of Physics
Jacobsen, C. S., Supervisor, Department of Physics
Lindelof, P. E., Supervisor, Department of Physics
Jauho, A., Examiner, Department of Physics
Bland, J. A. C., Examiner
Heitmann, D., Examiner
DTU-lønnet stipendie
01/02/2000 → 02/12/2003
Award relations: Spin-polariseret transport i halvledere
Project: PhD

Spatio-temporal dynamics of localized excitons in semiconductor nanostructures
Leossson, K., PhD Student, Department of Photonics Engineering
Hvam, J. M., Main Supervisor, Department of Photonics Engineering
Østergaard, J. E., Supervisor, Department of Micro- and Nanotechnology
Jauho, A., Examiner, Department of Physics
Klingshirn, C. F., Examiner
Larsen, A. N., Examiner
DTU-lønnet stipendie
01/09/1998 → 14/03/2002
Award relations: Spatio-temporal dynamics of localized excitons in semiconductor nanostructures
Project: PhD

Density-matrix Renormalization Group Study of Nanoscale Transport Phenomena
Bohr, D., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Micro- and Nanotechnology
Bruus, H., Examiner, Department of Micro- and Nanotechnology
Jeckelmann, E., Examiner
Østlund, S., Examiner
DTU-lønnet stipendie
01/08/2004 → 29/10/2007
Award relations: Density-matrix Renormalization Group Study of Nanoscale Transport Phenomena
Project: PhD

Quantum-limited measurement in mesoscopic
Flindt, C., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Micro- and Nanotechnology
Flensberg, K., Supervisor
Mark, J., Examiner, Department of Photonics Engineering
Brandes, T., Examiner
Loss, D., Examiner
DTU-lønnet stipendie
15/08/2004 → 29/10/2007
Award relations: Quantum-limited measurement in mesoscopic
Project: PhD

Inelastisk Elektrontransport i nanosystemer
Frederiksen, T., PhD Student, Department of Micro- and Nanotechnology
Brandbyge, M., Main Supervisor, Department of Physics
Jauho, A., Supervisor, Department of Micro- and Nanotechnology
Schütz, J., Examiner, Department of Physics
Persson, M., Examiner
Todorov, T. N., Examiner
DTU-lønnet stipendie
01/03/2004 → 29/05/2007
Award relations: Inelastisk Elektrontransport i nanosystemer
Project: PhD

Dynamical effects in molecular electronics
Engelund, M., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Micro- and Nanotechnology
Brandbyge, M., Supervisor, Department of Physics
Vegge, T., Examiner, Risø National Laboratory for Sustainable Energy
Cuniberti, G., Examiner
Fernández, A. A., Examiner
DTU-lønnet stipendie
01/03/2007 → 01/09/2010
Award relations: Dynamical effects in molecular electronics
Project: PhD

Transport in nanostructures
Donarini, A., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Physics
Novotny, T., Supervisor
Mark, J., Examiner, Department of Photonics Engineering
Armour, A. D., Examiner
Platero, G., Examiner
DTU-lønnet stipendie
01/09/2001 → 27/10/2004
Award relations: Transport in nanostructures
Project: PhD

Vekselvirkningseffekter i lavdimensionale elektronsystemer
Mortensen, N. A., PhD Student, DTU Danchip
Jauho, A., Main Supervisor, Department of Physics
Flensberg, K., Supervisor
Jacobsen, K. W., Examiner, Department of Physics
Büttiker, M., Examiner
Jonson, M. S., Examiner
DTU-lønnet stipendie
01/01/1999 → 25/09/2001
Award relations: Vekselvirkningseffekter i lavdimensionale elektronsystemer
Project: PhD

Modellering af transportegenskaber i Nanowires
Markussen, T., PhD Student, Department of Micro- and Nanotechnology
Brandbyge, M., Main Supervisor, Department of Physics
Jauho, A., Supervisor, Department of Micro- and Nanotechnology
Mortensen, N. A., Examiner, Department of Micro- and Nanotechnology
Biase, K., Examiner
Wacker, A., Examiner
DTU-lønnet stipendie
01/03/2006 → 21/10/2009
Award relations: Modellering af transportegenskaber i Nanowires
Project: PhD

Fundamentale egenskaber af komponenter til kvanteinformationsteknologi
Nielsen, P. K., PhD Student, Department of Photonics Engineering
Mark, J., Main Supervisor, Department of Photonics Engineering
Jauho, A., Supervisor, Department of Micro- and Nanotechnology
Lodahl, P., Supervisor, Risø National Laboratory for Sustainable Energy
Knorr, A., Examiner
Mølmer, K., Examiner
Institut stipendie (DTU) Samf.
01/02/2009 → 20/09/2012
Award relations: Fundamentale egenskaber af komponenter til kvanteinformationsteknologi
Project: PhD

