1. Why do we want to test the fluctuation relation?

We want to obtain information on the invariant measure (ECM93, GC95)
(for this reason deterministic systems were chosen – masochistically)

Transient fluctuation relations (ES94, Jarzinski) hold in much more generality. They give no information on the system (but have interesting applications).

cond-mat/0612019

1. Why do we want to test the fluctuation relation?

We want to obtain information on the invariant measure (ECM93, GC95)
(for this reason deterministic systems were chosen – masochistically)

Transient fluctuation relations (ES94, Jarzinski) hold in much more generality. They give no information on the system (but have interesting applications).

2. Is it possible that the FR seems to hold even if it does not?

Yes it is. One should be VERY careful when testing the FR

cond-mat/0612019

1. Why do we want to test the fluctuation relation?

We want to obtain information on the invariant measure (ECM93, GC95)
(for this reason deterministic systems were chosen – masochistically)

Transient fluctuation relations (ES94, Jarzinski) hold in much more generality. They give no information on the system (but have interesting applications).

2. Is it possible that the FR seems to hold even if it does not?

Yes it is. One should be VERY careful when testing the FR

3. Can the FR hold for irreversible models?

Not globally. But can hold *locally*, if the irreversible model can be thought to be equivalent to a reversible model.

cond-mat/0612019

1. Why do we want to test the fluctuation relation?

We want to obtain information on the invariant measure (ECM93, GC95)
(for this reason deterministic systems were chosen – masochistically)

Transient fluctuation relations (ES94, Jarzinski) hold in much more generality. They give no information on the system (but have interesting applications).

2. Is it possible that the FR seems to hold even if it does not?

Yes it is. One should be VERY careful when testing the FR

3. Can the FR hold for irreversible models?

Not globally. But can hold *locally*, if the irreversible model can be thought to be equivalent to a reversible model.

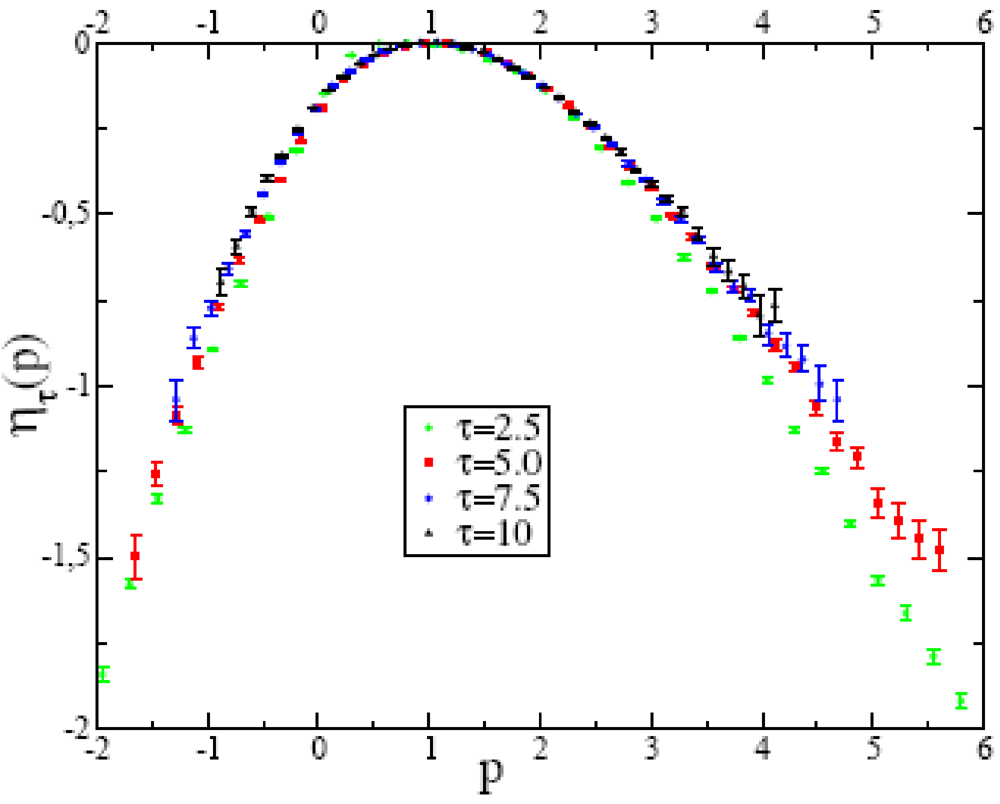
4. Is it possible to measure the phase space contraction rate?

