

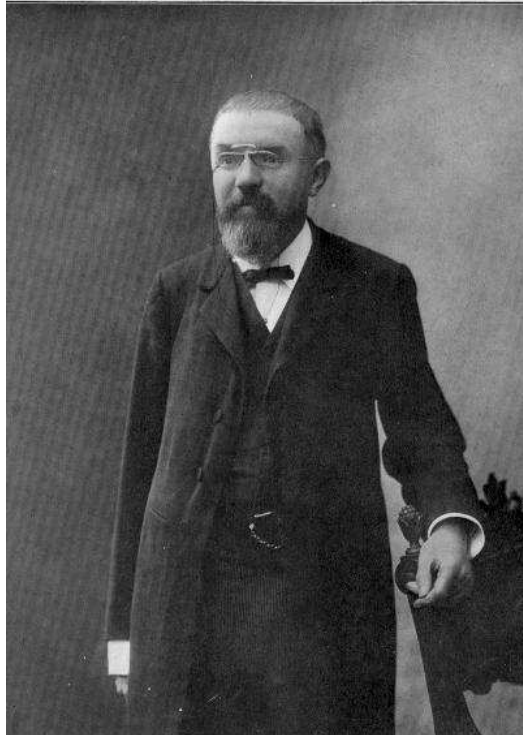
Four Words Welcome to the QIPC Review

by QICC Organizers: Philippe Grangier, Miklos Santha and Dima Shepelyansky



The Institut Henri Poincaré has been founded in 1928, with the help of the Rockefeller foundation and the Rothschild family. The initial aim, which got active support from George Birkhoff, was to promote French research in Mathematics and Theoretical Physics. The actual project realisation of a research center is due to Emile Borel. The impulse of french - american collaboration created at the IHP a spirit of openness to researchers from all continents providing public access to most modern scientific developments.

This spirit becomes also present in the EC QIPC Review which now opens to public most fascinating technological and scientific developments in EU.



Four words of the **QICC** Programme name from a historical view point:

The last one, **complexity**, is directly related to **H.Poincaré** who writes in **1908**: “**it may happen that small differences in the initial conditions produce very great ones in the final phenomena. A small error in the former will produce an enormous error in the latter. Prediction becomes impossible**”. This exponential instability leads to emergence of complex dynamics called nowadays chaos. Such a dynamics extracts all **information** hidden in initial conditions (numbers).

In 1965 A.N.Kolmogorov proved that almost all numbers in a finite interval (initial conditions) are uncomputable and **information** contained in them grows linearly with the number of their digits (that gives positive Kolmogorov **complexity**). Thus, a chaotic dynamics shows all randomness of initial conditions and leads to emergence of statistical laws in purely deterministic systems.

The importance of **computation** for understanding of dynamical evolution in such systems was first demonstrated by Fermi, Pasta, Ulam who used MANIAC 1 in their studies of nonlinear chain dynamics in 1954. Analytical physical criteria for emergence of chaos are still very rare (e.g. Chirikov resonance-overlap criterion, 1959). Thus, the further development of computers gave important contributions to the understanding of complex dynamics even if any computer is unable to simulate real chaotic trajectory.

Classical: von Neumann (1944) → Fermi-Pasta-Ulam (1954)

Quantum: Shor (1994) → quantum chaos maps (2002 - 2005) ?



It is interesting that from the very beginning the importance of computers was realized by mathematicians.

Thus in 1959 A.N.Kolmogorov writes in a brochure for school pupils: “A real revolution happened in the domain of technology of computations ten years ago. It was shown that mechanical displacements of computational elements can be replaced by electrical lamps”.

New Step: compute and communicate by moving Entanglement !