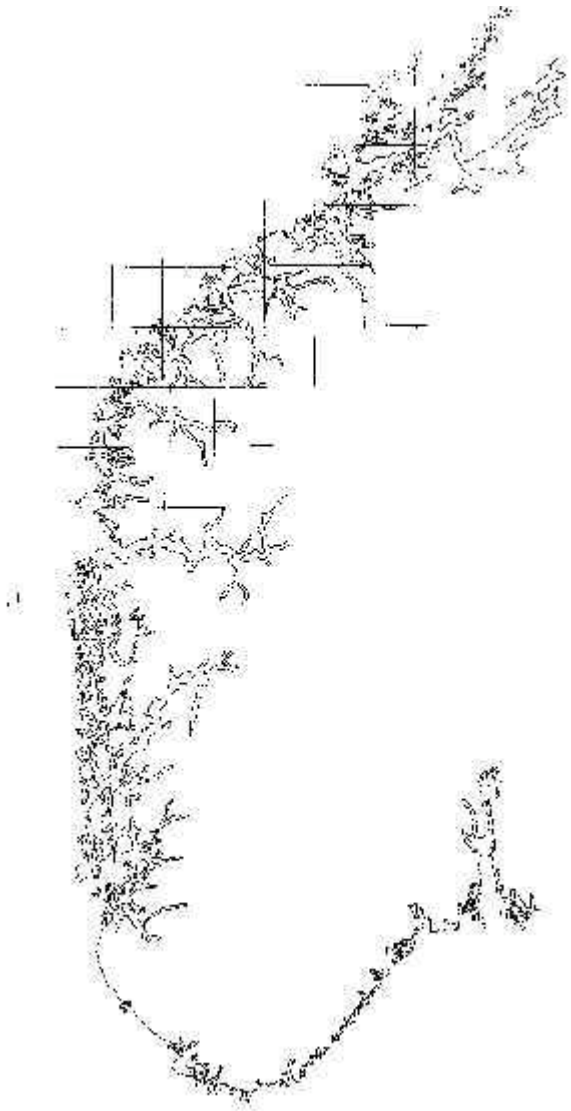
Self-Organized Critical Behavior (SOC)

