

Statistical properties of acoustic emission controlled tensile experiments on paper

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Objective

The aim was to determine which statistical properties a specific loading method changes. Motivation for using this method was increase in stability of fracture propagation.

Experimental methods

350 paper samples with an small initial crack were stressed in a tensile testing machine and acoustic activity in the samples was captured with a piezoelectric transducer.

Acoustic emission control

By controlling the strain rate $\dot{\epsilon}$ according to the acoustic activity arising from microfractures in the sample the fracture propagation was greatly stabilized.

Power-law distributions

Energy (E) and waiting time (τ) distributions of events are known [1, 2] to follow power-laws

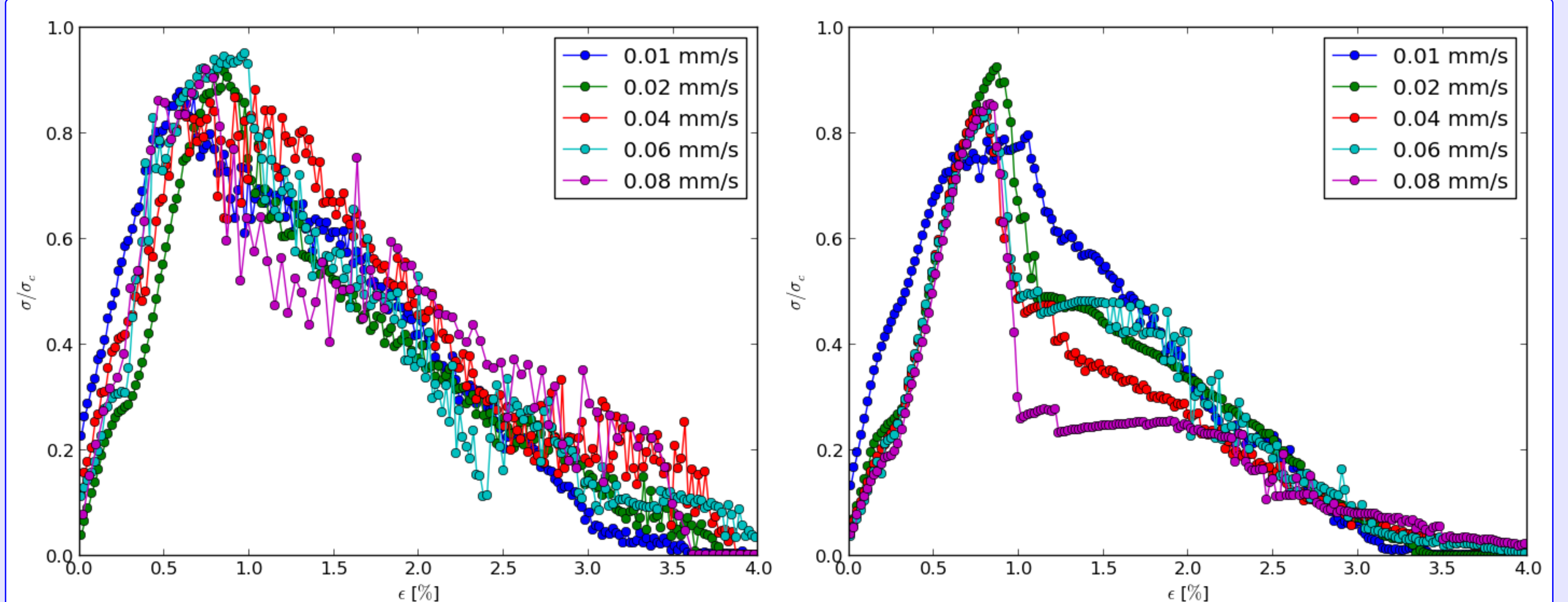
$$P(E) \propto E^{-\beta}$$

$$P(\tau) \propto \tau^{-\gamma}.$$

Conclusions

The probability distributions follow the power-laws relatively well and stress-strain curves show no clear changes in mechanical properties. Therefore the method only changes the waiting time distribution.