Suspended Nanopatterned Graphene Devices
Gammelgaard, L., PhD Student, Department of Micro- and Nanotechnology
Beggild, P., Main Supervisor, Department of Micro- and Nanotechnology
Booth, T., Supervisor, Department of Micro- and Nanotechnology
Jauho, A., Supervisor, Theoretical Nanotechnology
Brandbyge, M., Examiner, Department of Physics
Hill, E. W., Examiner
Lemme, M. C., Examiner
Hill, E. W., Examiner
Lemme, M. C., Examiner
Anden EU-finansiering
15/08/2013 → 07/12/2016
Award relations: Suspended Nanopatterned Graphene Devices
Project: PhD

Graphene Plasmonics
Christensen, T., PhD Student, Department of Photonics Engineering
Mortensen, N. A., Main Supervisor, Structured Electromagnetic Materials
Jauho, A., Supervisor, Theoretical Nanotechnology
Wubs, M., Supervisor, Department of Photonics Engineering
Andersen, U. L., Examiner, Department of Physics
Engheta, N., Examiner
Theory of nanoscale four-probe point (N4PP) spectroscopy of nanostructured graphene

Settnes, M., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Micro- and Nanotechnology
Petersen, D. H., Supervisor, Department of Micro- and Nanotechnology
Power, S., Supervisor, Department of Micro- and Nanotechnology
Mortensen, N. A., Examiner, Structured Electromagnetic Materials
Peeters, F. M., Examiner
Pereira, V. M., Examiner

Institut stipendie (DTU) Samf.
15/04/2012 → 29/09/2015
Award relations: Theory of nanoscale four-probe point (N4PP) spectroscopy of nanostructured graphene
Project: PhD

Atomar skala kvante transport i kommende halvleder komponenter

Fürst, J. A., PhD Student, Department of Micro- and Nanotechnology
Brandbyge, M., Main Supervisor, Department of Physics
Jauho, A., Supervisor, Department of Micro- and Nanotechnology
Bøggild, P., Examiner, Department of Micro- and Nanotechnology
Palacios, J. J., Examiner
Zozoulenko, I., Examiner

DTU, Samfinansiering
01/09/2006 → 21/12/2009
Award relations: Atomar skala kvante transport i kommende halvleder komponenter
Project: PhD

Quantum Kinetics of charge carriers in quantum dots: applications to slow light and light amplification

Houmark-Nielsen, J., PhD Student, Department of Micro- and Nanotechnology
Jauho, A., Main Supervisor, Department of Micro- and Nanotechnology
Mørk, J., Supervisor, Department of Photonics Engineering
Nielsen, T. R., Supervisor, Department of Photonics Engineering
Willatzen, M., Supervisor, Department of Photonics Engineering
Mortensen, N. A., Examiner, Department of Micro- and Nanotechnology
Kuhn, T., Examiner
Pedersen, T. G., Examiner

Forskningsrådsfinansiering
15/05/2006 → 20/01/2010
Award relations: Quantum Kinetics of charge carriers in quantum dots: applications to slow light and light amplification
Project: PhD

Properties of single quantum dot lasers

Lund, A. M., PhD Student, Department of Photonics Engineering
Mørk, J., Main Supervisor, Department of Photonics Engineering
Nielsen, P. K., Supervisor, Department of Photonics Engineering
Jauho, A., Examiner, Department of Micro- and Nanotechnology
Björk, G., Examiner
Kapon, E., Examiner

Institut stipendie (DTU)
01/09/2010 → 19/03/2014
Award relations: Properties of single quantum dot lasers
Project: PhD

Quantum theory of plasmonic excitations in metallic nanostructures

Toscano, G., PhD Student, Department of Photonics Engineering
NATEC: Nanophotonics for terabit communications : VKR centre of excellence - NATEC

We propose to establish a Willum Kann Rasmussen Centre of Excellence that explores the fundamental physics and technology of nanophotonic materials and devices in order to reach data rates in the terabit per second regime. Following a brief introduction, the goals of the Centre, its organization, the main research activities, research plans and proposed budget are described.

