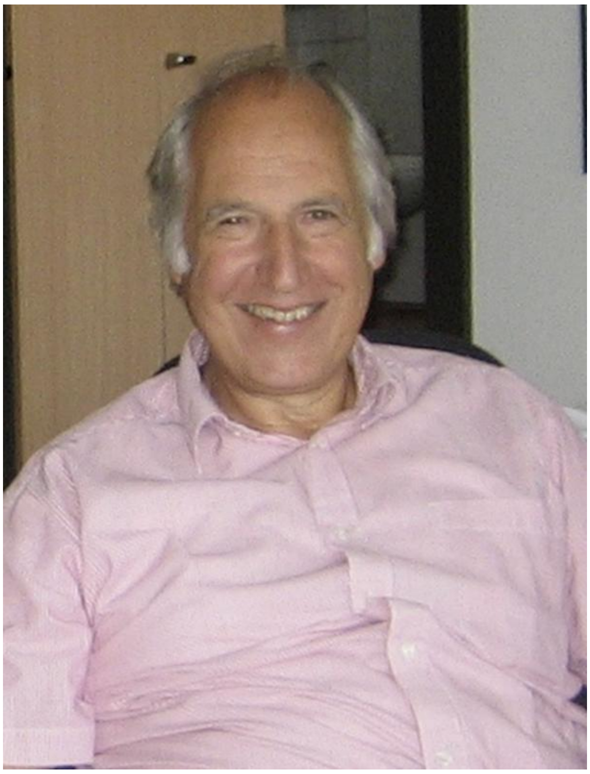

Short CV for Hermann G. Matthies

Hermann G. Matthies is an Emeritus Professor in the Carl-Friedrich-Gauss faculty at TU Braunschweig (Germany). A native of Hamburg (Germany), he has his first degree from TU Berlin (Germany), where he studied mathematics, computer science, physics, and engineering, and he obtained his PhD in mathematics at MIT (USA). In the following, he worked for an extended period in industry in different places and functions, where he was concerned with the development of algorithms for finite element analyses and plasticity, and their application in offshore engineering, naval architecture, civil engineering, and wind energy, among others. Later he returned to academia to become the founding director of the Institute of Scientific Computing at the TU Braunschweig, where he also served as the director of the University Computing Centre. He has received a number of international distinctions, among them the IACM Fellow Award and the Gay-Lussac Humboldt Prize for Experienced Researchers of the French Academy of Sciences, and he is a full member of the academy “Braunschweigische Wissenschaftliche Gesellschaft”. He has also been an invited or visiting professor at numerous universities in different countries. His current research interests include uncertainty quantification, inverse and identification problems, algorithms for coupled problems, as well as non-smooth problems like plasticity.

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Modelling Non-Uniqueness by Stochastic Solutions
-- A New Paradigm for Cracking Behaviour --

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Abstract

In quite a few areas one finds that experiments are difficult to reproduce, as the outcome seemingly depends on minute practically random details. When one tries to model this behaviour mathematically and compute appropriate solutions, one finds a similar behaviour: the outcome of the computation depends on practically random details, the solution seems to be non-unique.

Further mathematical analysis shows that for example in variational phase-field modelling of brittle fracture, the functional to be minimised in the solution process is not convex, so that the necessary stationarity conditions of the functional may admit multiple solutions. The solution obtained in an actual computation is typically one out of several local minimisers. Evidence of multiple solutions induced by small perturbations of numerical or physical parameters was occasionally recorded but not explicitly investigated in the literature on cracking. In other fields, such as fluid dynamics, where an analogous situation may be found, the concept of "measure valued solutions" is considered.

Here the focus is on this issue and a paradigm shift is advocated, away from the search for one particular solution towards the simultaneous description of all possible solutions (local minimisers), along with the probabilities of their occurrence. Inspired by recent approaches advocating measure-valued solutions (Young measures as well as their generalisation to statistical solutions) and their numerical approximations in fluid mechanics, it is proposed to stochastically relax the variational brittle fracture problem through random perturbations of the functional. Thereby the concept of stochastic solution is introduced, with the main advantage that point-to-point correlations of the crack phase fields in the underlying domain can be captured.

These stochastic solutions are represented by random fields or random variables with values in the classical deterministic solution spaces. The final result of the computation is not a single crack pattern, but rather several possible crack patterns and their probabilities. The stochastic solution framework using evolving random fields allows the interesting possibility of conditioning the probabilities of further crack paths on intermediate crack patterns.