

# Transition to chaos in an acoustic-driven cavity flow.

**Gaby Launay**<sup>1</sup>, Daniel Henry<sup>2</sup>, Alban Potherat<sup>3</sup>, Valéry Botton<sup>1</sup>

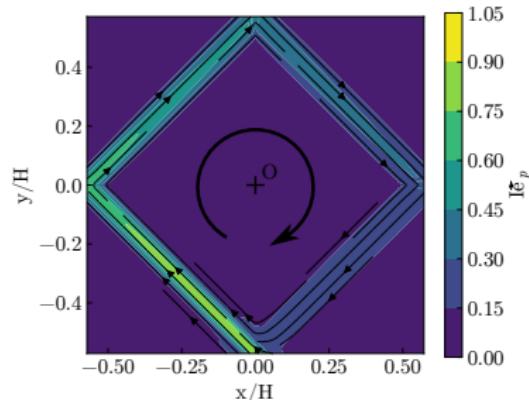
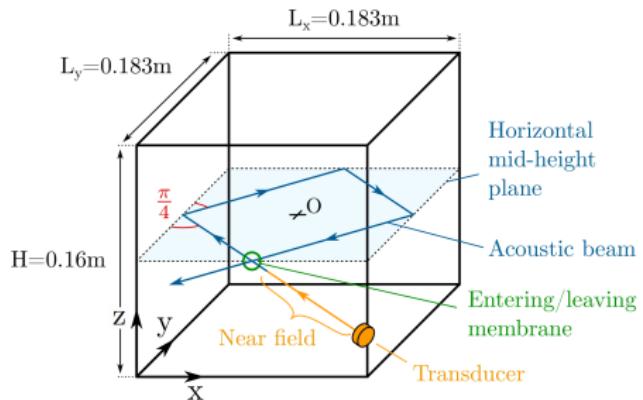
<sup>1</sup>: Lyon University, LMFA

<sup>2</sup>: CNRS, LMFA

<sup>3</sup>: Coventry University

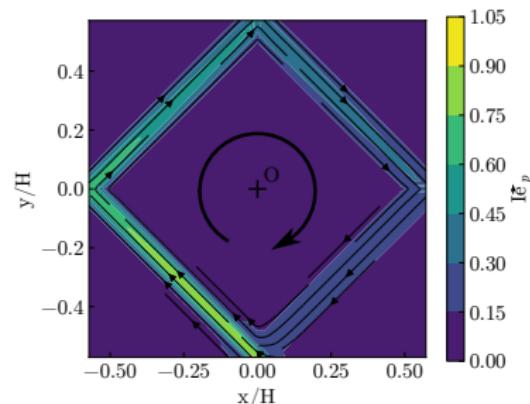
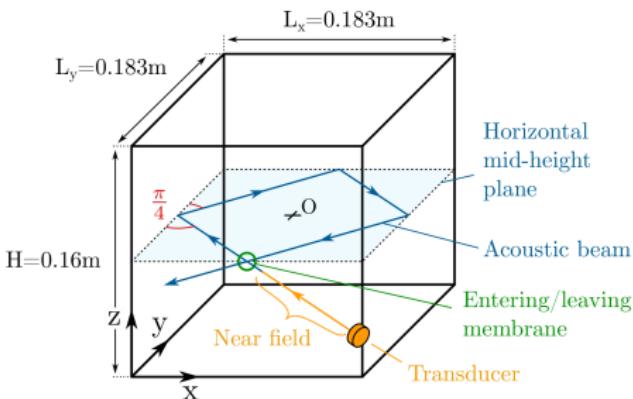


# Introduction



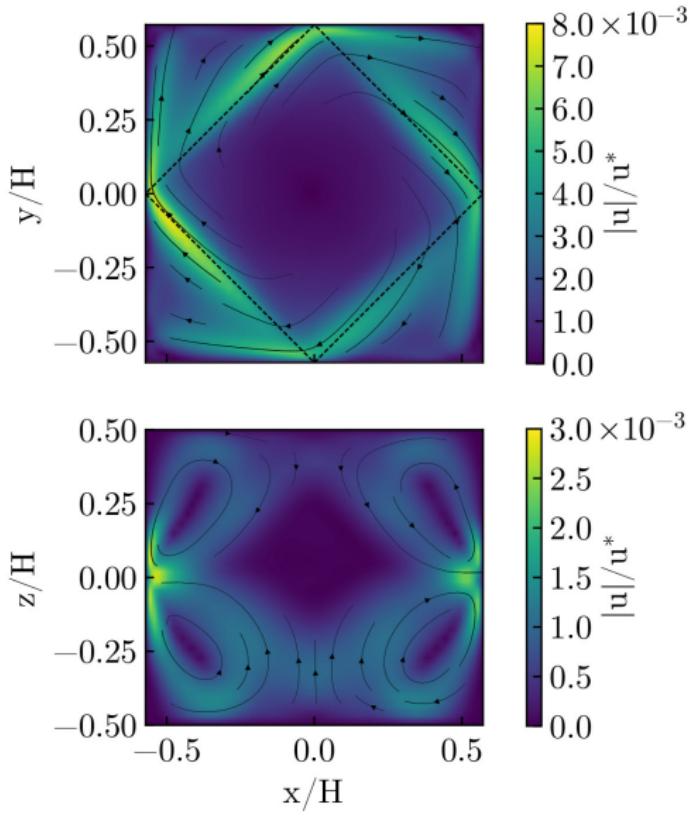
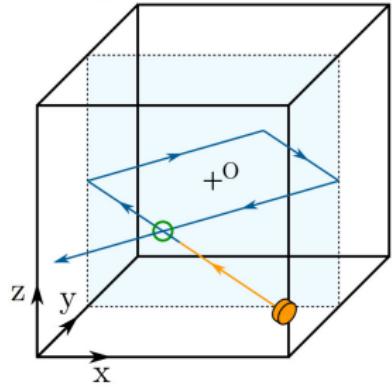
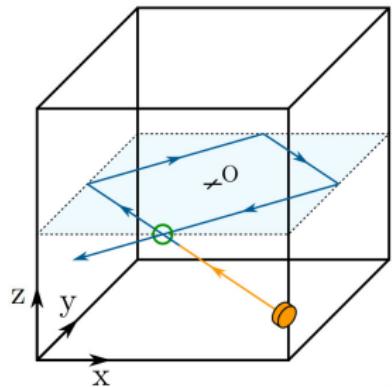
- Objectives
  - Characterization of the transition to chaos with increasing acoustic forcing
- Experimental campaign (Camberie et al., 2017)
- Numerical simulations
- Acoustic beam from Blackstock, 2000