Mark, J., Project Manager, Department of Photonics Engineering
Hvam, J. M., Project Participant, Department of Photonics Engineering
Yvind, K., Project Participant, Department of Photonics Engineering
Mørk, J., Project Participant, Department of Photonics Engineering
Hvam, J. M., Project Participant, Department of Photonics Engineering
Yvind, K., Project Participant, Department of Photonics Engineering
Poel, M. V. D., Project Participant, Department of Photonics Engineering
Hansen, P. L., Project Participant, Department of Photonics Engineering
Willatzen, M., Project Participant, University of Southern Denmark
Kamath, H., Project Manager, University of Southern Denmark
Wang, L., Project Participant, University of Southern Denmark
Jauho, A., Project Participant, Department of Micro- and Nanotechnology
Houmark-Nielsen, J., Project Participant, Department of Micro- and Nanotechnology

Project ID: 70319

Forskningsrådene - STVF: DKK12,269,000.00
01/01/2006 → 30/06/2012
Collaborators: University of Southern Denmark
Award relations: Nanophotonics for terabit communications : VKR centre of excellence - NATEC
Project: Research

QUEST: Quantum dot structures enabling light slow-down and amplification

QUEST is a research project exploring the use of semiconductor quantum dot technology for realizing practical slow-light devices and integrated optical amplifiers. Such devices find important applications within information, communication and sensor technology and the project targets practical demonstrations within these areas, leading to possibilities of commercial exploitation. From a wider perspective, the proposed project contributes to the ongoing evolution of the information society. The project brings together three groups from the Technical University of Denmark (DTU) and The University of Southern Denmark (SDU) with strong and complementary research experience.

Mark, J., Project Manager, Department of Photonics Engineering, Nanophotonic Devices
Hvam, J. M., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Yvind, K., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Poel, M. V. D., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Hansen, P. L., Project Participant, Department of Photonics Engineering, Nanophotonic Devices
Willatzen, M., Project Participant, University of Southern Denmark
Kamath, H., Project Manager, University of Southern Denmark
Wang, L., Project Participant, University of Southern Denmark
Jauho, A., Project Participant, Department of Micro- and Nanotechnology
Houmark-Nielsen, J., Project Participant, Department of Micro- and Nanotechnology

Project ID: 70319

Forskningsrådene - STVF: DKK12,269,000.00
01/01/2006 → 30/06/2012
Collaborators: University of Southern Denmark
Award relations: Quantum dot structures enabling light slow-down and amplification
Project: Research

Non-equilibrium response in strongly driven systems

Ben Hu and K. Johnsen are studying the response of strongly periodically driven time-dependent systems, such as the optical properties of semiconductors driven by free-electron lasers fields. We are attempting to derive relatively straightforward methods to calculate the statistical distribution of the occupation of the Floquet states and the linear-response properties of these strongly driven systems. In a joint project with experimental researchers from U S C B and Japan K. Johnsen and Antti-Pekka Jauho have analyzed optical absorption in a strongly driven multiple quantum well system. The characteristic features of the measured absorption spectrum, as a function of photon energy or flux intensity, can be
understand in terms of an interplay of (excitonic) dynamic Franz-Keldysh effect (introduced by A.-P-J and K.J in 1996), and ac Stark Effect. Work is in progress to analyze non-linear mixing signals, and superlattice effects.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology
Hu, B. Y., Project Participant, Department of Micro- and Nanotechnology
Johnsen, K., Project Participant, Department of Micro- and Nanotechnology

01/01/1997 → …

Project: Research

**Microscopic modeling of ballistic transport in gated structures**

We have recently launched a project whose goal is to understand in detail magnetotransport measurements on gated 2-dimensional electron systems. The motivation is twofold: first, standard interpretation of experiments, based on simple semiclassical electron trajectory concepts, has led to a number of apparent contradictions, and, second, numerical techniques have been refined so as to be able to treat realistic sample geometries. A significant step, achieved by our Russian collaboration partners, has been the reduction of computational labor so that supercomputing is no longer necessary. We expect to apply these techniques to the analysis of several recent experiments, and can offer exciting projects and theses topics to students.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology

01/01/1997 → …

Project: Research

**Theory of charge transport in superlattices**

Antti-Pekka Jauho and Andreas Wacker (now at TU-Berlin) have developed microscopic theories for charge transport in superlattices and multiple quantum wells. Their approach allows a detailed description of various physical mechanisms, such as surface roughness scattering or disorder caused due to doping impurities. Impurity bands have been shown to play a significant role in photon-assisted transport for low doped samples. Recently, a quantum theory of transport was proposed, which reduces to earlier theories in the appropriate limits, but, more importantly, allows one to define the limits of validity of standard theories, and to treat hitherto unaccessible regions in parameter space. The the quantum theory has been extended to include inelastic scattering, e.g., due to acoustic phonons, and compared to corresponding Boltzmann equation simulation. The next challenge will be to address the time-dependent situation, i.e., develop a fully quantum mechanical theory of photon-assisted transport in superlattices.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology
Wacker, A., Project Participant, Department of Micro- and Nanotechnology

