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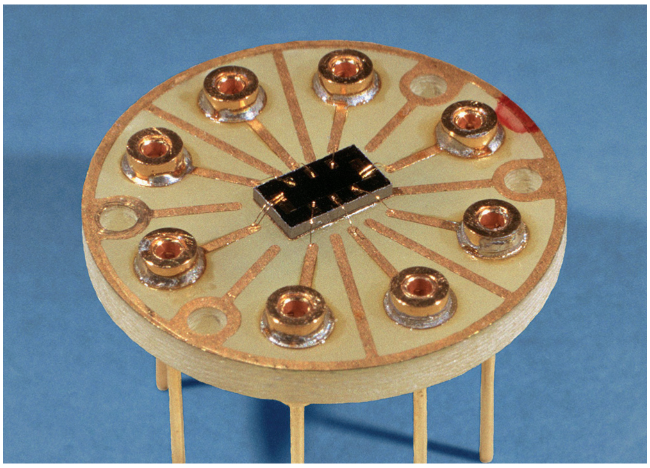
Highlights from the previous volumes

Equilibrium noise correlations in quantum Hall effect devices as a test of a formula by Büttiker

Voltage fluctuations across two-terminal passive elements in thermal equilibrium are described by the well-known Johnson-Nyquist formula. This formula has been extensively tested in an enormous number of experiments over wide ranges of temperature, frequency and resistance of the two-terminal element.

In 1990 M. Büttiker derived a generalization of the Johnson-Nyquist formula, which is a statement about noise correlations in multiterminal elements. To date, no experimental confirmation of this generalization has been given in the literature: in this work we address this problem.

Noise correlation measurements were carried out on several nonreciprocal linear networks realized with a multiterminal quantum Hall effect device (originally developed for resistance metrology) with configurable external connections. The sample lies within a cryogenic environment under strong magnetic field to achieve quantization. Noise is measured with a two-channel sampling spectrum analyzer provided with ultra-low–noise amplifiers. For all the configurations tested, the predictions of Büttiker's formula were verified with an uncertainty of a few percent.

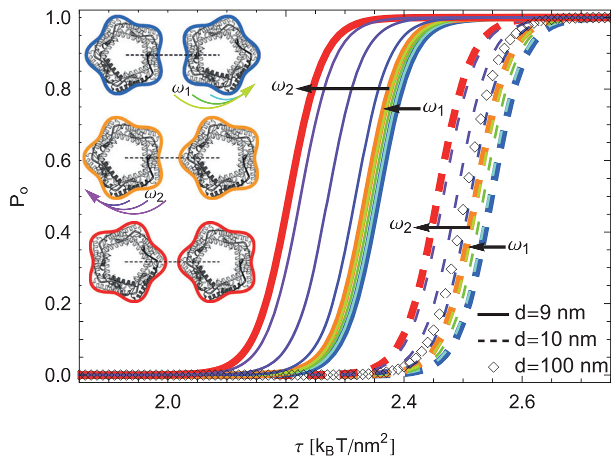


This multiterminal quantum Hall effect device has been employed to realize the nonreciprocal electrical networks whose thermal noise correlations were measured in the work.

Original article by CALLEGARO L. *et al.*
EPL, **101** (2013) 50003

Directional interactions and cooperativity between mechanosensitive membrane proteins

Cell membranes display a fascinating organization of lipids and membrane proteins, and play an integral role in many physiological processes. While great progress has been made in the detailed structural elucidation of membrane proteins, the biological function of membrane proteins is often influenced by interactions with lipids. In particular, membrane proteins generally deform the surrounding lipid bilayer, yielding membrane-mediated interactions between neighboring membrane proteins. A model system for the coupling between protein function and lipid bilayer deformations is provided by mechanosensitive ion channels, which transition from closed to open states with increasing membrane tension. Here we develop an analytic approach which establishes a quantitative link between the molecular structure of membrane proteins and the organization and cooperative function of membrane proteins in the crowded membrane environment provided by living cells. For the model system of mechanosensitive ion channels our approach predicts that the sign and strength of elastic interactions depend on the protein shape and conformation, yielding distinct cooperative gating curves for distinct protein orientations (see figure).

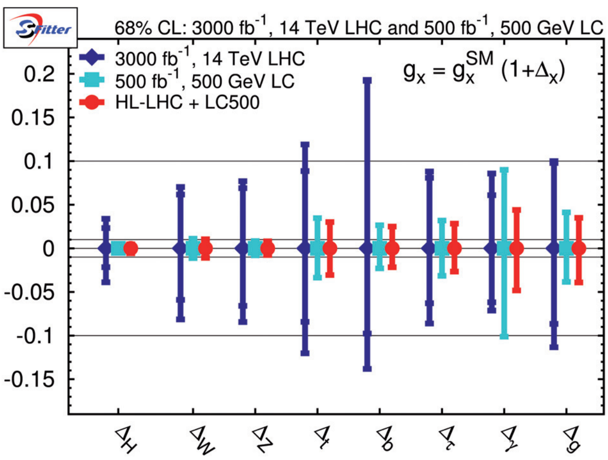


Calculated gating probability, P_o, for a pair of pentametric mechanosensitive channels to transition from the open-closed to the open-open state as a function of membrane tension, τ, protein separation, d, and protein orientation.

Original article by HASELWANDTER CHRISTOPH A. and PHILLIPS ROB
EPL, **101** (2013) 68002

Measuring Higgs couplings at a linear collider

In 2012 the experiments ATLAS and CMS discovered a new particle in proton-proton collisions at CERN's Large Hadron Collider (LHC). The measurements show that the properties of the particle are compatible with those predicted for the Higgs boson of the Standard Model. In the paper we estimate the precision with which some of the fundamental properties of the particle, its couplings to other particles, can be measured including theoretical errors, at a high-luminosity LHC (HL-LHC), a linear electron-positron collider and the combination of the two. The uncertainties are expected to be better than 1% for a single parameter modifying all Higgs couplings simultaneously, and at the percent level if all relevant couplings are left free and independent of each other. The combination of the measurements at the two machines improves on the uncertainty of each one of these. Thus a HL-LHC and a linear collider form a dream team to study the properties of the Higgs boson with high precision.



Expected precision for Higgs coupling measurements for the HL-LHC, ILC and the combination of the HL-LHC and the ILC.

Original article by Klute Markus *et al.*
EPL, **101** (2013) 51001

Gauge theory of topological phases of matter

Topologically protected states of matter are the focus of recent intensive research efforts. Such states may play an important role in future concrete implementations of devices for topological quantum computing. Prominent examples are incompressible 2D electron gases exhibiting the Quantum Hall effect or the spin Hall effect, 3D topological insulators and superconductors, etc. From a conceptual point of view it is important to note that the low-energy effective theories describing all these states can be derived, using only very general principles, from a unified theoretical framework which we have called "*gauge theory of states of matter*". A key idea underlying our framework is to promote fundamental or emergent global symmetries of idealized systems to *local gauge symmetries* of realistic systems, and to then study the response of such systems under variations of the corresponding gauge fields. For systems with a bulk energy gap, our theory predicts the general form of the response laws, transport equations, and the structure of gapless surface modes. It also elucidates how the structure of the ionic background, electromagnetic fields, velocity fields and curvature influence the properties of such systems.

Original article by Fröhlich Jürg
and Werner Philipp
EPL, **101** (2013) 47007