- Numerical simulations
  - Spectral finite element code
  - Two elements in each directions (42 points)
  - No-slip boundary conditions
- Acoustic forcing:  $A \in [0.1, 8]$
- Reynolds:  $Re_H \in [80, 3000]$



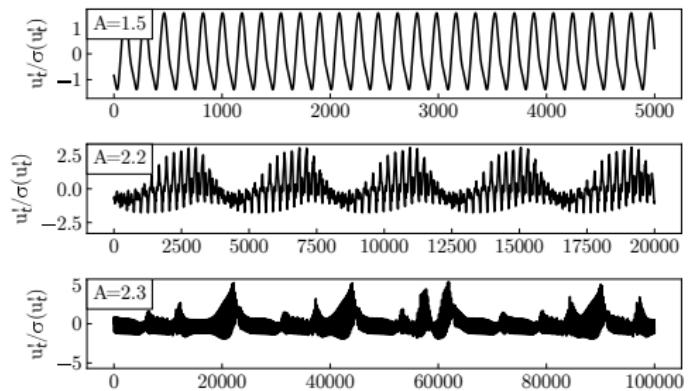
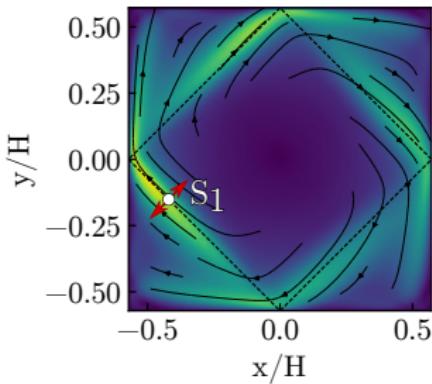
# Flow overview