01/01/1997 → 31/12/2000

Project: Research

**Time-dependent effects in mesoscopic transport**

We are applying nonequilibrium Green function techniques to a number of problems in nonstationary transport in mesoscopic semiconductor structures. Examples include a proposed phase-measurement of photon-assisted transport through a quantum dot (collaboration with N.S. Wingreen, NEC Research Institute), and analysis of resonant tunneling assisted by nonequilibrium phonons (collaboration with P. Kral, U. of Toronto).

Jauho, A., Project Manager, Department of Micro- and Nanotechnology

01/01/1997 → 31/12/1997

Project: Research

**Frictional drag in coupled mesoscopic systems**

In frictional drag experiments, a pair of independently contacted mesoscopic systems (quantum wells, quantum wires etc) are placed a few hundred Å apart. Current is driven through one subsystem and, due to the proximity of the systems, the coupling forces cause a measurable voltage build-up, or an induced current, in the other subsystem. This provides a unique opportunity for a transport measurement to probe interparticle interactions, and it gives important insights to the properties of the dimensionally restricted interacting electron systems. K. Flensberg and Ben Hu showed that, at intermediate temperatures, collective modes of the coupled electron system can enhance the Coulomb drag rate by almost an order of magnitude over previous predictions. Together with M. C. Bønsager (then a student at MIC), KF, APJ and BH theoretically studied the complex magnetic-field dependence of the drag transresistivity, including large enhancements and effects due to the interplay of the Landau level quantization and screening of the inter-well interaction. Lastly, BH, MCB, KF, AMD have studied the role of phonons mediating the drag, and we have proposed that a coupled transresistivity, which may explain the anomalously large magnitude of the experimental observations of phonon-mediated drag. We are continuing to study various aspects of frictional drag, such as the search for a theory to explain the observation by J. Eisenstein (Cal Tech) of a nonvanishing frictional drag to T = 0 in u = 2 fractional quantum hall effect samples, which seems to contradict currently accepted theoretical models. Another example is mesoscopic Coulomb drag; we expect that the finite size will give rise to interesting fluctuation properties. Niels Asger Mortensen is looking at this problem as a part of his ph.d study, supervised by APJ and KF.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology
Hu, B. Y., Project Participant, Department of Micro- and Nanotechnology
Electric field effects in scanning tunneling microscopy

We have developed a theory for tunneling between a surface and a model probe tip, including the effect of a finite electric field between the tip and the surface, and applied the theory to understand STM experiments of the hydrogen passivated Si(100) surface. The theoretical model is based on first principles electronic structure calculations and has no adjustable parameters. We have applied the theory to obtain theoretical STM images at relatively high voltages (2-3V) of the monohydrate Si(100) surface with missing hydrogen defects, and found excellent agreement with experimental images. However, our main goal is to use the theory to understand experimental measurements of current and voltage dependence in STM induced desorption of hydrogen. We have found that experimental measured iso-lines of constant desorption probability in the I-V plane coincide with iso-lines of constant electric field, indicating a strong dependence of the desorption mechanism upon the electric field between the tip and the sample.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology
Stokbro, K., Project Participant, Department of Micro- and Nanotechnology
Grey, F., Project Participant, Department of Micro- and Nanotechnology
Quaade, U., Project Participant, Department of Micro- and Nanotechnology

01/01/1996 → …
Project: Research

Optical absorption in mesoscopic structures in intense THz-fields

We have theoretically studied the effect of THz radiation on the linear optical absorption spectra of semiconductor structures. A general theoretical framework, based on nonequilibrium Green functions, is formulated and applied to the calculation of linear optical absorption spectrum for several nonequilibrium mesoscopic structures. We show that a blue-shift occurs and sidebands appear in bulk-like structures (the dynamical Franz-Keldysh effect). The properties of the calculated side-band intensities and energies appear to resolve problems in the interpretation of data obtained with the Free Electron Laser at UCSB. An analytical calculation leads to the prediction that in the case of superlattices distinct stable steps appear in the absorption spectrum when conditions for dynamical localization are met.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology
Johnsen, K., Project Participant, Department of Micro- and Nanotechnology