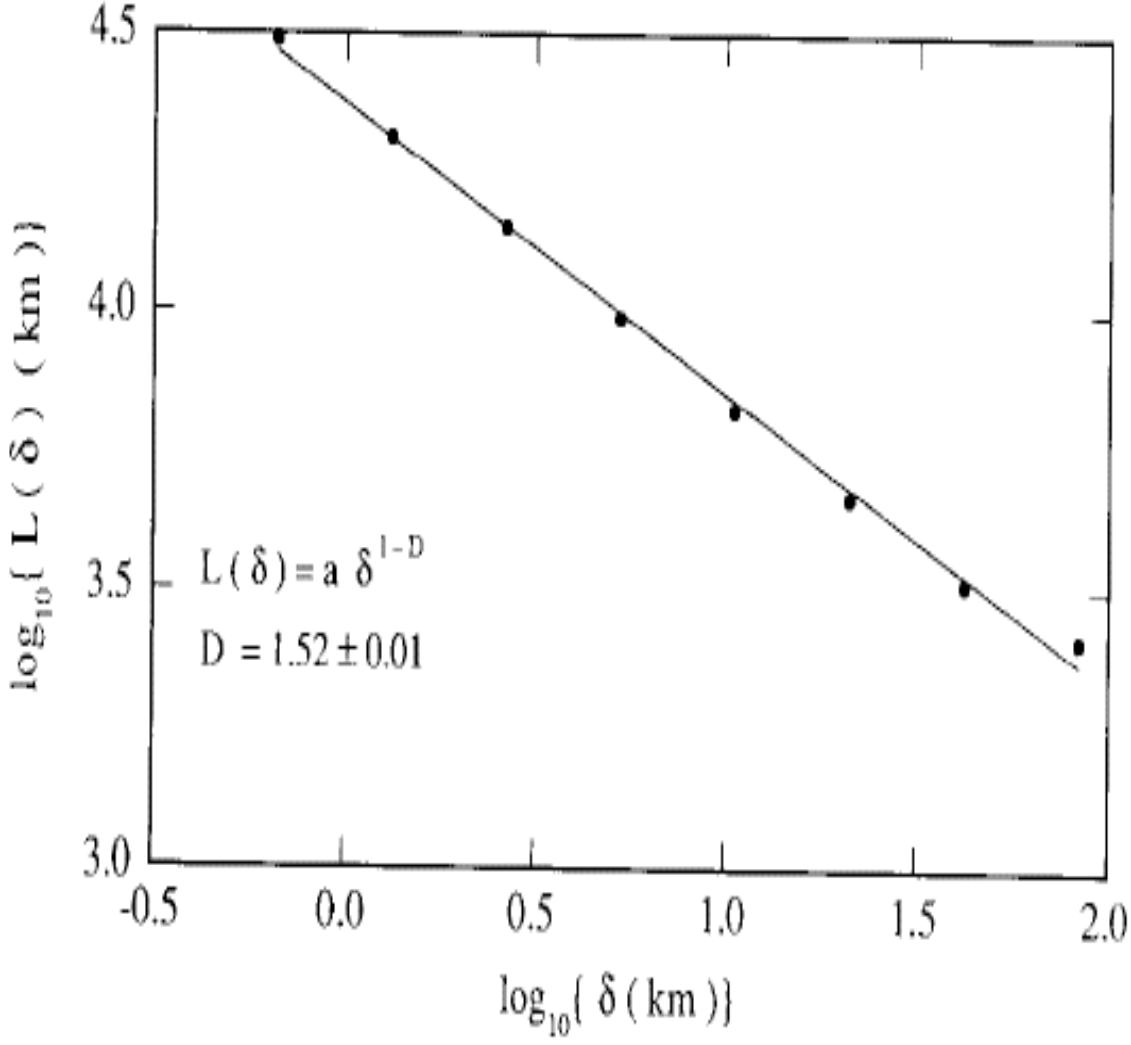
- Equilibrium
- Chaos
- Complexity

Complexity – Self-Organized Behavior

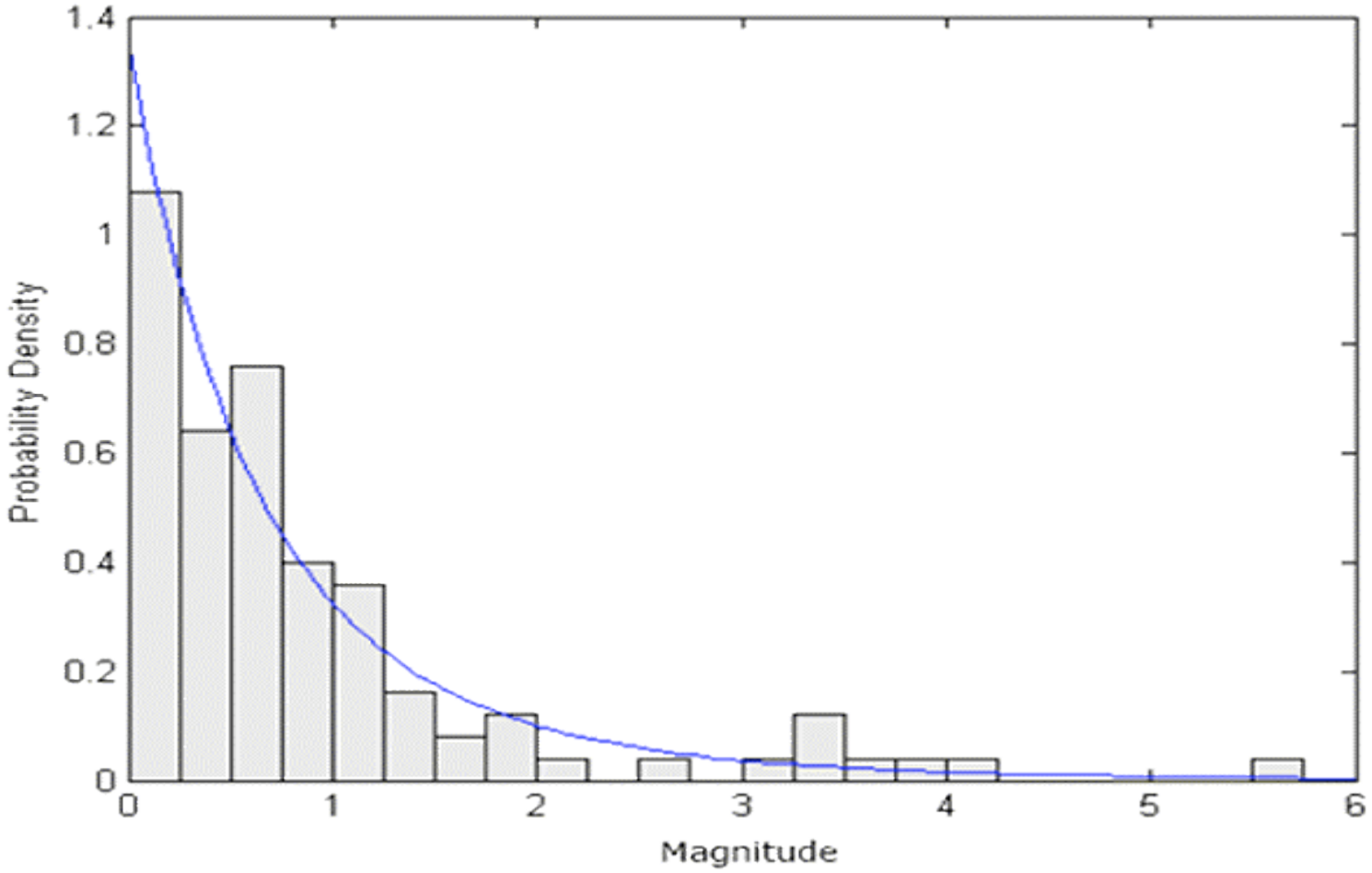
- Coast Lines – Fractals
- Earthquake
- 1/f noise
- Sandpile

