GRAEME W. MILTON

Graeme W. Milton is currently distinguished professor at the University of Utah (U.S.). He started his brilliant career studying in Australia, his native country. He got his PhD at Cornell University and has been full professor at the NY Courant Institute, one of the most famous research institutes in the world. His free spirit led him to choose among prestigious propositions a position at the University of Utah which allows him to enjoy the out-doors activities he loves.

His scientific activity combines the mathematical rigour with the physical intuition and his articles are unanimously appreciated in both the communities of mathematicians and physicists. His scientific standing has been recognised by the innumerable invitations to conferences and workshops and by his participation to the editorial boards of prestigious journals.

His preferred research field concerns the behaviour of composite materials in different physical contexts: he co-authored more than 150 peer reviewed papers, with an outstanding impact. Among these papers let us notice:

- The study of the bounds on the complex permittivity of a two-component composite material which are now known as the "Bergman-Milton bounds".

- The rigorous proof that the coherent potential approximation (also known as the self-consistent scheme, or effective medium approximation) is a realizable effective medium theory, i.e. actually realizable by a limiting microstructure.

- The description of composite materials with Poisson ratio close to -1, a paper which answers the old question as to whether materials with a negative Poisson ratio could exist: such materials become fatter as they are stretched.

- The statement of the invariant properties of the stress in plane elasticity and equivalence classes of composites (a theorem due to Cherkaev, Lurie and Milton now known as CLM theorem).

- The study of optical and dielectric properties of partially resonant composites, a work which began a series devoted to cloaking or invisibility. For instance, the study of cloaking effects associated with anomalous localized resonance gave a spectacular result: the fact that any finite collection of polarizable dipoles (or dipolar sources radiating finite energy) sufficiently near a superlens would become invisible to any external field in the limit as the loss in the lens tends to zero has received considerable attention. The extension of cloaking phenomenon to elasticity has been obtained by showing that, through homogenization, the equations of elasticity can take the more general form of "Willis equations". The study of active exterior cloaking for the 2D Laplace and Helmholtz equations leads to a broadband quiet zone in which the incoming waves do not radiate. Overall, the paper about quasistatic cloaking of two-dimensional polarizable discrete systems by anomalous

resonance has attracted the attention of both the scientific community and of the general public. Actually the topic of invisibility is a subject which excites the imagination of the layman and of the mass media.

- The problem of determining which material properties are realizable by homogenisation is a central topic in the scientific activity of Prof. Milton. For instance he proved, using a very stiff material and a very compliant material that every positive elasticity tensor (in the 21-dimensional space in which these tensors live) can be realized. As a byproduct pentamode materials were conceived (they were built much later). He also stated a very general theory of exact relations for effective tensors of composites, which reduces their determination to an algebraic computation. This theory encompasses all the results found one by one by many previous investigators. He also established that the homogenization of the three-dimensional Hall effect can lead to a change of sign of the Hall-coefficient. Finally, he obtained the complete characterization and synthesis of the response function of elastodynamic networks and the complete characterization of the macroscopic deformations of periodic unimode metamaterials of rigid bars and pivots.

- The description of a fast numerical scheme for computing the response of composites using grid refinement allowed, using the Fast Fourier Transform, to apply the methods studied in the more theoretical cases to more practical ones.

Beyond these topics that we have extracted from a much more complete career, let us emphasize that Professor Milton demonstrates a wide and general vision about science: his knowledge about the various fields of physics enables him to see the unifying nature of physics and to free himself from usual paradigms. For instance, he showed the universal character of minimization variational principles for acoustics, elastodynamics, and electromagnetism in lossy inhomogeneous bodies at fixed frequency or suggested modifications to replace Newtons second law of motion by more general law which is a better approximation for describing the motion of bodies with microstructure.

All his papers form a coherent corpus of investigations which could be valorised into many monographs. This challenge has been initiated: the huge monograph entitled “Theory of Composites” has become a classic in the field of composite materials as it gives a comprehensive treatment of exact relations of composites, exactly solvable microstructures, approximation schemes, analytic properties of the effective moduli as functions of the component moduli, perturbation expansions for the effective moduli, variational principles for effective moduli and bounds for effective moduli. It is the only book on this subject which allows a newcomer to get a general knowledge of the state of the art. For this reason, the name of Graeme Milton has become familiar to all young researchers in this field.

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 Graeme W. Milton as recipient of the 2015 edition.