01/01/1996 → …
Project: Research

Quantum Kinetics in Transport and Optics of Semiconductors

Nanoscale miniaturization and femtosecond laser-pulse spectroscopy require a quantum mechanical description of the carrier kinetics that goes beyond the conventional semiclassical Boltzmann theory. On these extremely short lengths and time scales the electrons behave like partially coherent waves. This monograph deals with the quantum kinetics for transport in low-dimensional microstructures and for ultrashort laser pulse spectroscopy. The nonequilibrium Green function theory is described and used for the derivation of the quantum kinetic equations. Numerical methods for the solution of the retarded quantum kinetic equations are discussed and results are presented for quantum high-field transport and for mesoscopic transport phenomena. Quantum beats, polarization decay, and non-Markovian behaviour are treated for femtosecond spectroscopy on a microscopic basis. A new, updated and expanded version of the book is under preparation (the first two printings are sold out).

Jauho, A., Project Manager, Department of Micro- and Nanotechnology

01/01/1996 → 31/12/2000
Project: Research

Transmission phases in time-dependent transport

Recent pioneering measurements by a group headed by M. Heiblum have shown that it is possible to directly probe the quantum mechanical phase of a quantum dot. Surprisingly, the experiments show that in the vicinity of a Coulomb oscillation peak a single-particle description is possible, even though the quantum dot has strong interparticle correlations. We point out that a time-dependent gate voltage, applied on the plunger gate controlling the occupation in the quantum dot, should yield a wealth of new information on the phase-relaxation mechanisms within a strongly interacting quantum system. We are in the process of extending our qualitative considerations to realistic experimental systems: the full two-dimensional potential landscape will be discretized and solved on a computer.

Jauho, A., Project Manager, Department of Micro- and Nanotechnology

01/01/1996 → 31/12/2000
Project: Research

Modulation response of semiconductor quantum dot nanolasers and nanoLEDs

To meet the continuously increasing need for progressively higher data transmission rates on the internet, faster signal modulation of the underlying semiconductor lasers or LEDs is required. High modulation bandwidth is a key quantity for the realization of high-speed data optical components, as it limits the maximum possible data rate. Recent developments
in nanotechnology allow fabrication of new device types for lasers and LEDs with quantum dots embedded in optical microcavities which have the potential to outperform current devices. The nanolasers and nanoLEDs belong to this class of future optical communication devices. Conventional analysis methodology needs to be reassessed based on more realistic models which are appropriate for this type of semiconductor quantum dot based devices. The project will be carried out at DTU Fotonik which is involved in several projects in the field of micro- and nanostructured materials. This gives access to experimental results on devices as well as inside knowledge on technological developments. DTU Nanotech is also a partner and will contribute to this project.

Nielsen, T. R., Contact Person, Department of Photonics Engineering
Lorke, M., Contact Person, Department of Photonics Engineering
Mørk, J., Contact Person, Department of Photonics Engineering
Jauho, A., Project Participant, Department of Micro- and Nanotechnology

Forskningsrådene - Andre: DKK1,699,000.00
01/01/2010 → 31/12/2012

Keywords: laser, nanotechnology, information technology, broadband

Award relations: Modulation response of semiconductor quantum dot nanolasers and nanoLEDs

Project: Research

Activities:

**Talk about "Radiative heat transport in quantum circuits" presented at Unifying Themes in Condensed Matter**
*Period: 11 Jan 2009 → 17 Jan 2009*  
Antti-Pekka Jauho (Speaker)

Department of Micro- and Nanotechnology

**Description**

Place: Aspen, Colorado, USA

**Related external organisation**

Unknown external organisation

Activity: Talks and presentations › Conference presentations

**Talk about "Atomistic Modeling of Electronic and Thermal Transport Properties af Si-nanowires" Presented at Advanced Heterostructures and Nanostructures Workshop**
*Period: 7 Dec 2008 → 12 Dec 2008*  
Antti-Pekka Jauho (Speaker)

Department of Micro- and Nanotechnology

**Description**

Place: Hawaii, USA

**Related external organisation**

Unknown external organisation

Activity: Talks and presentations › Conference presentations

**Talk about "Atomistic Modeling of Electronic and Thermal Transport Properties af Si-nanowires" Presented at International Workshop on Nonequilibrium Nanostructures**
*Period: 1 Dec 2008 → 6 Dec 2008*  
Antti-Pekka Jauho (Speaker)

Department of Micro- and Nanotechnology

**Description**

Place: Dresden, Germany

**Related external organisation**

Unknown external organisation

Activity: Talks and presentations › Conference presentations