One should distinguish between the experimental system and the model.

If different models are equivalent, then one can try to identify the PSCR of one of them with a measurable quantity.

If not, it is a disaster (the result of the experiment depends on all the details of the experimental setup).

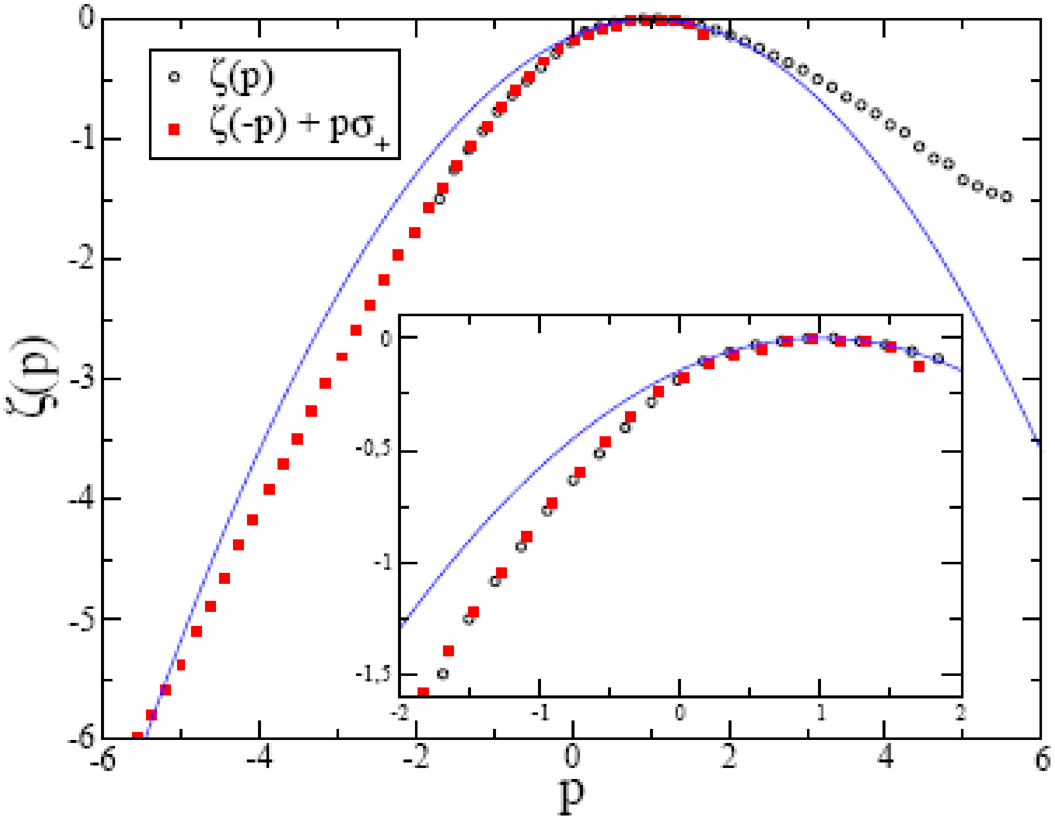
cond-mat/0612019



1. Plot the large deviation function
2. For asymmetric distribution shift the maximum in p=1
3. Search for an interval of p where it does not depend on τ
4. The interval must contain the origin
   - τ not too large
   - small forcing
   - small system size

