日大理工船橋・一般教育教室・物理系列・談話会

講演題目：Record statistics of crackling noise during the compressive failure of porous rocks

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（東西線直通・東葉高速鉄道・船橋日大前駅下車正面）

要旨:An accurate understanding of the interplay between random and deterministic processes in generating extreme events is of critical importance in many fields, from forecasting extreme meteorological events to the catastrophic failure of materials and in the Earth. In the presentation we focus on the statistics of record-breaking events in the time series of crackling noise generated by local rupture events during the compressive failure of porous materials. The events are generated by computer simulations of the uni-axial compression of cylindrical samples in a discrete element model of sedimentary rocks that closely resemble those of real experiments.

We show that the number of records grows initially as a decelerating power law of the number of events, followed by an acceleration immediately prior to failure. The distribution of the size and lifetime of records are power-laws with relatively low exponents. We demonstrate the existence of a characteristic record rank which separates the two regimes of the time evolution. Up to this rank deceleration occurs due to the effect of random disorder. Record breaking then accelerates towards macroscopic failure, when physical interactions leading to spatial and temporal correlations dominate the location and timing of local ruptures. Scaling analysis revealed that the size distribution of records of different ranks has a universal form independent of the record rank. Sub-sequences of bursts between consecutive records are characterized by a power law size distribution with an exponent which decreases as failure is approached. High rank records are preceded by bursts of increasing size and waiting time between consecutive events and they are followed by a relaxation process.

As a reference, surrogate time series are generated by reshuffling the crackling bursts. The record statistics of the uncorrelated surrogates agrees very well with the corresponding predictions of independent identically distributed random variables, which confirms that the temporal and spatial correlation of cracking bursts are responsible for the observed unique behaviour. In principle the results could be used to improve forecasting of catastrophic failure events, if they can be observed reliably in real time.

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