## Mean flow



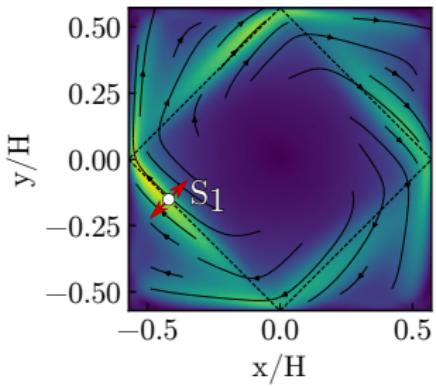
# Flow overview

## Velocity time-series

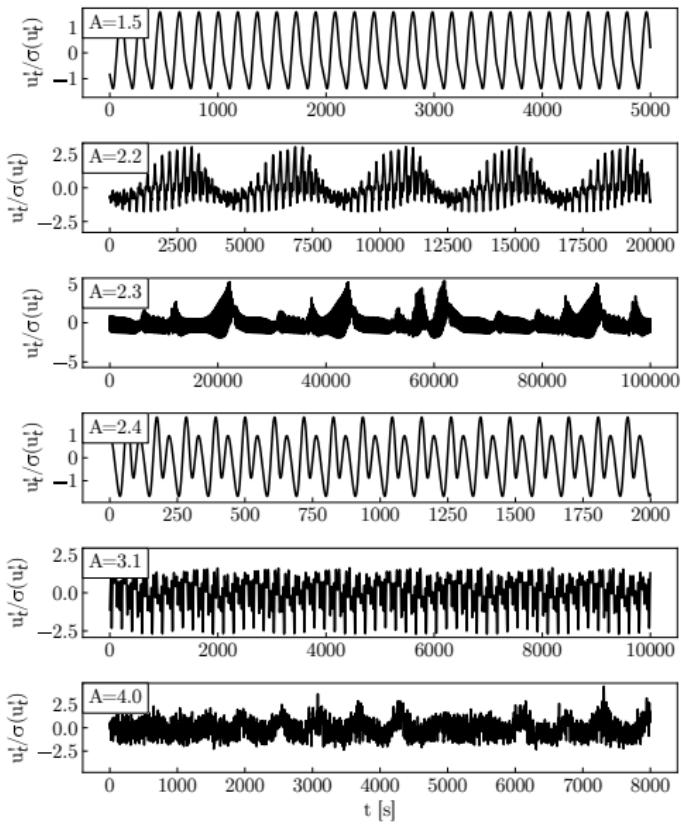


# Flow overview

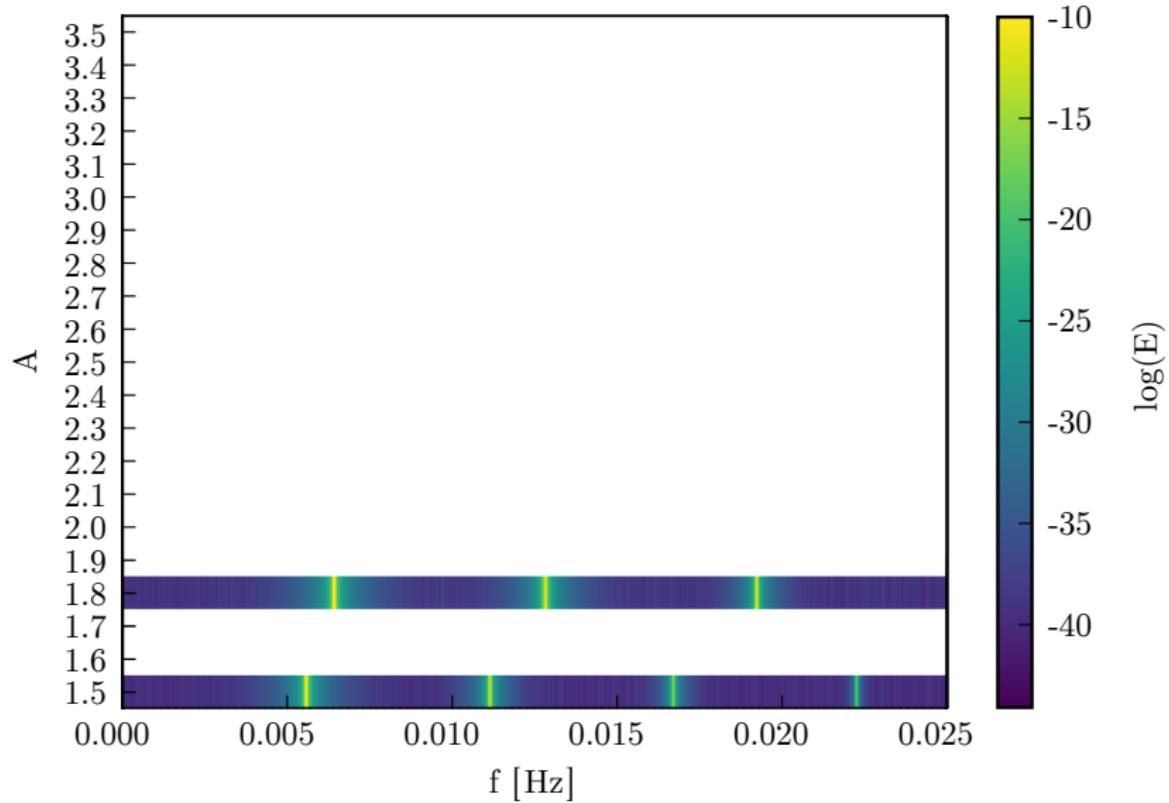
## Velocity time-series



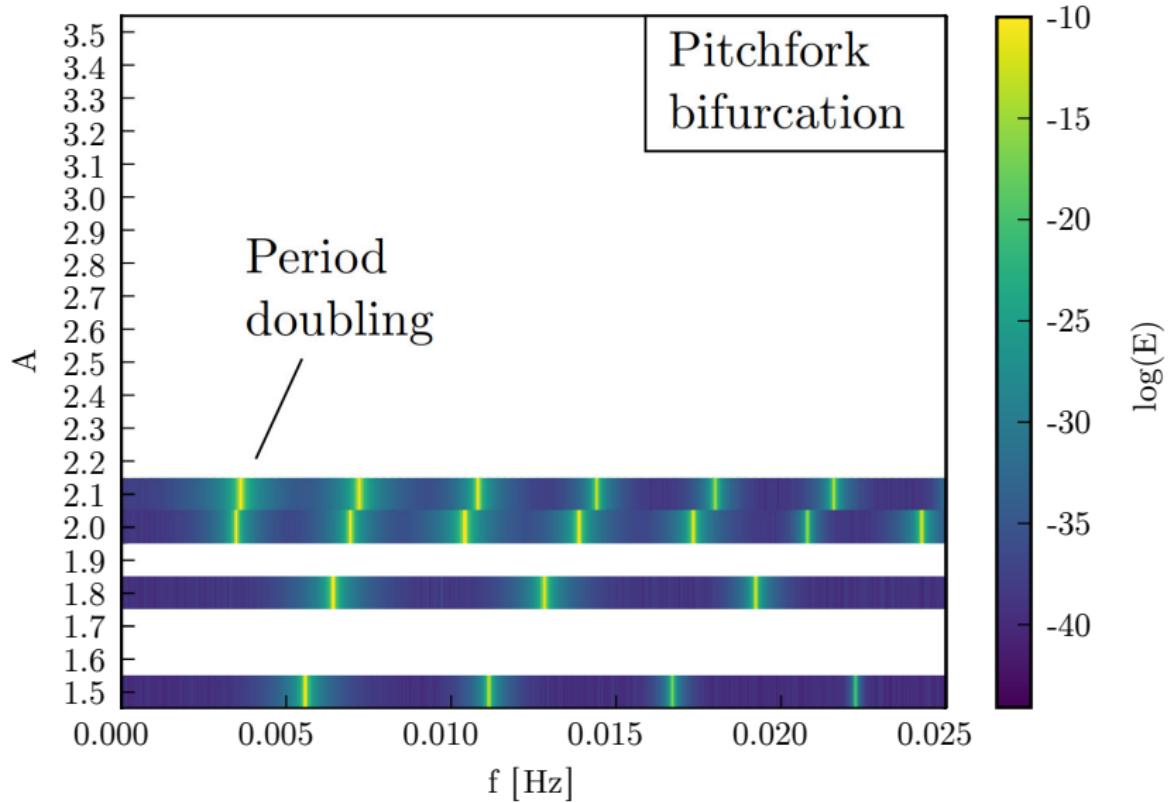
- Two transitions
- Simplification between  $A = 2.3$  and  $2.4$



