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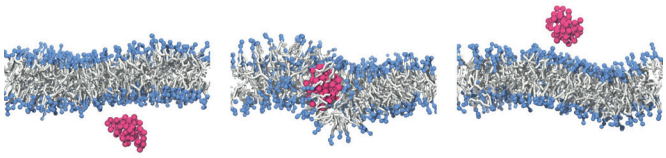
Highlights from the previous volumes

Critical adsorption controls translocation of polymer chains through lipid bilayers and permeation of solvent

Lipid bilayers emerge by self-organization of amphiphilic molecules and are the essential component of membranes of living cells. An important task of them is the selective exchange of substances between the cell and its environment. This becomes particularly interesting for delivering foreign molecules and RNA into the cell. In the classical view of cell biology static structures such as pores and channels formed by specific proteins control the translocation of molecules. In this work we show that there exists a straight forward mechanism for translocation of polymers through lipid bilayers if the monomers of the chain show a certain balance of hydrophobic and hydrophilic strength. Using the bond fluctuation method with explicit solvent to simulate the self-organized lipid bilayer and the polymer chain we show that the chain is adsorbed by the bilayer at a critical hydrophobicity of the monomers. At this point all monomers have an intermediate degree of hydrophobicity which is large enough to overcome the insertion barrier of the ordered lipids, but still small enough to avoid trapping in the core of the bilayer. In a narrow range around this critical hydrophobicity the chain can almost freely penetrate through the model membrane whose hydrophobic core becomes energetically transparent here. Our simulations also allow to calculate the permeability of the membrane with respect to the solvent. We show that the permeability is strongly increased close to the critical hydrophobicity suggesting that here the perturbation of the membrane patch around the adsorbed chain is highest.

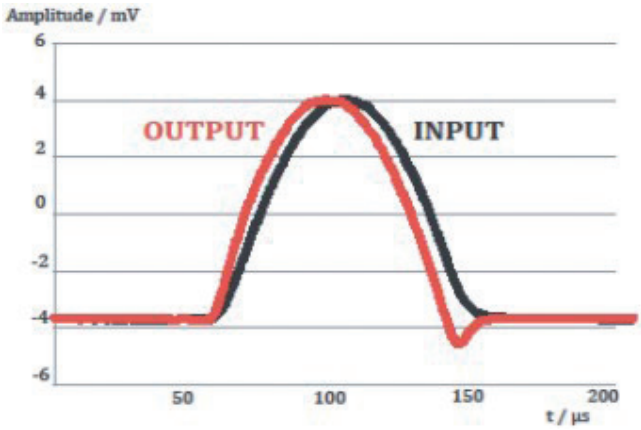


Snapshots of a polymer chain diffusing through the bilayer at the critical hydrophobicity. Strong perturbations of the lipid ordering can be observed during the adsorption/translocation event (middle).

Original article by Sommer Jens-Uwe *et al.*
EPL, **98** (2012) 18003

Giant negative group time delay by microwave mode adaptors

In 1960 Brillouin wrote in his famous book on *Wave Propagation And Group Velocity* (p. 79) a footnote: The negative parts of the (theoretical) group velocity have no physical meaning. A negative velocity shows the maximum of the group at the output before it has entered the input of a special medium. However, since 1985 several physicists measured a negative delay and thus a negative group velocity at a sharp molecular resonance. Recently a giant negative group time delay was observed in a medium of two microwave mode adaptors separated by a 20 m long waveguide when they are not parallel aligned. Instead of +60 ns vacuum time −2.2 μs were measured for the same distance. Such adaptors are used in communication technology to transform rectangular waveguide modes into circular waveguide modes. For instance, in the case of TV reception via satellite. The strange behavior is based on a 90° shift of the linear polarization of the superimposed right and left circular wave modes in the case of a perpendicular adaptor orientation. Remarkable, the polarization shift of 90° takes place at each reflection and in this way makes the shifted adaptors to reflectors, whenever the distance between the adaptors equals a multiple of half the wavelength.



Input (black) of a pulse traversing a 20 m adaptor cavity and its output (red). The adaptor cavity delay is 2200 ns and leads to a negative time shift.

