INSTITUT DE FRANCE
Académie des sciences

Séance solennelle de l'Académie des sciences / 15 juin 2010
Réception des nouveaux Associés étrangers sous la coupole de l'Institut de France

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I am conscious of the great honour of being elected to the Académie des sciences and speak about my own modest contributions to research with corresponding diffidence. Before attempting a description, I would like to acknowledge that environment plays a large role in an individual's development, and I have been fortunate throughout my career in having had the stimulus of interaction with outstanding colleagues, in the Universities of Bath and Cambridge in the UK, and at École Polytechnique in France.

Such expertise as I have is in the mechanics of solids. I have, over the years, obtained solutions to a number of basic problems for anisotropic bodies, including that of the contact between two such bodies and problems for cracks and inhomogeneities. I was involved in some of the early developments in fracture mechanics, and through that have been a member of a panel concerned with structural integrity of nuclear plant for about half of my life. I also took an interest in the analysis of the effective properties of composite materials, at a time when the field happened to be ripe for a variety of mathematical developments. I was able to advance the methodology for finding bounds for effective properties, in terms of limited statistical information on the microstructure, and also pushed this methodology towards the study of composites whose response is nonlinear. In the area of fracture, besides finding some solutions for growing cracks, I studied cracks on interfaces between different materials. Interest in some of these topics has increased in succeeding years, with the result that several of my solutions have received continuing attention. A comparatively recent contribution to crack theory had its motivation in seismology: the stability of the front of a propagating crack and, associated with this, the development of crack-front disorder. The basic mathematical problem is to study the dynamic perturbation of the leading edge of a propagating crack. I was fortunate enough to find a solution to this problem. It enabled, amongst other things, the rigorous confirmation of a remarkable phenomenon whose existence had been suggested from computations: a "crack front wave", which is a disturbance that can travel along the edge of a crack, without attenuation, as though the crack edge were a stretched string.

I realised fairly early on during my studies of composites that some of the methods could be developed so as to apply to the dynamics of composites. This interested me mostly because of the mathematics. The requirement to consider disturbances whose wavelength could be on the scale of the composite's microstructure led to new challenges, even for the formulation. Recently, however, there has been an explosion of interest in so-called "metamaterials". There is no general definition of a metamaterial, but what is meant is a material whose microstructure is designed so as to accentuate behaviour not usually seen in natural materials. Applications that are envisaged include "superlenses" (with sub-wavelength resolution) and “invisibility cloaks”. Metamaterials are no more than specially designed composites and my main present preoccupation is with further development of methods to study their dynamical response.