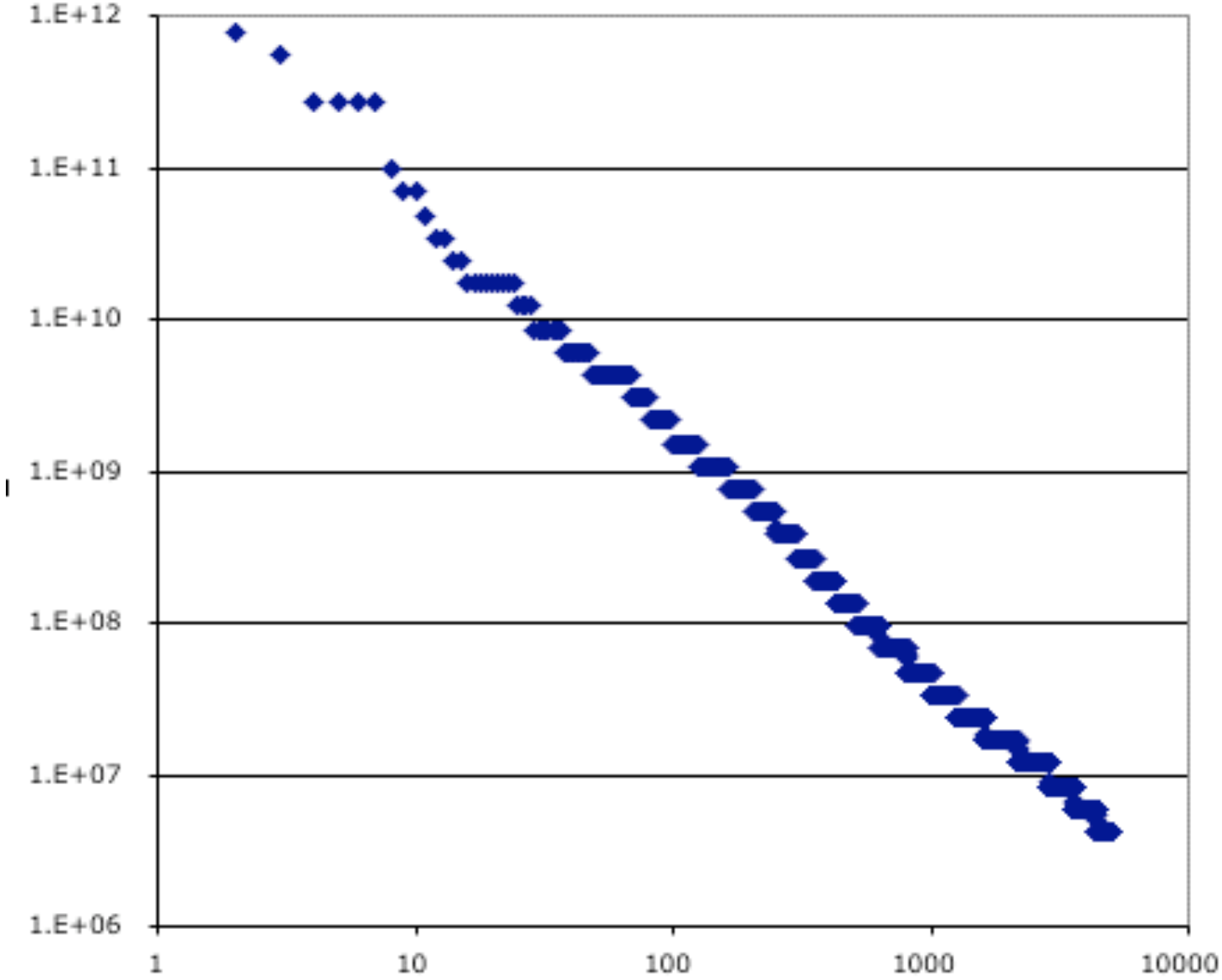
…




4.5
4.0
3.5
3.0
-0.5
0.0
0.5
1.0
1.5
2.0
$\log_{10}\{ L(\delta)\ (km)\}$
$L(\delta) = a\ \delta^{1-D}$
$D = 1.52 \pm 0.01$
$\log_{10}\{ \delta\ (km)\}$

