MAURO CARFORA

Mauro Carfora is full professor of mathematical physics at the University of Pavia (2001). A student of Carlo Cattaneo, he obtained his Laurea with honors in Physics from the University at the University of Rome La Sapienza in 1977, and his Ph. D. in Physics at the University of Texas at Dallas in 1981 under the guidance of Wolfgang Rindler. He was researcher at the University of Rome and the University of Pavia, before being appointed an associate professorship at SISSA (1992-97) and then at Pavia.

His research activities have been mainly directed to Quantum gravity, Ricci flow and Renormalization group flow, Relativistic cosmology, and in general to the use of methods of geometric analysis in theoretical physics. He is the author of more than 80 research papers and of three Springer Lecture Notes in Physics. He has been the recipient of the *Bruno Finzi Prize for Mathematical Physics* (Istituto Lombardo, Accademia di Scienze e Lettere) (1997), of the *2nd Prize of The Gravity Research Foundation* (with C. Rovelli and A. Bareira, 1996), and was honored with the *Profile of Success of the Graduate School of Physics of the University of Texas at Dallas* (2011).

His first significant contribution was a mathematically rigorous characterization of an averaging technique in relativistic cosmology. Since the early 80's a large debate emerged in the cosmology community around the so-called «averaging problem», a question introduced on a more general ground in general relativity by G.F.R. Ellis in 1982. To describe the debate in a nutshell, let us say that because on the non-linearity of the Einstein equations, a non-trivial backreaction effect of the small-scale matter inhomogeneities in the average large-scale dynamics of the spacetime is expected. This issue has been rather controversial for many years, if nothing else because is extremely difficult to give a mathematical status to an averaging technique smoothing out both the matter as well as the geometric inhomogeneities of a realistic cosmological spacetime. In the paper "*Smoothing out spatially closed cosmologies", Physical Review Letters 53 (25), 2445*, co-authored with A. Marzuoli, he introduced a very

sophisticated averaging technique by exploiting the Ricci flow, a geometric flow introduced by R. Hamilton (1982) that ever since has played a basic role in differential geometry and geometric analysis. Mauro Carfora was also one of the very first authors to introduce the circle of ideas associated with the renormalization group (a' la Wilson) in relativistic cosmology (*M. Carfora and K. Piotrkowska, "Renormalization group approach to relativistic cosmology", Physical Review D 52 (8), 4393*). This line of research in relativistic cosmology has been quite seminal. In particular, it led to a fruitful collaboration with Thomas Buchert, producing a number of highly cited papers (*e.g. T. Buchert, M. Carfora, " Cosmological parameters are dressed", Physical Review Letters 90 (3), 031101*) addressing the delicate mathematical issues in dealing with the averaging problem in relativistic cosmology, offering a rigorous ground to investigate the spacetime geometry of a realistic, lumpy universe and culminating in a collective work which has seen some of the most distinguished cosmologist taking a stand on this delicate issue (*T Buchert, M Carfora, GFR Ellis, EW Kolb, MAH MacCallum, JJ Ostrowski, S Räsänen, BF Roukema, L Andersson, AA Coley, DL Wiltshire "Is there a proof that backreaction of inhomogeneities is irrelevant in cosmology?", Classical and Quantum Gravity 32 (21), 215021).*

A second important contribution by Mauro Carfora has been explicitly in Ricci flow theory. In particular, in a fruitful collaboration with J. Isenberg and M. Jackson he was the first to prove that one may have a global Ricci flow evolution starting from an initial manifold whose Ricci curvature was negative, (*M. Carfora, J. Isenberg, M. Jackson, "Convergence of the Ricci flow for metrics with indefinite Ricci curvature", Journal of Differential Geometry 31 (1), 249-263*), and the first to advocate the role of the Gromov-Hausdorff topology in discussing singularity development in Ricci flow theory (*M. Carfora and A. Marzuoli, "Model geometries in the space of Riemannian structures and Hamilton's flow", Classical and Quantum Gravity 5, p. 659-693, and "Functional measures on the space of n-dimensional Riemannian structures", Physical Review Letters 62, p. 1339-1342*). His work "*Fokker-Planck Dynamics and Entropies for the normalized Ricci Flow*", *Advances in Theoretical and Mathematical Physics 11, pp. 635-681*, was among the first to pinpoint the deep interaction between Ricci flow theory and optimal transport stressing the role of (quadratic) Wasserstein distance in discussing Ricci flow diffusion.

The studies in quantum gravity have occupied a large part of his scientific career. By exploiting the piecewise-linear geometry methods initiated by Tullio Regge (*Regge calculus*) he contributed significantly to the development of the theory in a fruitful collaboration with Annalisa Marzuoli and Jan Ambjorn. His work, concentrating on the analysis of entropy estimates (counting inequivalent triangulations of n-dimensional manifolds, with n>2), on the structure of the moduli space of triangulated manifolds, and in general on the applications of triangulations in quantum gravity and rigorous quantum field theory has produced a long list of publications culminating in three Springer Lecture Notes which are among the standard references in the subject.

A distinctive feature of the research activity of Mauro Carfora is the application of sophisticated geometrical methods to basic problems arising from fundamental Physics. His results often point to unexpected aspects in the open terrain of relativity and quantum physics, perceptive of where Mathematics unfailingly captures us with the depth and elegance of its arguments.

For all exposed reasons the committee, entrusted by the Scientific Committee of the International Research Center MEMOCS with the responsibility of awarding the International Levi-Civita Prize, unanimously proposes Professor Mauro Carfora as recipient of the 2016 edition.