ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ

ΤΜΗΜΑ ΦΥΣΙΚΗΣ

ΓΕΝΙΚΟ ΣΕΜΙΝΑΡΙΟ ΤΜΗΜΑΤΟΣ ΦΥΣΙΚΗΣ

PHYSICS COLLOQUIUM

Thursday, 5 April 2012

17:00 -18:00

3rd Floor Seminar Room

"Statistical Mechanics of Brittle Fracture: From Paper Webs to Earthquakes"

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Abstract

This colloquium presentation will focus on the statistical physics of brittle fracture emphasizing the universal properties of fracture statistics. The probability distribution derived by W. Weibull, to date serves as a prototypical model for the strength of brittle materials (ceramic, paper, rock, fibre matrix composites), and for engineering reliability analysis. I will show how the Weibull distribution is obtained in the framework of the weakest-link theory, and I will discuss modifications of the theory that can change the tail dependence of the Weibull for finite-size systems, as observed in some experimental data. I will also show experimental measurements of tensile strength from paper samples to motivate the concept of critical clusters used in weakest-link theory.

I will then focus on the problem of earthquake recurrence times (ERT). This topic is of both theoretical and practical interest, since it derives from a complex (nonlinear and stochastic) process, and it is a basic ingredient of seismic risk assessment. The earthquake process results from the interplay of a driving force (plate motion) with mechanical defects (faults) in the Earth's crust that result in failure of the Crust along geological faults. First, I will review statistical and dynamic models proposed for understanding ERT statistics, and in particular the Weibull distribution. I will discuss the observational and numerical evidence supporting the Weibull dependence and arguments related to the asymptotic behavior of its hazard rate function. Finally, I will focus on my group's recent research connecting fracture mechanics and ERT statistics. This is accomplished in the framework of a stochastic stick – slip model of a single fault that is subject to tectonic loading. I will argue that the Weibull distribution is motivated for ERT by the stick-slip model and by numerical simulations of fibre bundle models. I will also discuss physical mechanisms and measurement biases that lead to deviations of the ERT distribution from the Weibull expression, as well as other ERT distributional forms that can be obtained from the stick-slip model. I will conclude with future research directions.