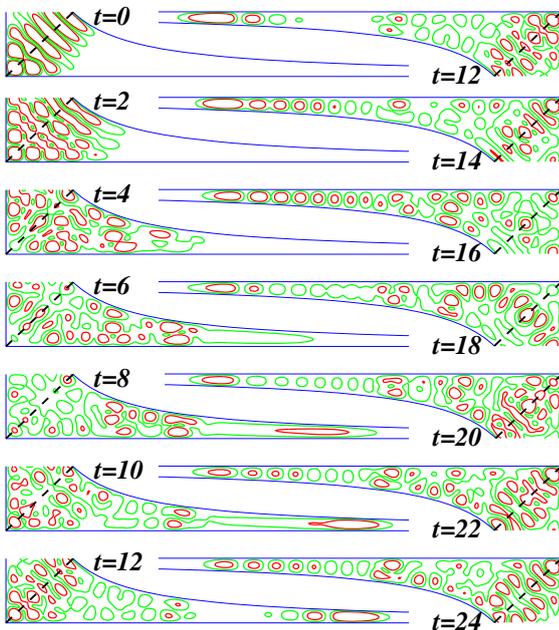


Highlights from the previous volumes

Semiclassical propagation up to the Heisenberg time

Semiclassical propagation of waves is a fruitful approach to understand and evaluate a wide set of physical processes. This is performed by associating quantum states with Lagrangian manifolds in phase space, and the propagation is accomplished by the evolution of manifolds. However, long time propagation in Hamiltonian systems with chaotic dynamics is a long-standing unsolved problem; the reason being that Lagrangian manifolds evolve into very complex objects.

Recently, we have shown that by using the stable and unstable manifolds of periodic orbits, the propagation is simplified enormously. For this reason, in this paper we study in detail the manifolds of a periodic orbit of the hyperbola billiard, finding that they are organized by a simple tree structure. Then, we compute a complete set of homoclinic orbits (resulting from the intersection of the manifolds), which is required to evaluate the autocorrelation function of a quantum state constructed in the neighborhood of the periodic orbit (resonance). Finally, we compare the quantum and semiclassical autocorrelation up to the Heisenberg time, finding a relative error of the order of the Planck constant.



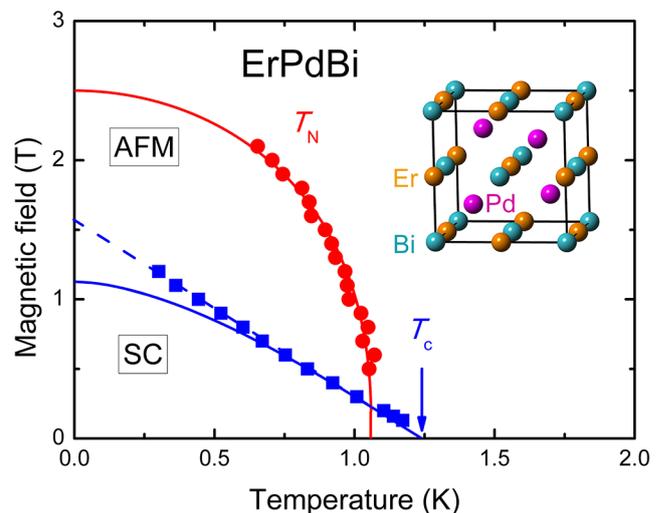
Long time propagation of a resonance in the hyperbola billiard. The Ehrenfest time is 2.2, and the Heisenberg time is 35.3.

Original article by VERGINI EDUARDO G.
[EPL, 103 \(2013\) 20003](#)

Superconductivity and magnetic order in the half-Heusler compound ErPdBi

Half-Heusler compounds attract ample attention because of their flexible electronic structure. A new electronic state in this respect is the topological insulator, where the interior of the material is insulating, while the surface states are conducting. Surprisingly some of the topological half-Heusler compounds become superconducting at low temperatures. Topological superconductors are predicted to have a fully gapped unconventional pairing state in the interior, while the non-trivial topology gives rise to Majorana fermion states at the edge of the sample. The further interplay with magnetic order may lead to exotic superconducting phases.

In the paper the discovery is reported of a new candidate for topological superconductivity: ErPdBi. Magnetic and transport measurements demonstrate superconductivity at $T_c = 1.22$ K, and, moreover, magnetic order at $T_N = 1.06$ K. Since $T_N \approx T_c$ the interaction of superconductivity and magnetic order is expected to give rise to a complex ground state. Electronic-structure calculations reveal a topologically non-trivial band inversion. Accordingly, ErPdBi is advocated as a novel, unique platform to study the interplay of topological states, superconductivity and magnetic order.



Superconducting (SC) and magnetic (AFM) phase diagram of ErPdBi. Inset: half-Heusler crystal structure.

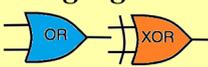
Original article by PAN Y. *et al.*
[EPL, 104 \(2013\) 27001](#)

An experimental evidence-based computational paradigm for new logic-gates in neuronal activity

This year we are celebrating the 70th anniversary of the publication of the seminal work by McCulloch and Pitts “A logical calculus of the ideas immanent in nervous activity”. They suggested that the brain is composed of threshold units, neurons, composing reliable logic-gates similar to the logic at the core of today’s computers. This suggested computational framework had a tremendous impact on the development of artificial neural networks and machine learning theory, but had limited impact on neuroscience, since neurons exhibit far richer dynamics. Here we propose a new experimentally corroborated paradigm in which the functionality of the brain’s logic-gates depends on the history of their activity, the stimulation frequencies of their input neurons, as well as the activity of their interconnections. Our results are based on an experimental procedure where conditioned stimulations were enforced on circuits of neurons embedded within a large-scale network of cortical cells *in vitro*. We demonstrate that the underlying biological mechanism is the unavoidable increase of neuronal response latency to ongoing stimulations, which imposes a non-uniform gradual stretching of network delays. This computational paradigm is anticipated to lead to a better understanding of the brain’s functionalities.

Universality in the symmetric exclusion process and diffusive systems

A system connected to two sources of heat or particles reaches, in the long time limit, a non-equilibrium steady state characterized by a non-vanishing and fluctuating current. Its study is an active topic in both classical and quantum systems. A relevant observable is the number Q_t of particles flowing through the system during a time t . It can be calculated for simple models such as the symmetric simple exclusion process (SSEP) which describes two reservoirs at fixed densities connected by an L -site chain on which particles diffuse with a same site hard core repulsion. The corresponding cumulants of Q_t are exactly known in one dimension and they coincide with those computed for the transport of free fermions through a mesoscopic conductor. We have generalized these results to arbitrary large but finite d -dimensional domains or graphs. Our numerical results indicate that, for large enough lattices and contacts to the reservoirs, the ratios of the cumulants of Q_t take universal values, independent of the domain dimension and shape.

Brain	Same language ?	Computer
		
$OR \rightarrow XOR \rightarrow OR$	Logic gates	XOR
Dynamic		Static

An illustration for the differences between computer and brain logic-gates.