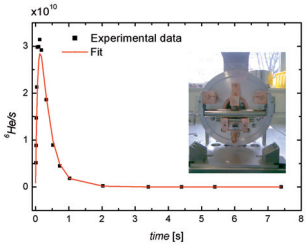
Original article by Carot A. *et al.*
EPL, **98** (2012) 64002

A high intensity ^{6}He beam for the β-beam neutrino oscillation facility

Nuclear structures of short-lived radioisotopes are nowadays investigated in large-scale facilities based on in-flight fragmentation or isotope separation online (ISOL) methods. The ISOL technique has been constantly extended for the last 45 years at CERN-ISOLDE, where 1.4 GeV protons are exploited by physicists to create radioisotopes in thick materials; these exotic nuclei are released and pumped online into an ion source, producing a secondary beam which is further selected in a magnetic mass spectrometer before post-acceleration.

Ten years ago in a *β-beam* facility concept, a proposal to inject suitable ISOL radioisotope beams into the CERN accelerator complex and to store these isotopes in a decay ring with straight sections was proposed; intense sources of collimated pure electron neutrinos produced by isotope disintegration are directed towards massive underground detectors for fundamental studies such as CP violation probed by the observation of neutrino flavor oscillations.

Our paper reports on experimental data collected to validate the production of the anti-neutrino emitter ^{6}He at the required rates for the *β-beam*. We use a two-step reaction in which the proton beam interacts with a tungsten neutron spallation source. The emitted neutrons intercept a BeO target to produce large amounts of ^{6}He by the ^{9}Be(n, α)^{6}He reaction. A good match between the neutron energy spectrum, simulated by Monte Carlo codes such as Fluka, and experimental measurements was obtained. The predicted ^{6}He production rates were also experimentally verified. The selection of a proper BeO target material, critical to drive fast ^{6}He diffusion, could be demonstrated for the first time, leading to the highest ^{6}He beam rates ever achieved at ISOLDE. These results provide a firm experimental confirmation that the *β-beam* will be able to deliver enough anti-neutrino rates using a neutron spallation source of about 200 kW similar to the one in operation at ISIS at RAL (UK). This work is now being completed by the experimental validation of the conceptual ^{18}Ne neutrino source design.

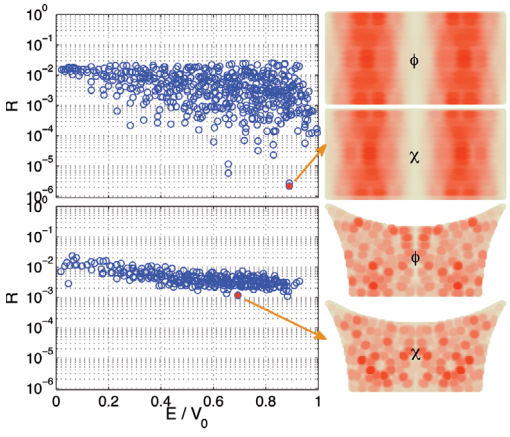


ISOLDE radioisotope beam production unit in which a tungsten spallation neutron source along the target oven uses the CERN's proton beam to produce ^{9}Be(n, α)^{6}He nuclear reactions. Experimental data of the fast release of ^{6}He anti-neutrino emitting ions and theoretical fit based on physical release processes in the thick porous BeO production target.

Original article by Stora Thierry *et al.*
EPL, **98** (2012) 32001

Effect of chaos on relativistic quantum tunneling

What classical chaos can do to a quantum system is a fundamental issue which is highly relevant to a number of branches in physics. The field, named quantum chaos, has been active for at least three decades, where the focus has been on non-relativistic quantum systems described by the Schrödinger equation. With respect to relativistic quantum systems governed by the Dirac equation, Berry and Mondragon were the first to investigate the energy-level statistics of a chaotic neutrino billiard. A recent paper in *EPL* presented an astonishing case of how chaos may affect relativistic quantum tunneling dynamics. By developing an efficient method to solve the Dirac equation in the setting where relativistic quantum particles can tunnel between two symmetric cavities through a potential barrier, the authors found that chaotic cavities can greatly suppress the spread in the tunneling rate. Specifically, when the classical dynamics is integrable, the tunneling rate for any given energy can assume values in a range that increases with the energy (upper panel of the figure). However, when the cavities permit fully chaotic dynamics, spread in the tunneling rate is greatly reduced (lower panel). The researchers found that this suppression can be explained by the emergence of a certain class of pointer states (see figure). A remarkable feature, which does not arise in non-relativistic quantum tunneling systems, is that substantial tunneling exists even when the particle energy approaches zero. This is a consequence of the relativistic quantum phenomenon of Klein tunneling. The researchers found similar results in tunneling devices made of graphene, implying that the field of relativistic quantum chaos can be highly relevant to the development of such devices.



Original article by Ni Xuan *et al.*
EPL, **98** (2012) 50007