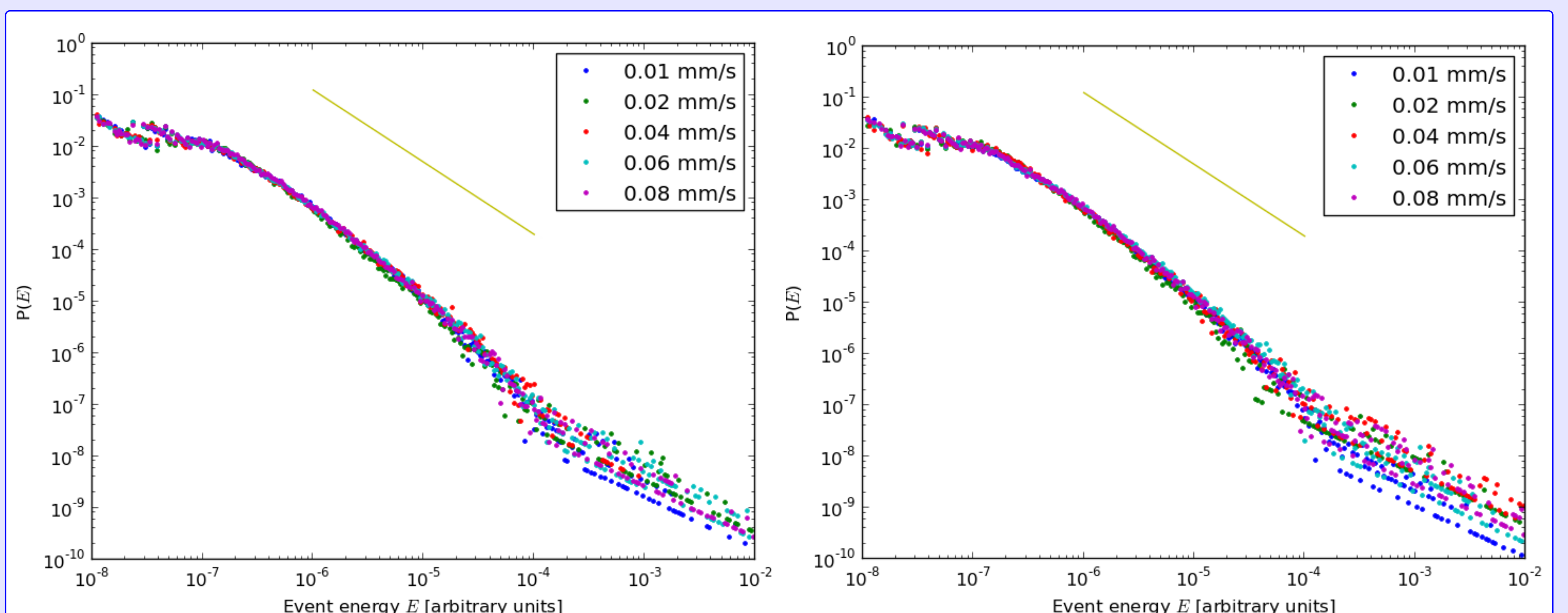
Stress-strain curves



Average stress-strain curves, left one AE-controlled, right one uncontrolled.

Curves look roughly the same, the drop in uncontrolled curves due to the larger number of samples breaking rapidly after the maximum stress.

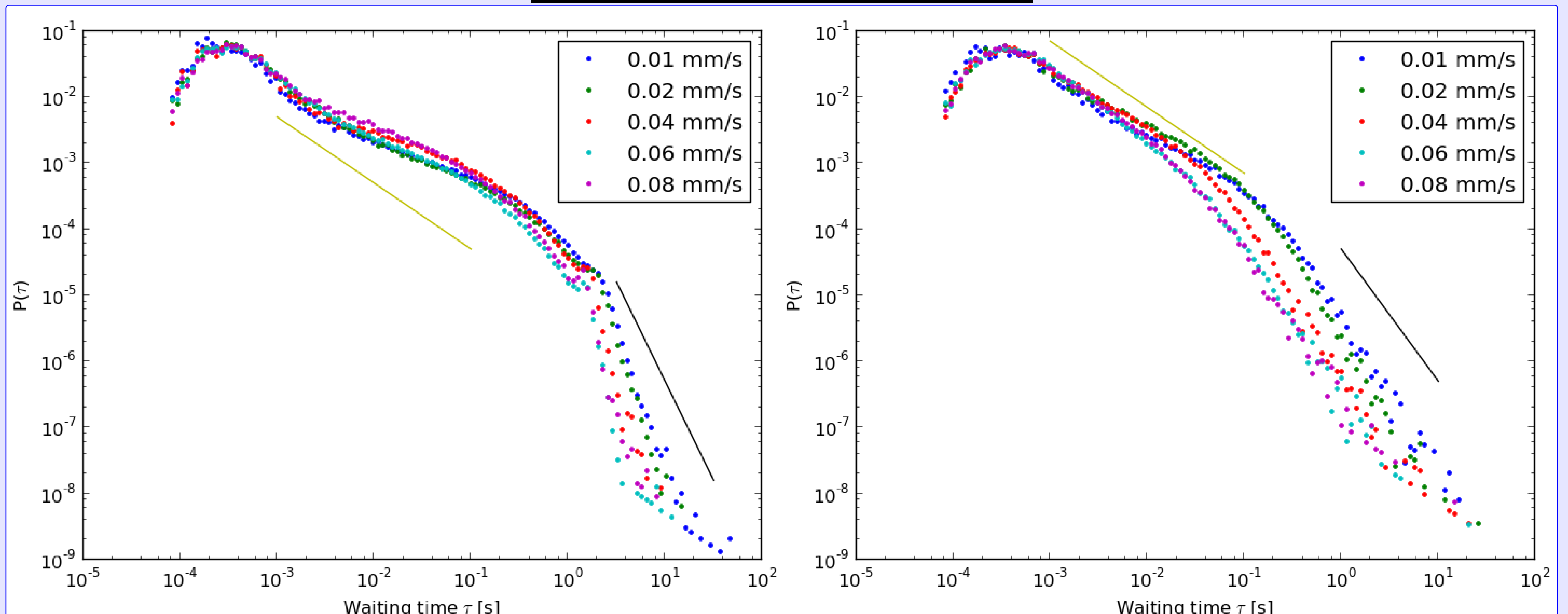
Energy distributions



Event energy distributions, left one AE-controlled, right one uncontrolled.

No change in energy distributions between different experiments.

Waiting time distributions



Waiting time distributions, left one AE-controlled, right one uncontrolled.

The control changes the shape of the distribution slightly but the mechanism of the change is not clear.

[1] E. Pursiainen, *Akustiseen emissioon perustuva ohjaus paperin rasiuskokeissa*, Aalto University School of Science, Bachelor's thesis (2011).

[2] J. Rosti, J. Koivisto, M.J. Alava, *Statistics of acoustic emission in paper fracture: precursors and criticality*, J. Stat. Mech. P02016 (2010).