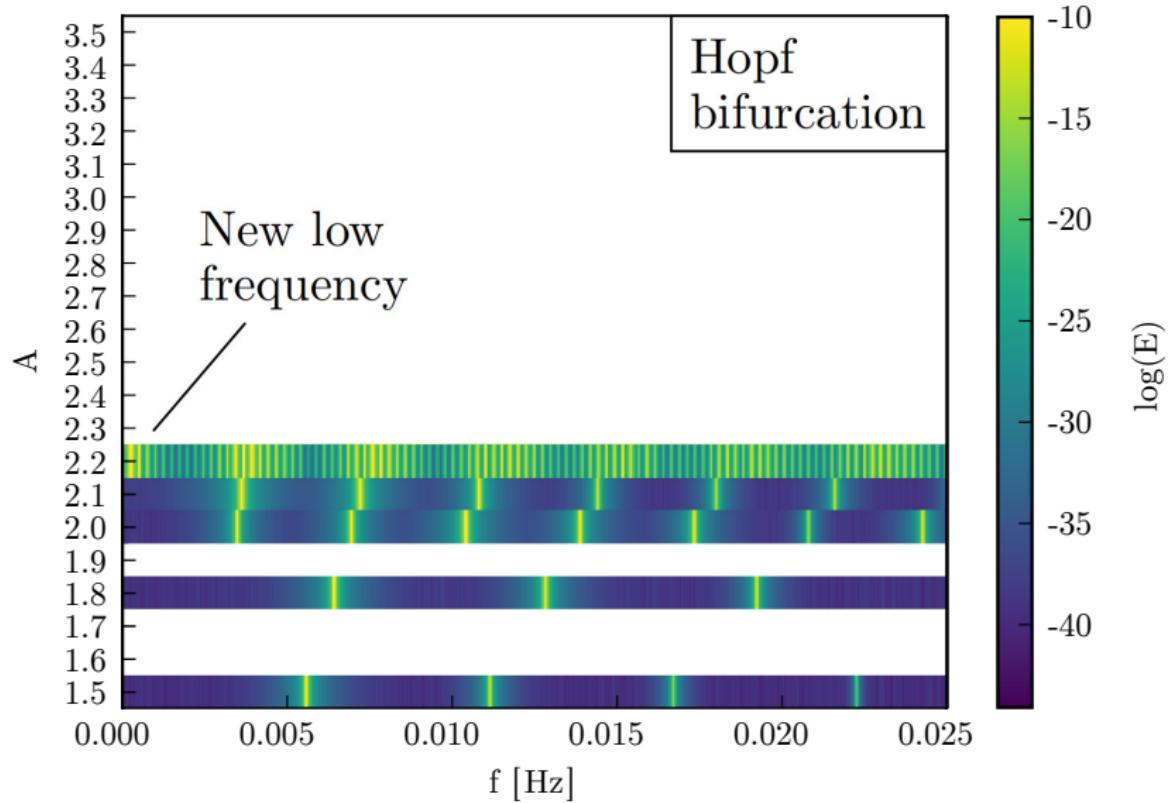
# Transition to chaos scenario



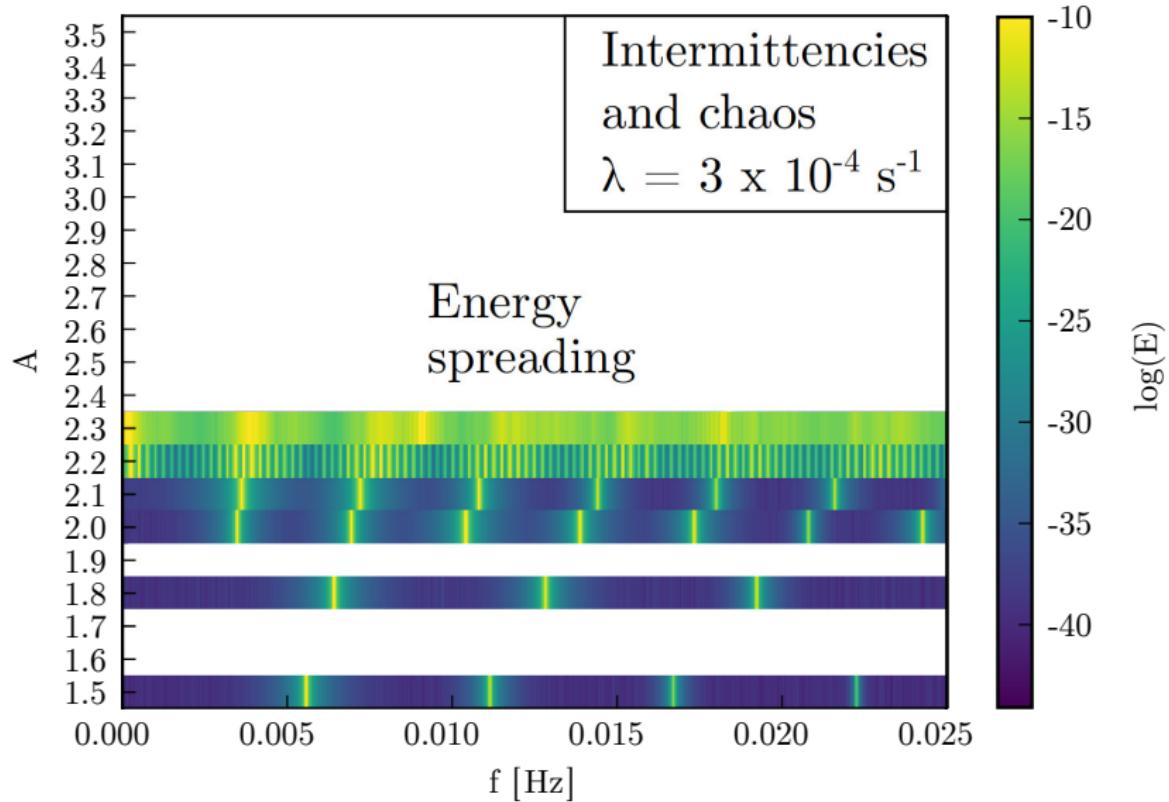
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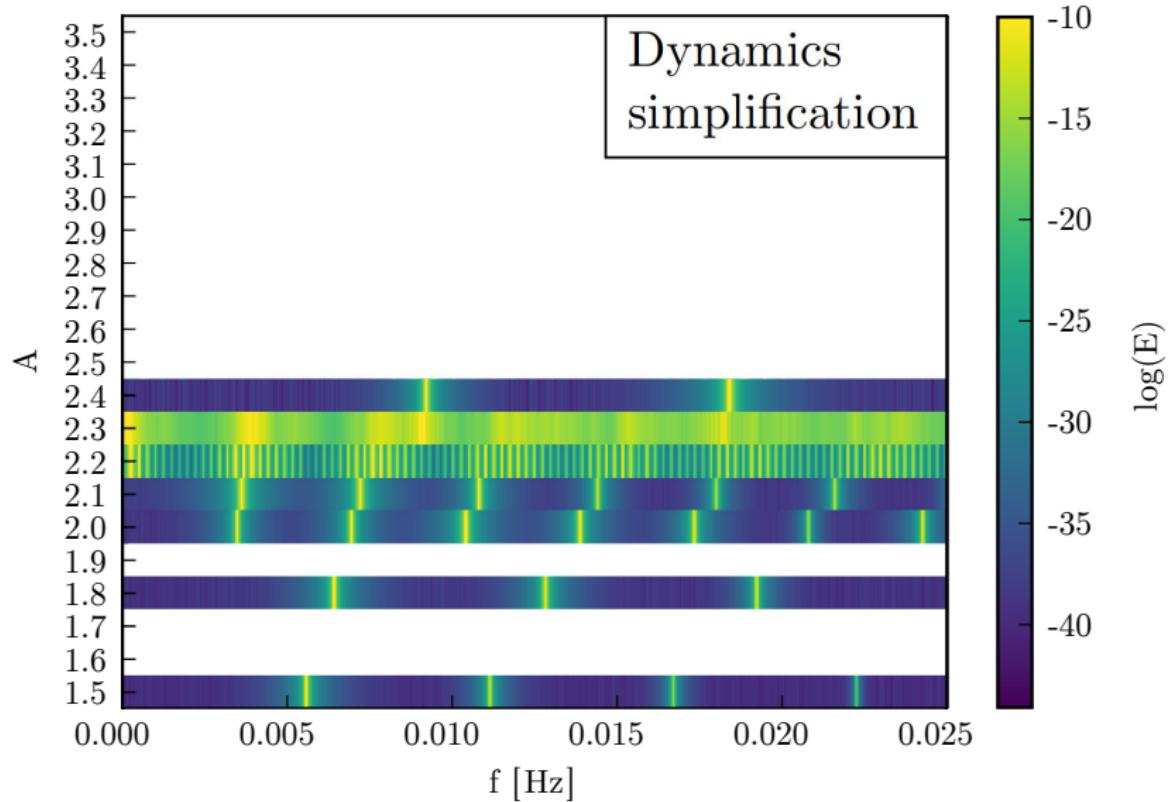
