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Service de Physique de l'Etat Condensé

SÉMINAIRE

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Fractal Avalanche Ruptures in Biological Membranes

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Lipid membranes envelope cells as well as organelles, and constitute the most ubiquitous building material in cell architecture. Cell membrane rupture is an important biological process, substantial rupture rates are found in skeletal and cardiac muscle cells under mechanical load, and active cell membrane repair mechanisms are therefore essential to preserve cell integrity. Pore formation in cell membranes is also at the heart of many biomedical applications, such as in drug delivery. According to common understanding, cell membranes rupture by formation of circular pores, and several studies consistently report circular pore rupture in lipid vesicles under strain. We observed a very different rupture mechanics in bilayer membranes and cell membranes adhering on solid supports: the rupture proceeded in a series of rapid avalanches causing fractal membrane fragmentation. The intermittent character of rupture evolution and the broad distribution in avalanche sizes is consistent with so called crackling-noise dynamics, which is characteristic to earth-quakes, fracture of solid disordered materials, dislocation avalanches in plastic deformations, and domain wall magnetization avalanches. Adhesion is widespread in biological cells, which suggest that the newly discovered rupture mechanism could be commonly occurring in cell biology.
