The Fiber Bundle Model

Eivind Bering,[1] Magnus H.-S. Dahle,[1] Jonas T. Kjellstadli,[1] Håkon Tormodsen Nygård,[1] Santanu Sinha,[1] Morten Vassvik,[1] Alex Hansen[1,*]

[1] Department of Physics, Norwegian University of Science and Technology,
N-7491 Trondheim, Norway
* Alex.Hansen@ntnu.no

ABSTRACT

The fiber bundle model is deceptively simple. First suggested and studied in 1926 by Peirce,[1] it is now established as a model that both is used for theoretical studies of the mechanisms behind brittle fracture, and as the starting point for numerical models used in the engineering of fiber-reinforced materials.[2,3] In its simplest form, the fiber bundle model consists of two parallel planes separated by some distance. Elastic fibers connect the two planes. The fibers are placed at the nodes of some regular lattice parallel to the planes. Each fiber has a maximum load it may sustain without irreversibly failing. When a fiber fails, the load it carried is transferred to the surviving fibers according to the elastic response of the two parallel plates.

We will in this talk present a number of new results concerning correlations between the failing fibers as the breakdown process proceeds. We will in particular discuss the surprising fact that a model where only the neighbors of the failing fibers absorb their load may under certain circumstances be more stable than a model where the load is evenly distributed among all surviving fibers. In a surprising way, this stability is related to a localization transition in the breakdown process where all failures from a given point on appear in a well-defined neighborhood.

We will also discuss the behavior of a one-dimensional version of the fiber bundle model, where one of the planes – now lines – is infinitely rigid whereas the other has a finite bending elasticity. With this model, we explore the different classes of behavior that may be found in one-dimensional fiber bundle models.

References

1. F. T. Peirce, J. Text. Ind. 17, 355 (1926).
2. S. Pradhan, A. Hansen and B.K. Chakrabarti, Rev. Mod. Phys. **82**, 499 (2010).
3. A. Hansen, P.C. Hemmer and S. Pradhan,The fiber bundle model (Wiley-VCH, Berlin, 2015),