CRACKING-QUAKES

LABORATORY : Institut Lumière Matière

LEVEL : M1 / M2
TEAM(S) : LIQ@INT

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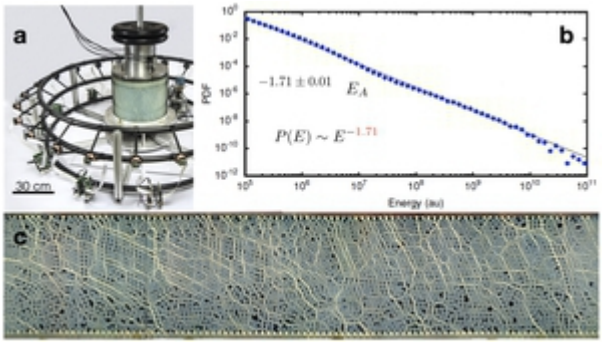
KEYWORD(S) : Scale-invariant avalanches / artificial intelligence / earthquake dynamics

SCIENTIFIC CONTEXT :

During the last years in our group at iLM we have developed an original system: the continuous and slow shear of a compressed granular layer results in scale-invariant avalanches (or Labquakes) with a statistical behavior quantitatively similar to the one of real earthquakes [1-3].



(a) Simplified image of the system. (b) Energy distribution of the events. (c) Granular fault.

-Why is this relevant? If both earthquakes and our experiment share a common physics, by understanding the behavior of our fully controllable system, we can improve the knowledge of earthquake physics. This means tackling questions like (i) parameter dependences, robustness and origin of this scale-invariant dynamic, (ii) existence of memory effects and (iii) possibilities of predicting catastrophic quakes.

-The experimental system is able to generate millions of scale-invariant events: in a 48h experiment we are able to obtain the same number of events as 150 years of magnitude larger than 2 earthquakes in California. This is an ideal scenario for applying the tools of Artificial Intelligence (AI), and we are currently exploiting them in our group.

-Besides earthquakes, other systems like subcritical fracture and the stock markets also have a scale invariant dynamic. The formalism of critical points has been used to explain scale-invariant behavior in nature. However, still many issues and open questions remain, as the relations between scale-invariance, critical properties and predictability. With our experimental results and experience in the subject we are trying to shed light on these ideas.

MISSIONS :

In dependence of the student, we can tune the internship/thesis into the following axes: (a) experimental work, (b) data analysis with AI, (c) theoretical work, either completely into one axis or as a combination of them.

OUTLOOKS :

Possibility to apply for a PhD grant at the University.

BIBLIOGRAPHY :

[1] S. Lherminier, R. Planet, V. Levy dit Vehel, G. Simon, K. J. Måløy, L. Vanel and O. Ramos,Continuously sheared granular matter reproduces in detail seismicity laws, Phys. Rev. Lett. 122, 218501 (2019). PRL Editors' Suggestion, Focus on Physics, Highlighted in PhysicsWorld, INP-CNRS, and Science Editor's Choice.

[2] Recent six-minutes captioned video of the project and some experimental facilities: https://youtu.be/jsosKaOvBBU

[3] Website: http://osvanny.net

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