Earthquake




1.E+12
1.E+11
1.E+10
1.E+09
1.E+08
1.E+07
1.E+06
1
10
100
1000
10000

Power Law

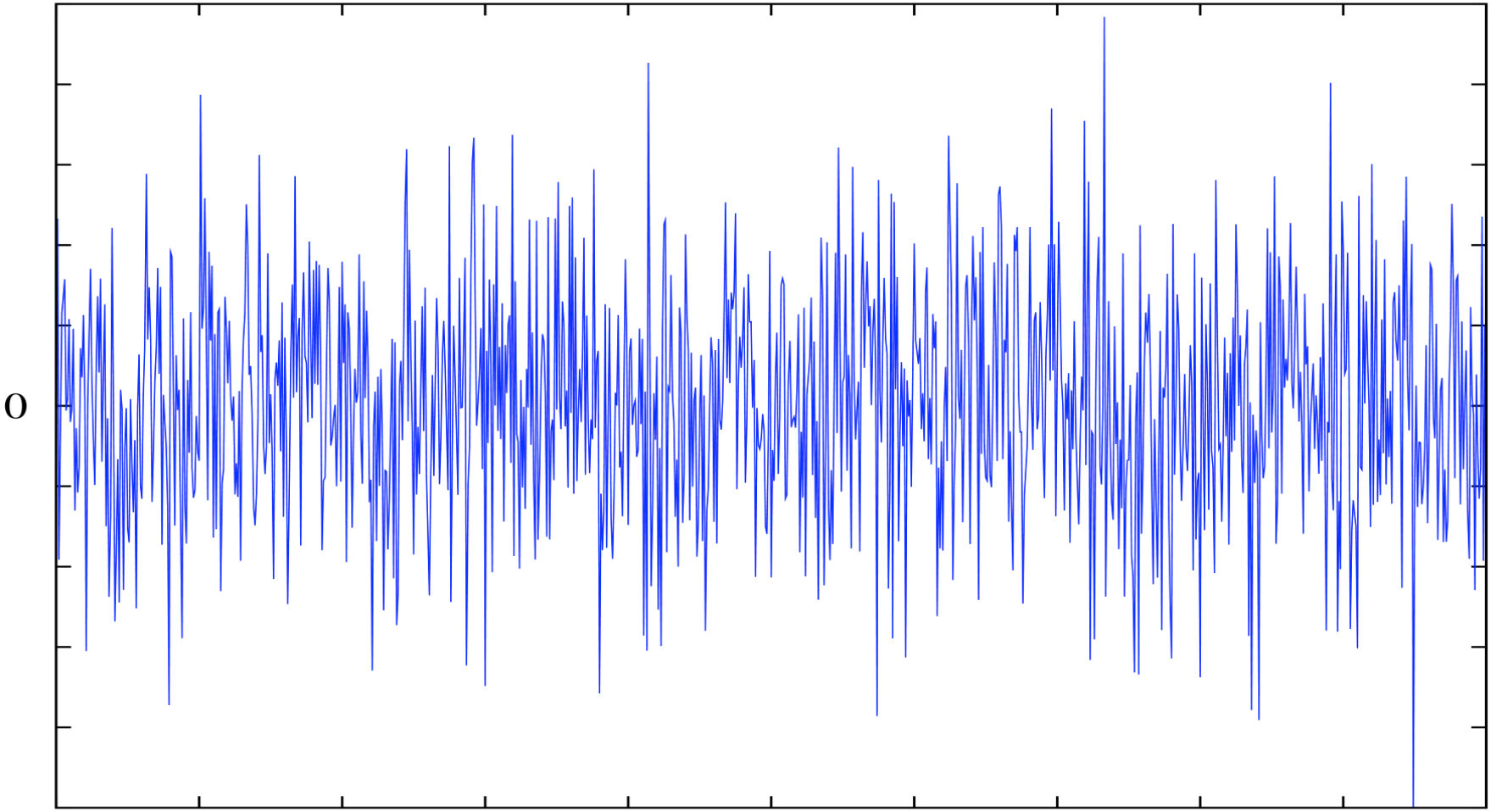
$$N(s) \sim s^{-\tau}$$

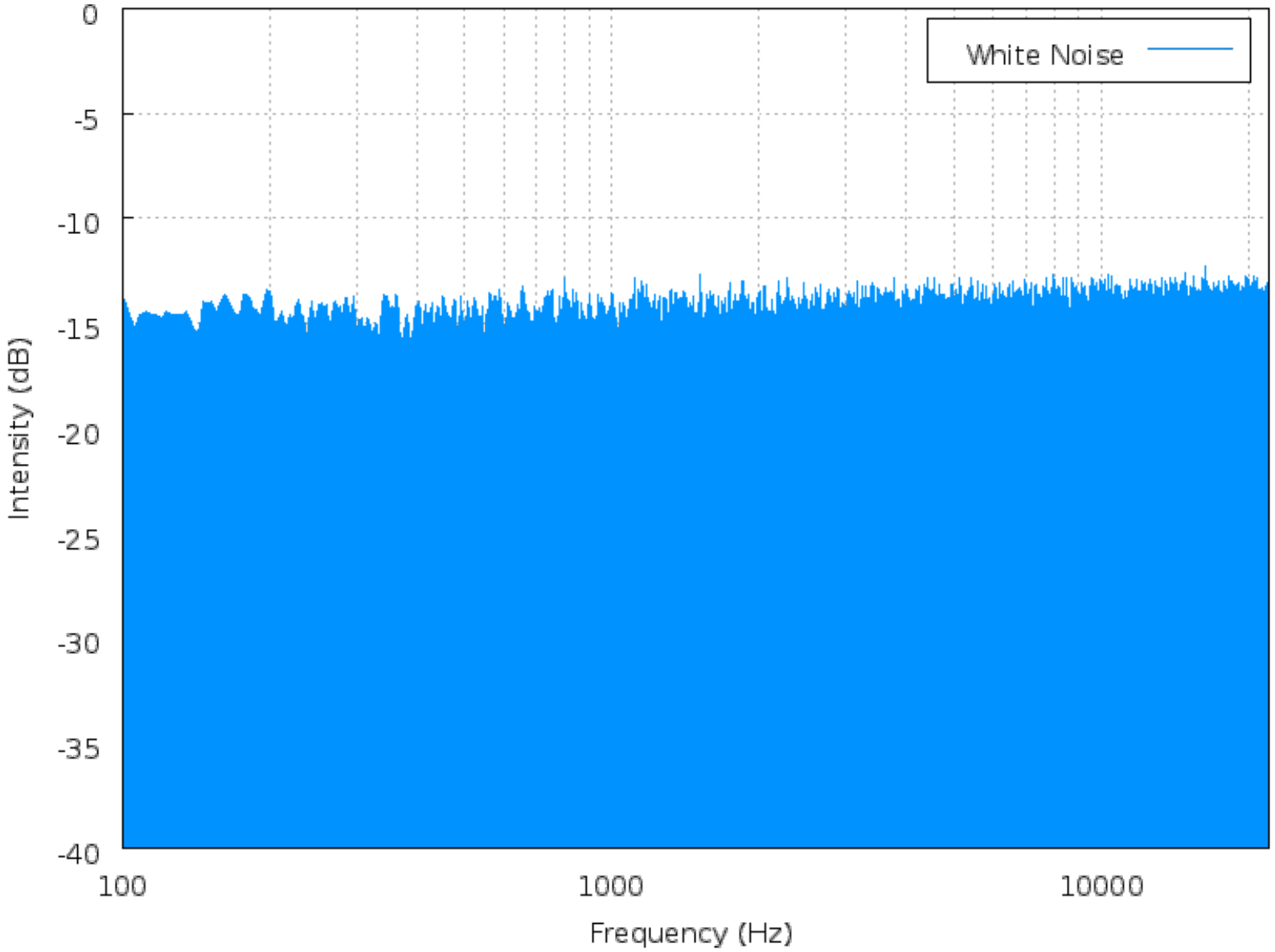
$$f(x) = ax^k + o(x^k)$$

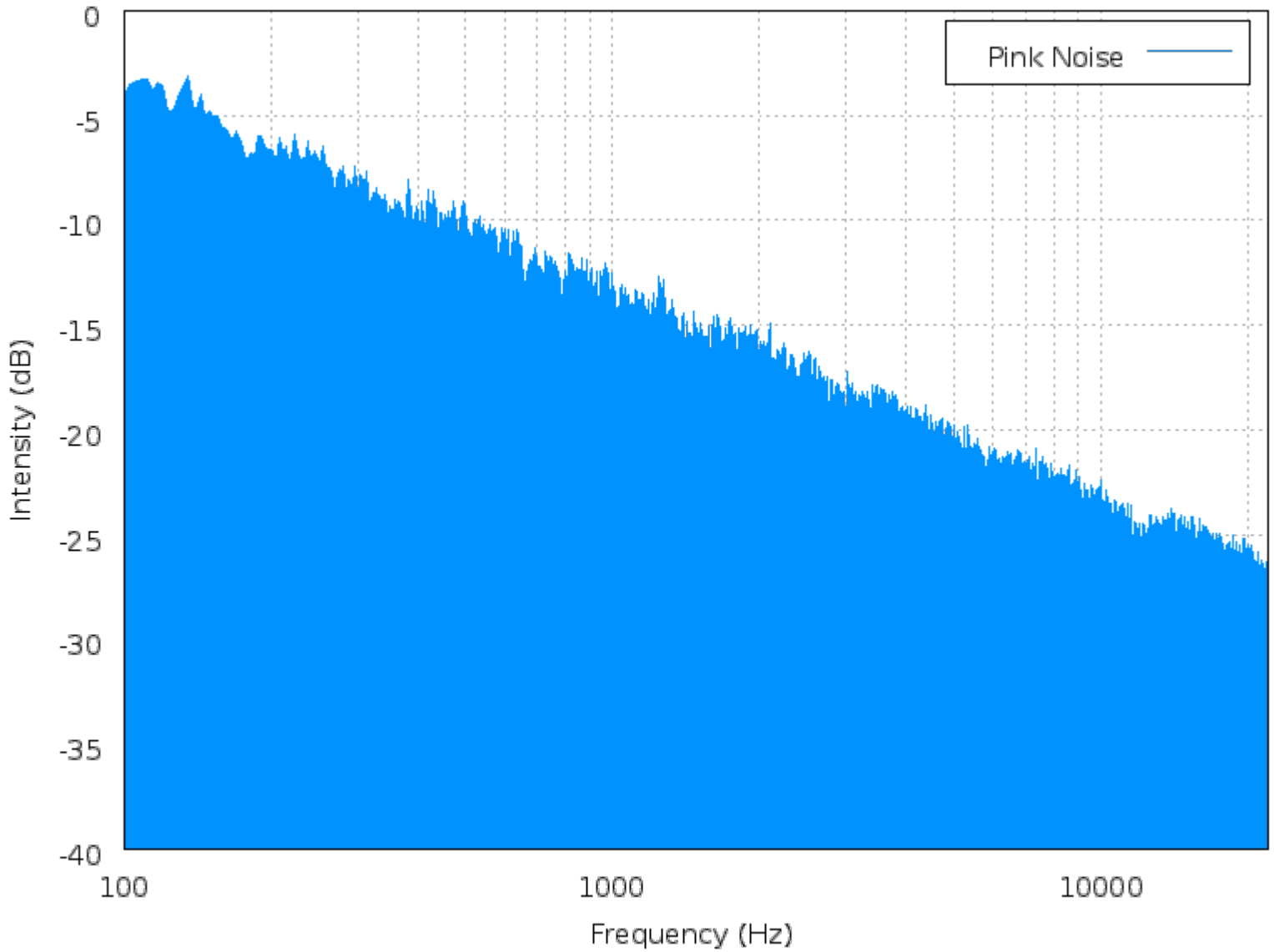
Pink Noise, White Noise

- White Noise
- Pink Noise

$$s(f) \sim 1/f^{\alpha}$$


O


White Noise
0
-5
-10
-15
-20
-25
-30
-35
-40
Intensity (dB)
100
1000
10000
Frequency (Hz)


Pink Noise
0
-5
-10
-15
-20
-25
-30
-35
-40
Intensity (dB)
100
1000
10000
Frequency (Hz)

