

# **STOCHASTIC THERMODYNAMICS OF COMPLEX SYSTEMS**

## **ONLINE CSH WORKSHOP**

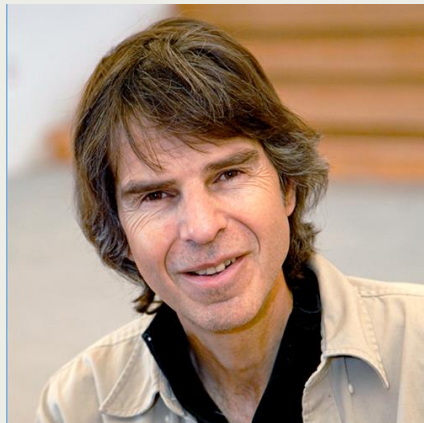
May 27 – May 29, 2020

# STOCHASTIC THERMODYNAMICS OF COMPLEX SYSTEMS

## ONLINE CSH WORKSHOP

May 27 – May 29, 2020

### Workshop organizers



**David Wolpert**



**Jan Korbelt**

### Host institution



# STOCHASTIC THERMODYNAMICS OF COMPLEX SYSTEMS

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### Workshop Genesis

Small workshop (ca 20 participants)

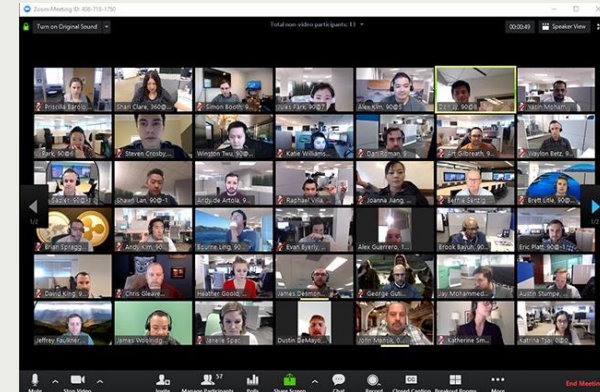


Palais Strozzi, CSH Vienna

COVID 19



Online workshop (ca 100 participants)



# STOCHASTIC THERMODYNAMICS OF COMPLEX SYSTEMS

## ONLINE CSH WORKSHOP

Workshop description & Main aims

**Stochastic thermodynamics:** *powerful tool for non-equilibrium thermodynamics of small systems*

### Main results

$$\frac{p(\bar{\Sigma}_t = A)}{p(\bar{\Sigma}_t = -A)} = e^{At}$$

**Fluctuation theorems**

$$\frac{\text{Var}(J_\tau)}{\langle J_\tau \rangle^2} \geq \frac{2k_B}{\bar{\Sigma}_t}$$

**Thermodynamic uncertainty relations**

$$\frac{L(p(0), p(\tau))^2}{2\Sigma_\tau \bar{A}_\tau^2} \leq \tau$$

**Speed limits**

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### Typical assumptions

**Linear Markovian dynamics**

$$\dot{p}_m(t) = \sum_n W_{mn}(t)p_n(t)$$

**No constraints on rate matrices**

$$W_{mn}(t) \text{ arbitrary (up to requirement of LDB)}$$

**Arbitrary work protocols**

$$E(t) \text{ arbitrary}$$

**Infinite heat bath(s)**

$$p_m^{\nu,*} = \frac{1}{Z} \exp(-\beta^\nu \epsilon_m)$$

**Local detailed balance (LDB)**

$$\frac{W_{mn}^\nu}{W_{nm}^\nu} = \frac{p_m^{\nu,*}}{p_n^{\nu,*}} = \exp(-\beta^\nu (\epsilon_m - \epsilon_n))$$

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Main question of the workshop:

*How does stochastic thermodynamics  
- especially the FT, TUR, SL, etc. -  
change if these assumptions do not hold?*

Some preliminary answers are known.  
Most questions remain unresolved.

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## ONLINE CSH WORKSHOP

Workshop website: <https://www.csh.ac.at/event/csh-workshop-stochastic-thermodynamics-complex-systems/>



### You can find here:

- Updated agenda
- Presentation files

# STOCHASTIC THERMODYNAMICS OF COMPLEX SYSTEMS

## ONLINE CSH WORKSHOP

### Sessions

- Title of each session describes the session's main focus.
- Due to the time zone restrictions, not all talks in a session match the session's title.
- Each session has a session chair who moderates the session

### Structure of a session

- Opening remarks by the chair
- 3-4 talks followed by Q&A
- Discussion on the topic of the session



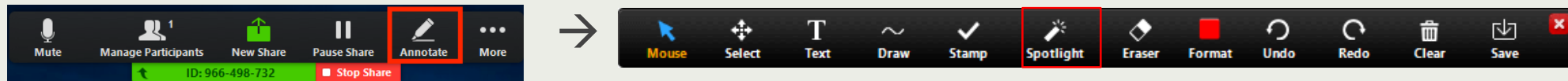
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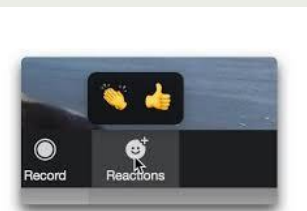
### Talks

- 20 minutes long
- No questions during the talk. Please make sure all chat is *private*.

**Tip for presenters:** laser pointer in Zoom



**Tip:** you can use the virtual applause after a talk

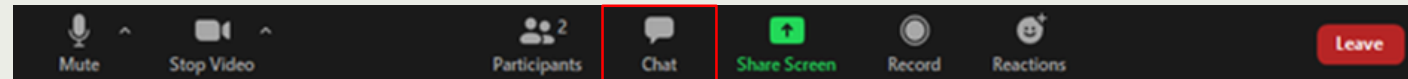


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### Q&A

- 10 minute long
- You can ask a question in chat
- Session chair will unmute you and you can ask and/or specify your question
- Q&A can continue in the *private* chat with the speaker

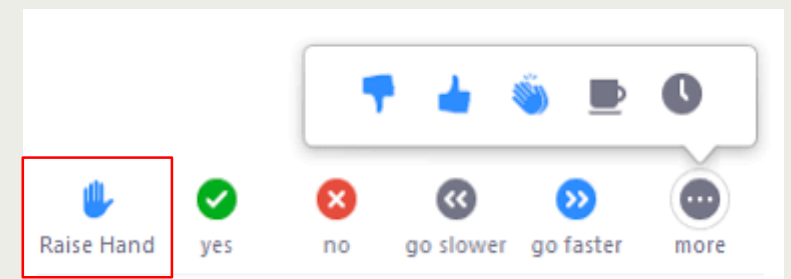
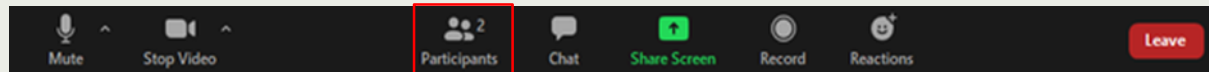


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### Discussion session

- At the end of each session
- Moderated by the session chair
- To contribute to the discussion raise your virtual hand



- Session chair will ask you to speak and unmute your microphone