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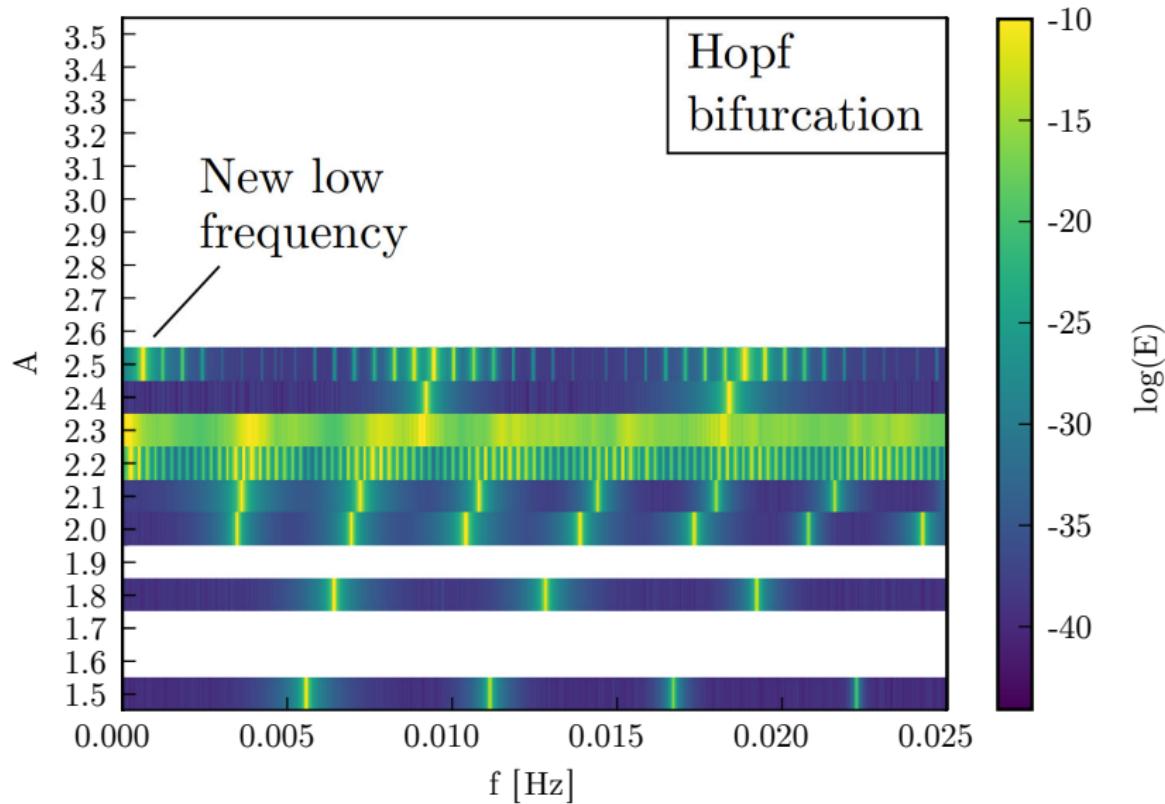
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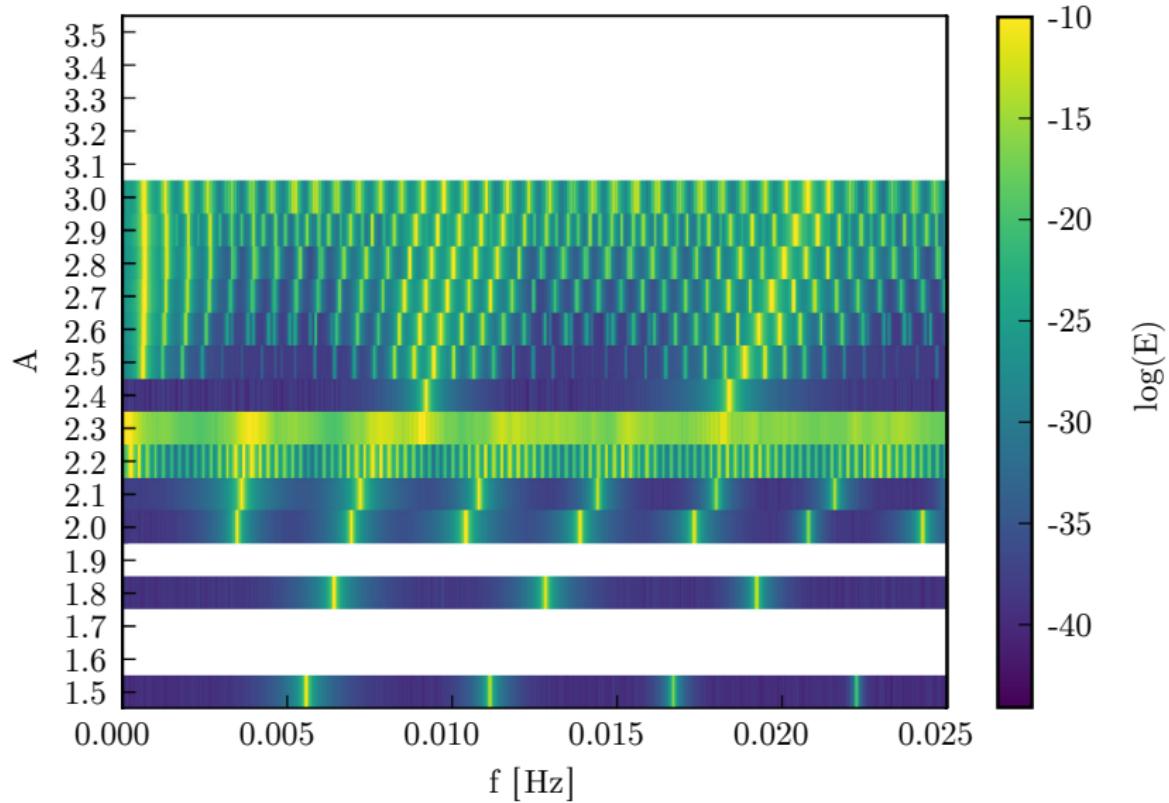