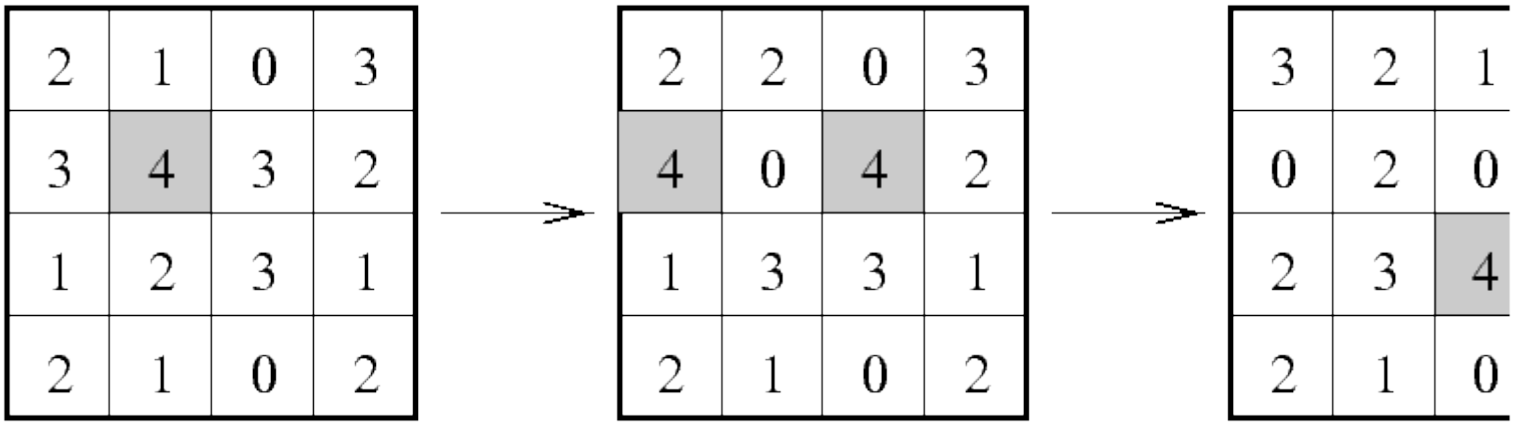
SOC, Driven Depinning

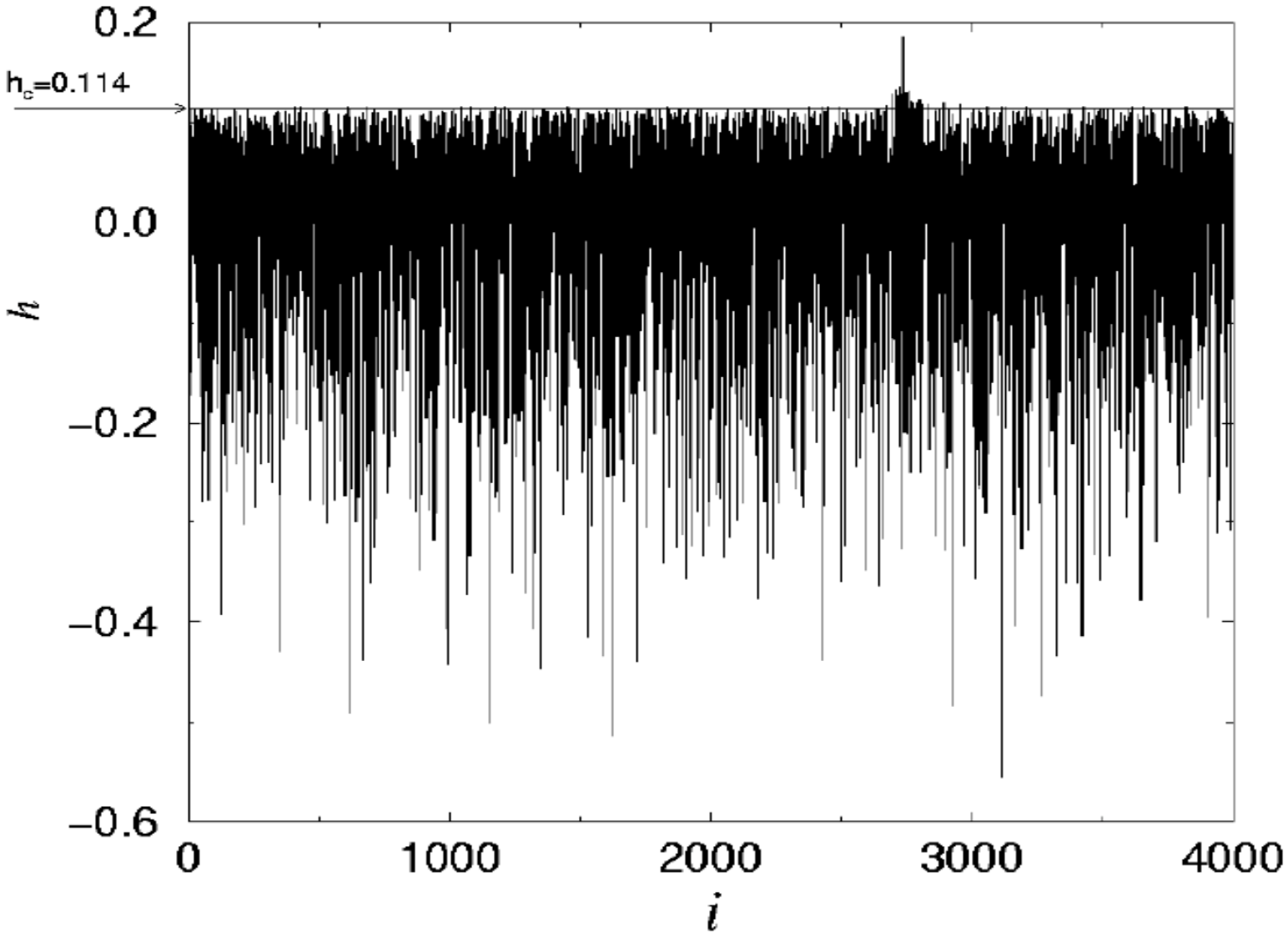
- Dry Friction
- Domain Wall
- Phase Transition