$\tau \gg \tau_0 = 0.1$

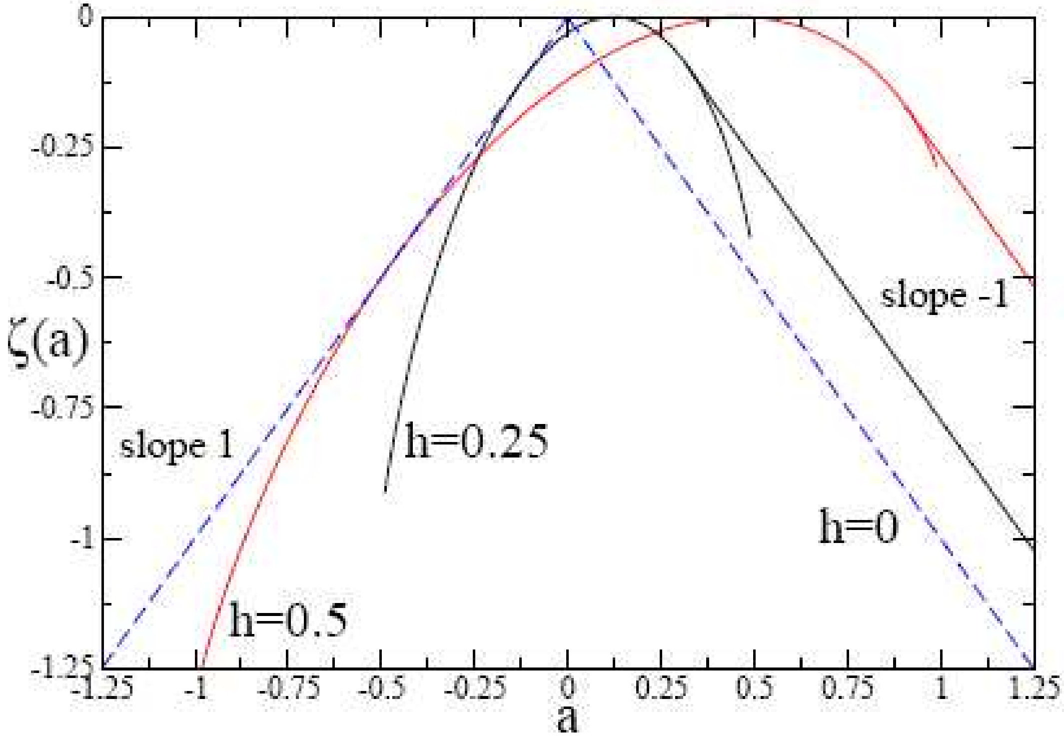
cond-mat/0612019



$\tau = 5.0$

1. Plot the large deviation function
2. For asymmetric distribution shift the maximum in p=1
3. Search for an interval of p where it does not depend on τ
4. The interval must contain the origin
   - τ not too large
   - small forcing
   - small system size
5. Observable difference w.r.t. a Gaussian around p=0 (otherwise linear response)
   - large forcing
   - low temperature
6. Check the slope (linearity might be due to the small interval)

cond-mat/0612019



In presence of singularities:

- Non-convex LDF
- Large tails (e.g. exponentials)

FR is for smooth and bounded (maps)

- Fix a set of timing events
  - particle collision
  - V(t) = Vo
  - W(t) = Wo
- Integrate between two timing events
- Check consistency by recomputing the original LDF

cond-mat/0612019

Equivalence between reversible – irreversible thermostats

$$m\dot{q}_i = p_i \ ,$$
$$\dot{p}_i = -\partial_{q_i} V(q) + F_i(q) - \alpha(p,q) p_i \ .$$

Equivalent irreversible model:

$$\nu(E) = \langle \alpha(p,q) \rangle_E = \int dp dq \, \mu_E(p,q) \alpha(p,q)$$

Very different fluctuations of α in the two systems -- *global quantity*
(e.g. energy in canonical-microcanonical)

cond-mat/0612019

Equivalence between reversible – irreversible thermostats

$$m\dot{q}_i = p_i \ ,$$
$$\dot{p}_i = -\partial_{q_i} V(q) + F_i(q) - \alpha(p,q) p_i \ .$$

Equivalent irreversible model:

$$\nu(E) = \langle \alpha(p,q) \rangle_E = \int dpdq \, \mu_E(p,q) \alpha(p,q)$$

Very different fluctuations of α in the two systems -- *global quantity*
(e.g. energy in canonical-microcanonical)

Equivalence of *local* observables:

$$\lim_{N,V\to\infty\,,\,\rho=N/V} \langle O_{V_0}(p,q) \rangle_{\nu(E)} = \lim_{N,V\to\infty\,,\,\rho=N/V} \langle O_{V_0}(p,q) \rangle_E$$

Local entropy production rate might satisfy a local fluctuation relation!
(completely open problem)

- Very important for the interpretation of experiments
- What is the time scale needed to observe reversibility?

cond-mat/0612019

If the fluctuation relation does not hold due to irreversibility still the chaotic hypothesis might hold.

It would be very interesting to derive from the SRB measure other measurable relations not explicitly dependent on reversibility.

A very nice historical review: G.Gallavotti, cond-mat/0606477