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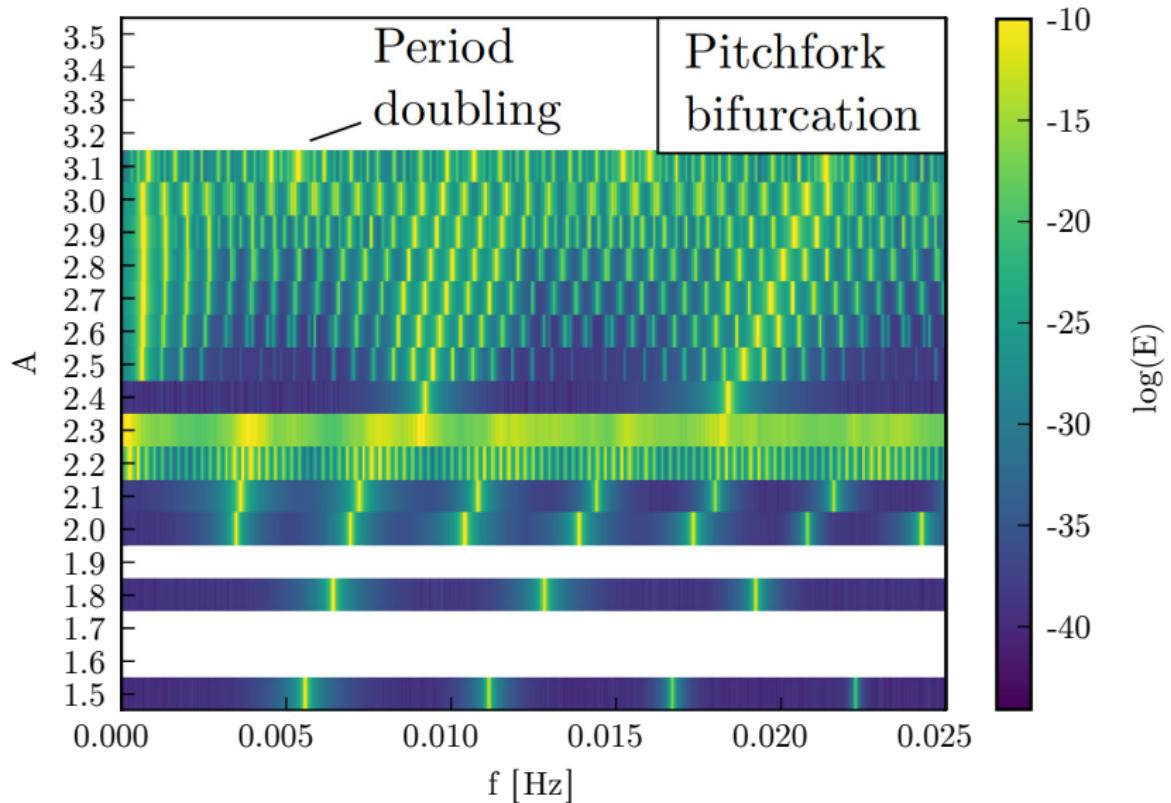
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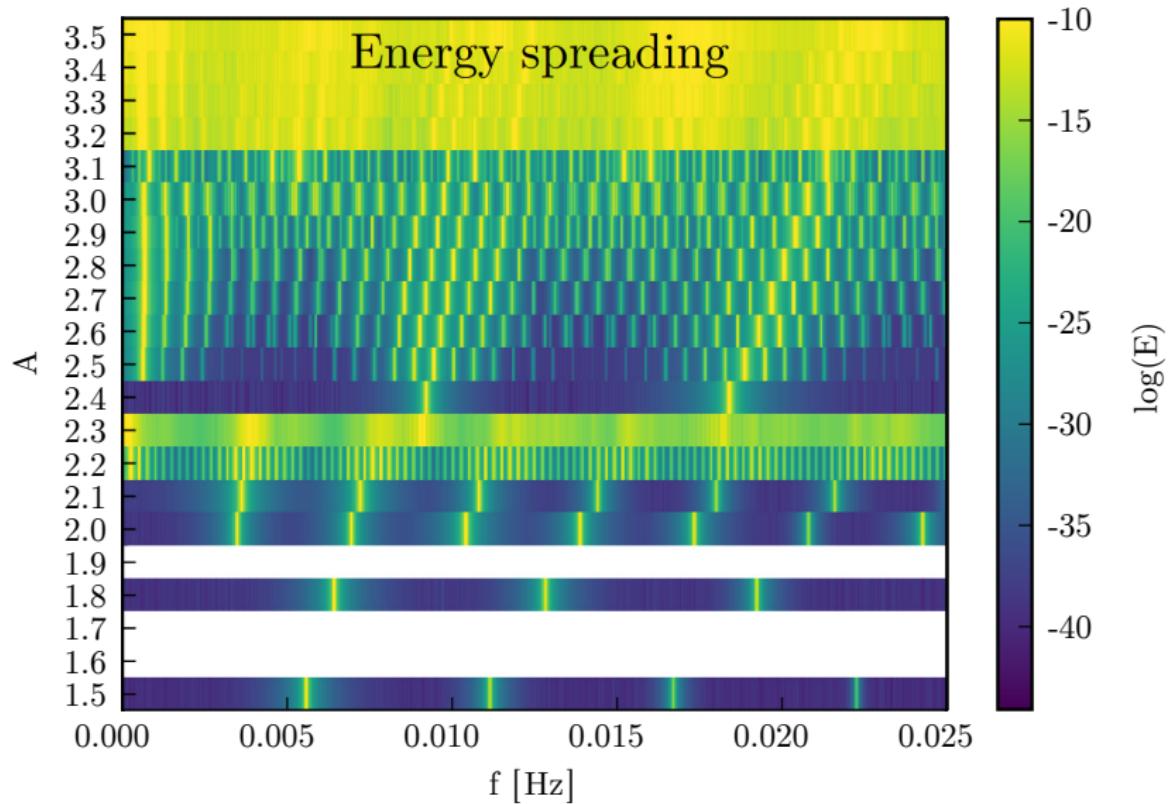
