INSTITUTE COLLOQUIUM

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Speaker:

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Title:

The Fiber Bundle Model

Abstract:

Research into fracture belongs mainly to the engineering sciences. Much of our knowledge today comes from trial and error through the ages. It has often been the case that only long after a certain material or practice has been implemented, that one understands the effect in terms of failure control. A good example of this is the medieval practice of mixing animal remains into mortar used for building. Only now one understands that the rotting of the remains causes gas bubbles to form, and that these bubbles prevent the building up of dangerous local stresses.

The theoretical study of fracture and failure phenomena has largely been cast in the framework of fracture mechanics, which is based on solid mechanics. It treats materials as elastic continua and fractures as evolving boundaries in these. It is a highly developed science which has seen important successes. Combined with finite element analysis, it provides the tool for practical numerical calculations for industrial purposes. On the other hand, fracture mechanics misses out on important aspects of fracture, such as the influence of spatial fluctuations in the material - the disorder. Fracture mechanics, as a model, is not complete.

In 1926, Peirce proposed the fiber bundle model as a model for fracture phenomena. It is more schematic than fracture mechanics, but it incorporates the important aspects that fracture mechanics leaves out, in particular the effect of disorder. The fiber bundle model

is a much more general model than that provided by fracture mechanics, amenable to many more theoretical techniques. It may be studied using a much larger toolbox than fracture mechanics.

Peirce, an important figure in the textile industry, was an engineer. The fiber bundle model, however, soon caught the eyes of statisticians, most notably Daniels, who in 1945 wrote a very influential paper in the Proceedings of the Royal Society, providing answers to such questions such as the maximum strength before collapse that a disordered fibrous material can sustain. Since the seminal paper by Daniels, there has been a constant trickle of papers on the fiber bundle model coming from both the mechanics and the statistics communities. Early during the last decade of the twentieth century, the fiber bundle model entered the statistical physics community. A decade earlier, fracture phenomena had caught the attention of this community, which at that point just had experienced tremendous successes with the unravelling of phase transitions and critical phenomena.
Immediately, various models for fracture phenomena were proposed within this community, but the fiber bundle model has proven ideal. Since its entrance in statistical physics, hundreds of papers have been published on it by this community.

The lecture will present the fiber bundle model ranging from its simplest form as studied by Daniels to variants tailored to address questions concerning the morphology of fracture surfaces.
