International Research Center on
MATHEMATICS AND MECHANICS OF COMPLEX SYSTEMS

and

FONDAZIONE TULLIO LEVI CIVITA

ERIC A. CARLEN

Eric A. Carlen was born in U.S.A. in 1957. He became full professor at Georgia Tech in 1997 and moved at Rutgers University in 2007. He obtained his B.A. with highest honors in Mathematics and Physics at the University of Virginia in 1980 (Awarded E.J. McShane Prize for outstanding mathematics major) and his Ph.D. in Physics at Princeton University in 1984. His Ph.D. supervisor was Professor E. Nelson. He spent two years at the M. I. T. as C.L.E. Moore Instructor and two years at Princeton University supported by a NSF post-doc grant under the supervision of Professor E. Lieb. For a period of six years he was assistant professor always at Princeton University, before becoming associate professor at Georgia Tech.

He got several NSF grants, with which he also supported many Ph.D. students.

His research activities has been mainly directed to mathematical analysis and probability, “preferably both simultaneously, and preferably with roots in mathematical physics”.

In the first period of his scientific career Prof. Carlen worked in the field of Stochastic Mechanics: this theory was proposed by E.Nelson, one of the founders of Quantum Field Theory, in its euclidean version (EFT). Actually Stochastic Mechanics is an equivalent version of Quantum Mechanics based on the introduction of a diffusion process driven by Newton Law. The ideas of Nelson were considered highly controversial as many experts believed that they were based on the existence of some “hidden variables”. However since it was possible to prove its complete equivalence with Schrödinger equation the controversy faded down. The existence of those diffusion processes in terms of which Stochastic Mechanics is formulated is a delicate mathematical problem to which Eric Carlen managed to give a brilliant solution in his Ph.D. Thesis.

A second important period of the scientific career of Eric Carlen is related to his interest for the role of entropy in Probability and Kinetic Theories. The first step in this direction has been the establishment of the connection between the theorem of central limit and entropy production. Subsequent developments lead to the quantitative estimate of entropy production in Kinetic Theory by means of which it was possible to get the first quantitative proof of convergence to equilibrium for Boltzmann equation, when initial data are far from equilibrium. This theorem gave a first partial proof of one famous conjecture put forward by Cercignani. The starting point is the celebrated Boltzmann H theorem, which states that the time derivative of H function (which is equal to minus thermodynamic entropy) is negative along the solutions of Boltzmann equations. This derivative, which is named “entropy production”, can be evaluated in terms of the entropy itself and some parameters of the solution. Aforementioned estimate allows to prove that H function converges, for large values of time and with a speed which can be calculated, to its minimum, which corresponds to equilibrium.

This was the first step of a series of results which have seen many authors involved in the same effort and in the production of a remarkable amount of ideas on which was possible to build one of the results mentioned in the for the choice of Cedric Villani as recipient of the Field Medal.

Variational methods are often used in the papers of Eric Carlen together with probabilistic techniques. Particularly fruitful has been the use of these methods in the study of equilibrium and stability of states characterized by the coexistence of different phases divided by interfaces. Indeed Statistical Mechanics forecasts that -in equilibrium conditions and when temperature is lower than a critical value- more than one phase (e.g. liquid and gaseous ones) may be present simultaneously and that the region occupied by different phases are separated by interfaces. The behavior of the system is described by the determination of the minima of suitable free energy functionals. These functionals are characterized by the presence of competing entropic and energetic terms. The balance between the two effects produces multiple coexisting phases localized in different regions, separated by interfaces. The problem to determine the evolution of these interfaces and their stability is a crucial issue. Its solution involves a very delicate analysis, which presents relevant mathematical difficulties. In a series of complex works Carlen managed to supply very elegant solutions to all these questions.

Although the motivations which lead Eric Carlen to these studies havetheir roots in mathematical physics, the solution of the problems which he successfully confronted required the analysis of questions which have an interest “per se” in the general framework of the Theory of Probability and Mathematical Analysis: among then some new important inequalities of general interest. Therefore the original contributions to science of Eric Carlen are not limited to Mathematical Physics but more generally are of relevance in Pure Mathematics.

The committee, entrusted by the
“Fondazione Levi-Civita”

and the Scientific Committee of the
International Research Center MEMOCS

with the responsibility of awarding the
International Levi-Civita Prize

unanimously propose Professor Eric A. Carlen as winner of the 2011 edition.