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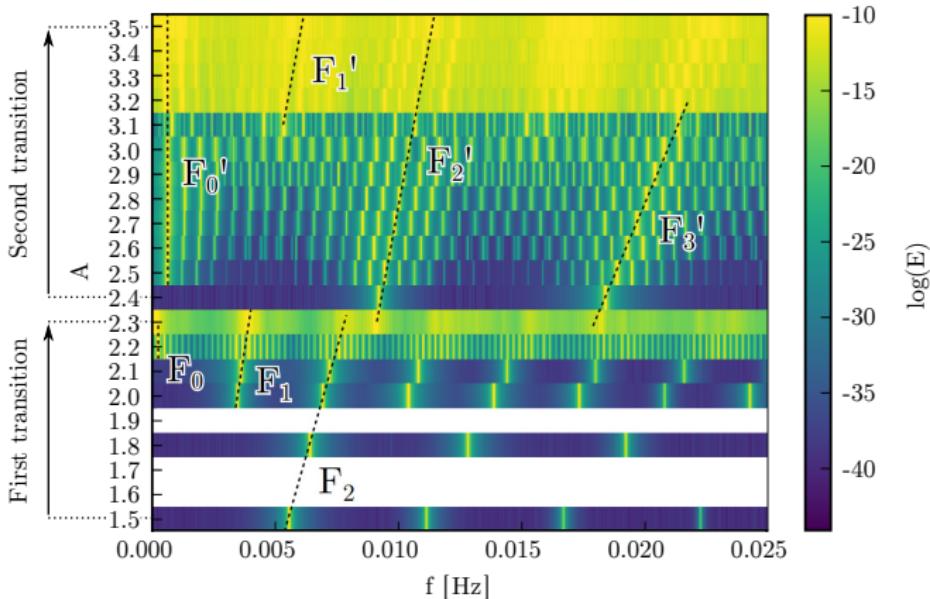
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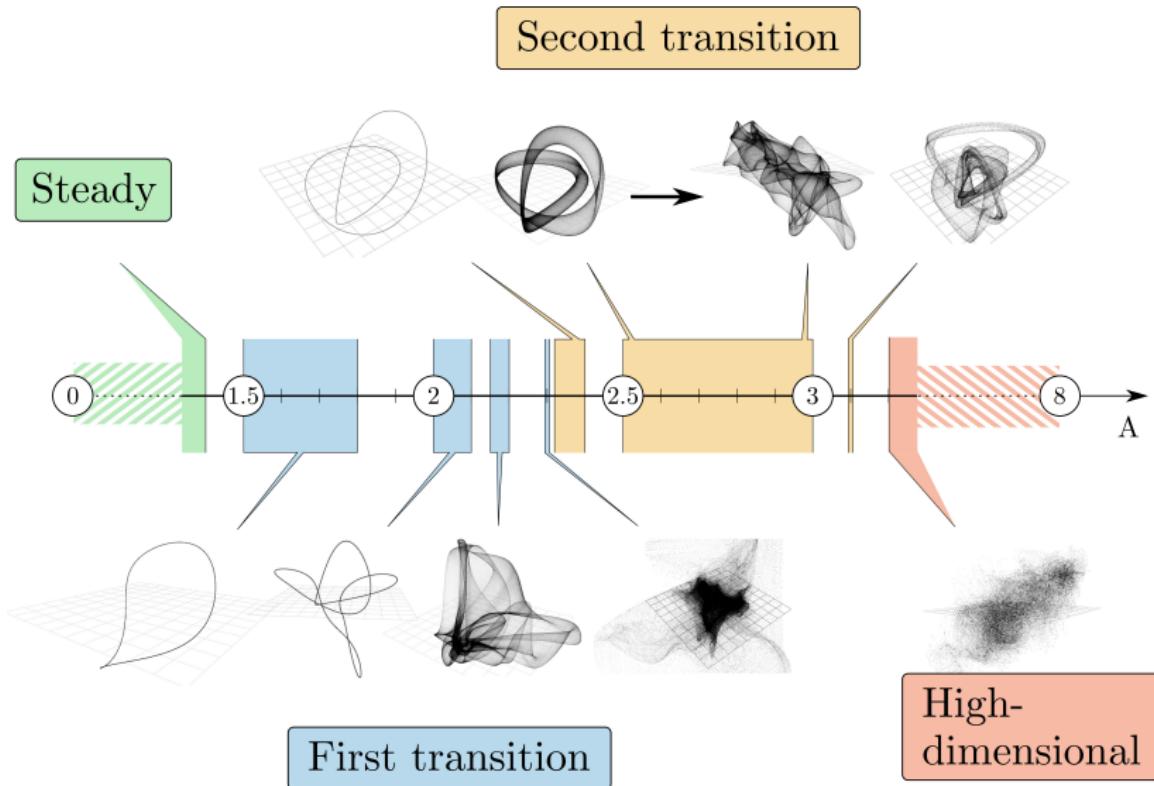
# Transition to chaos scenario



