Statistics of burst avalanches in fiber bundle models and connections with earthquake dynamics

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ABSTRACT: Fiber bundle models (FBM) are simple, yet rich statistical models of fracture, currently used in many research fields, ranging from the study of composite materials to earthquake dynamics.

Our aim is to study the statistical properties of the fiber burst avalanches (utilizing computer simulations) with respect to the statistical and spatial distribution of the strength thresholds and the load transfer rules. In particular, we aim to determine to what extent the statistics of the high-energy break avalanches can capture the classical laws of statistical seismology.

We investigate the impact of the distributional properties of the fiber strength thresholds on the number of high-energy avalanches and the respective recurrence intervals distribution. We consider both unimodal and bimodal Weibull strength distributions. Bimodal distributions are used to simulate the inclusion of low-strength inhomogeneities in the FBM.

A broad fiber failure threshold distribution yields a Weibull distribution of avalanche recurrence intervals and the Gutenberg-Richter scaling relation, in agreement with models and experiments for large earthquakes in the seismological and physics literature. Narrow and bimodal failure threshold distributions exhibit deviations from the Weibull expression. We investigate such deviations using generalizations of the Weibull distribution.