…

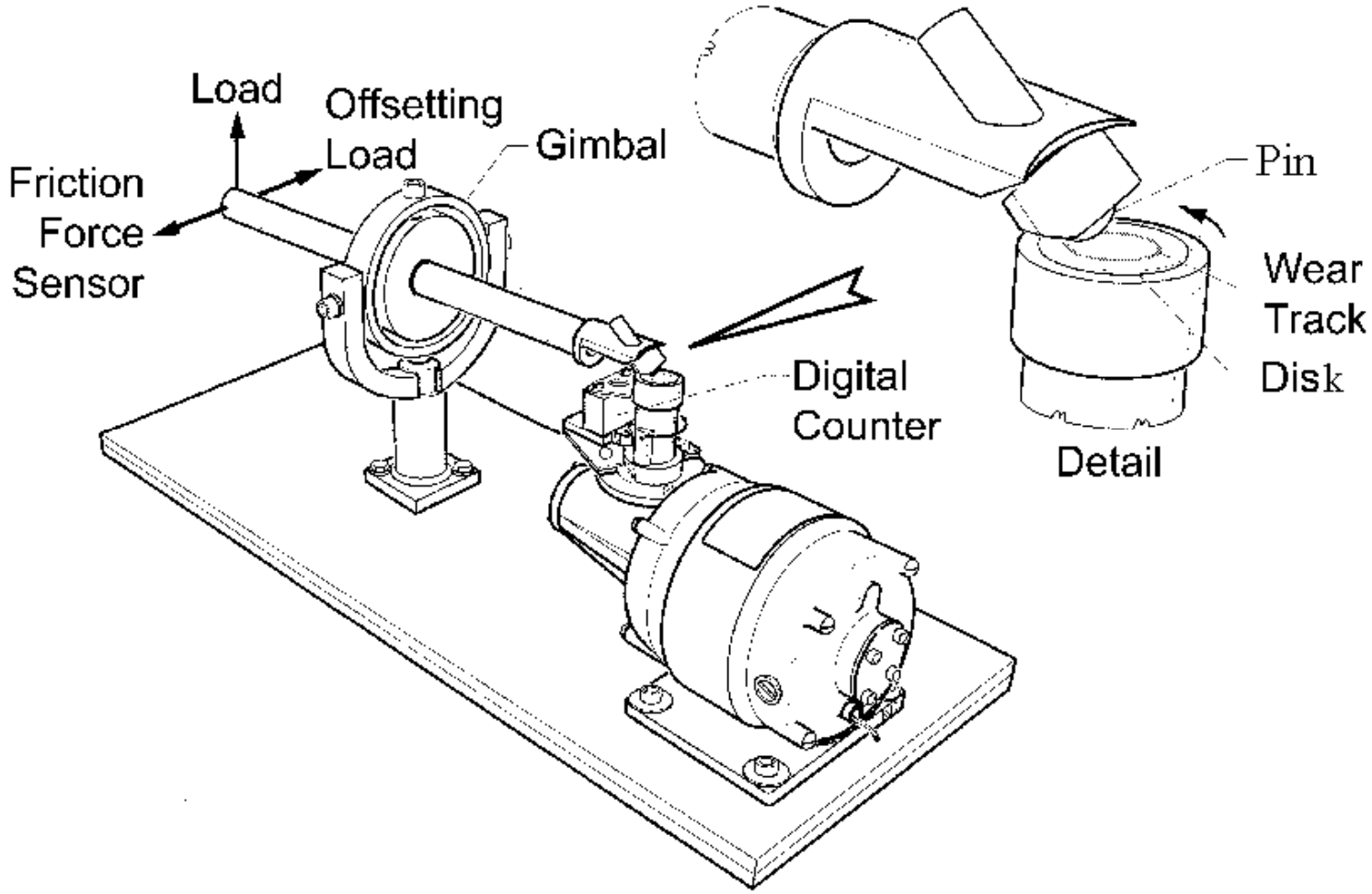
- Sandpile Model
- Robin Hood Model

Sandpile Model

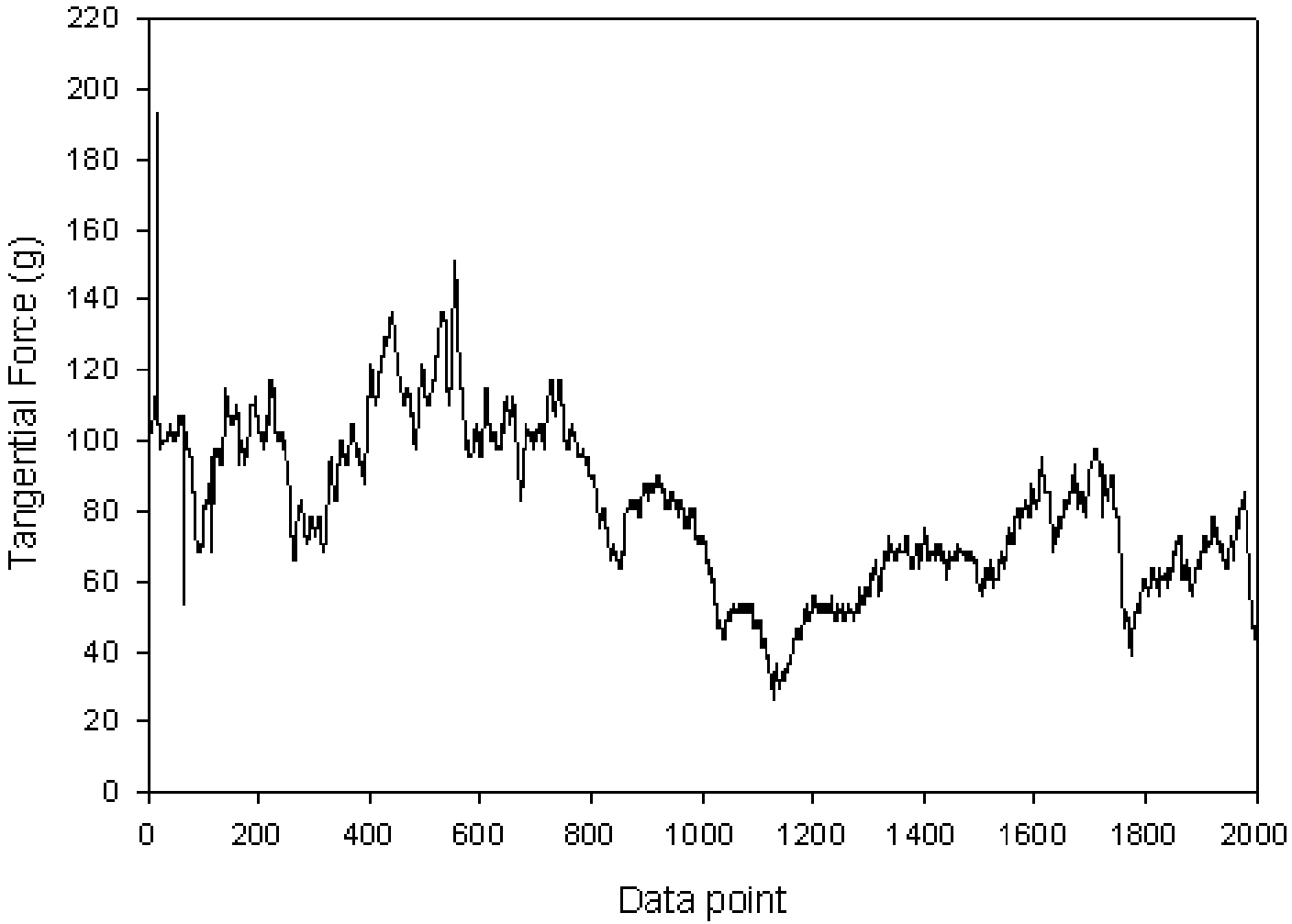


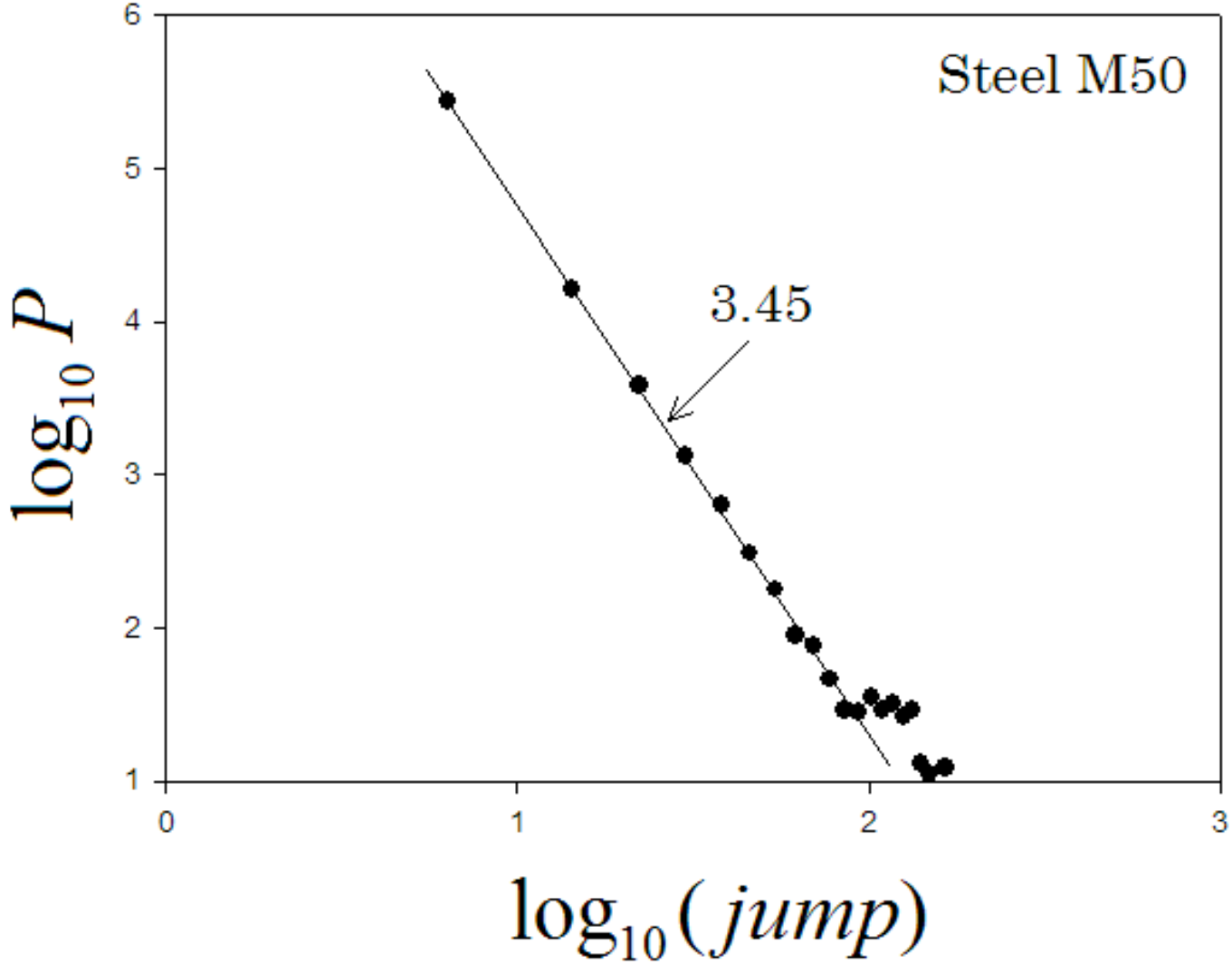

0.2
h_c=0.114
0.0
−0.2
−0.4
−0.6
h
0
1000
2000
3000
4000
i

Dry Friction



Tangential Force




Steel M50
3.45
$\log_{10} P$
$\log_{10}(jump)$
6
5
4
3
2
1
0
1
2
3

Reference

- **Bak P, 1996, How nature works : the science of self-organized criticality.** New York, NY, USA : Copernicus, c1996

- Buldyrev SV, Ferrante J, Zypman FR, **2005, Dry Friction Avalanches: Experiment and Robin Hood model. Condensed Matter,** 0511037.