- Two transitions to chaos
- Dynamic simplification

# Dynamical system evolution

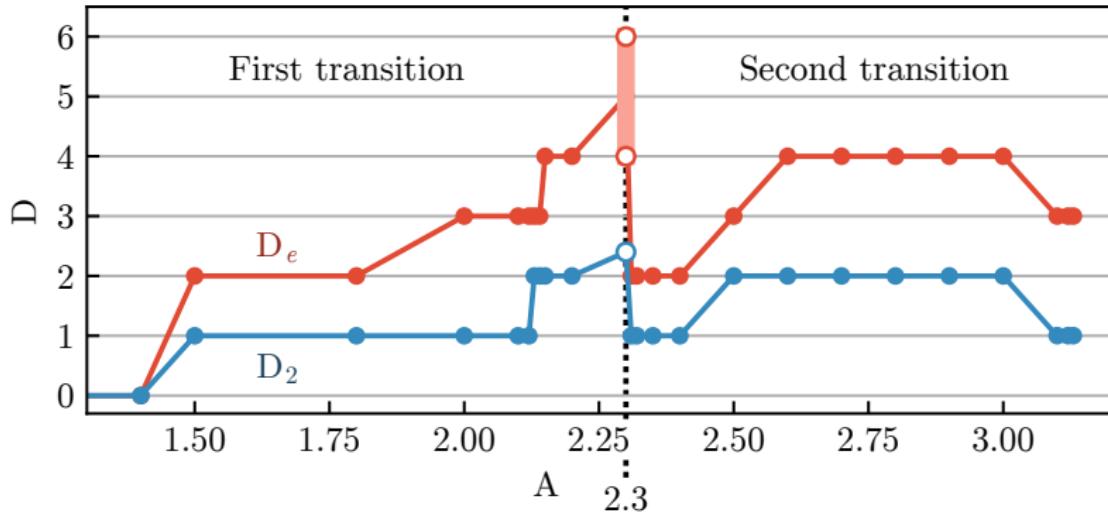
## Attractor evolution



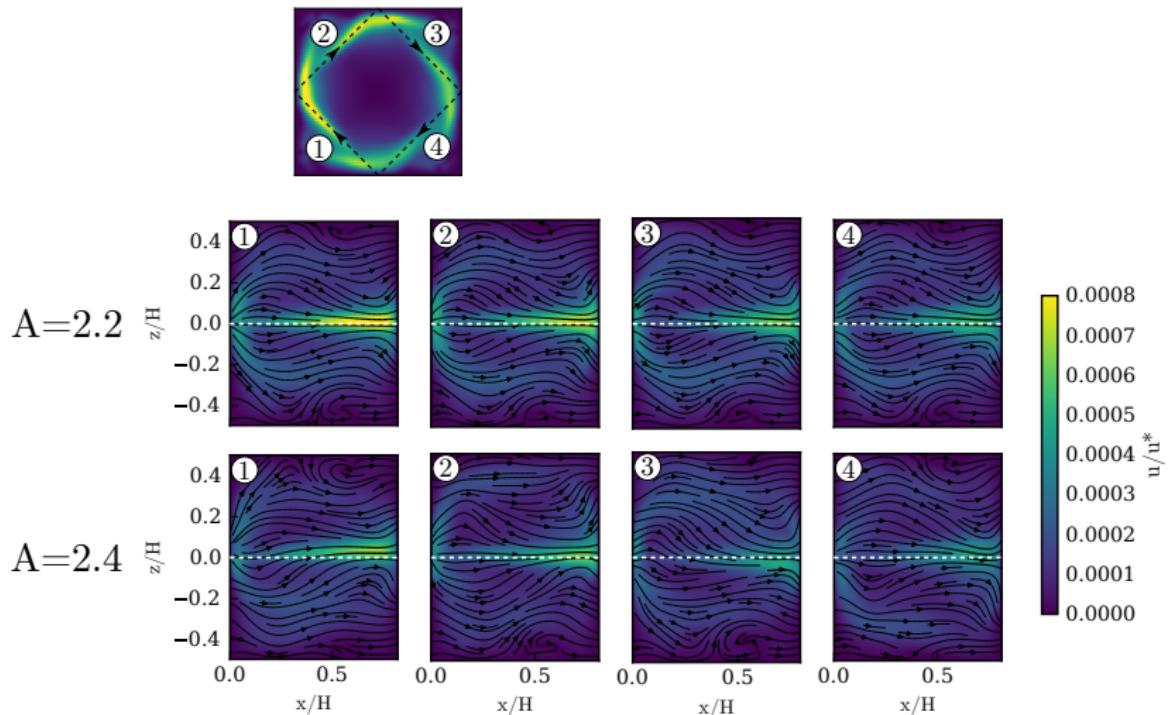
# Dynamical system evolution

## NL properties

- NL dynamic invariants (Kantz et Schreiber, 2004):
  - Embedding dimension  $D_e$
  - Correlation dimension  $D_2$

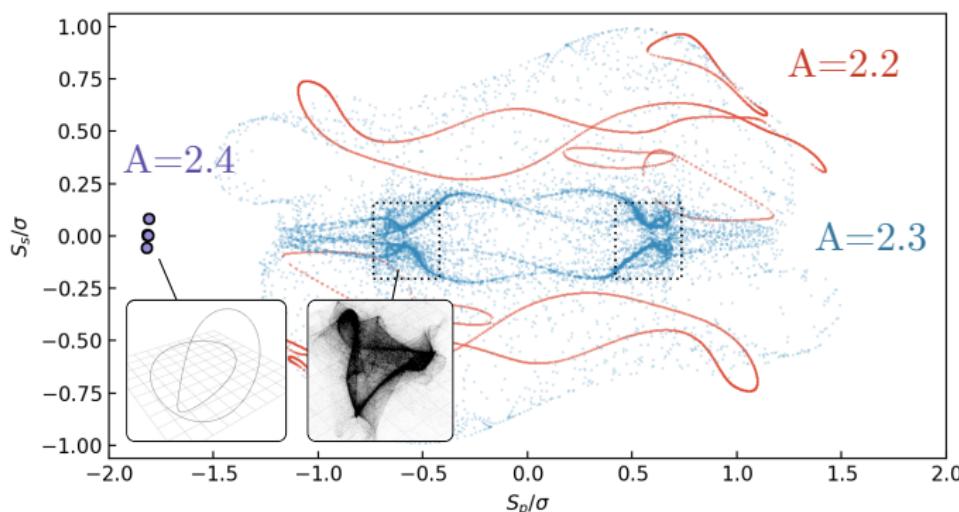


# Dynamics simplification



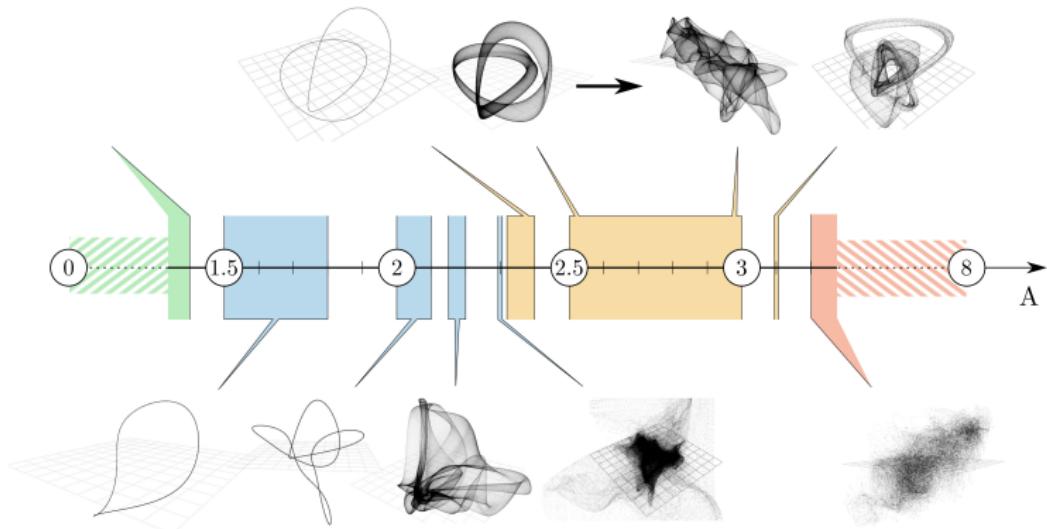
## Intermediary case $A = 2.3$

- System is in the boxes 80% of the time.
- Poincare section for vertical velocity  $w$

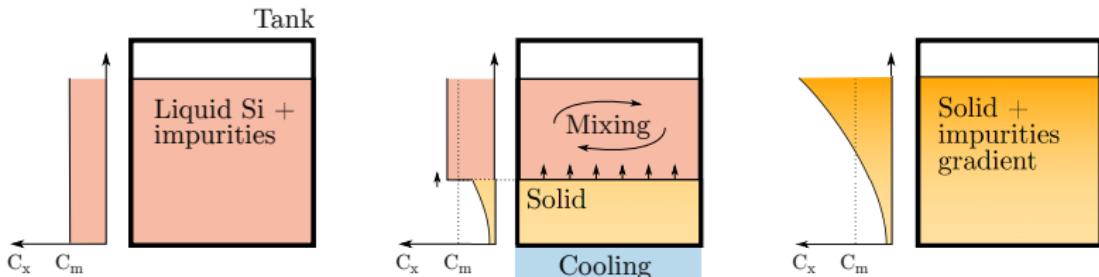


- Conclusion

- Complex transition to chaos from  $A = 0.1$  to  $A = 8$
- Dynamics simplification due to symmetry breaking
- $A = 2.3$  as a hinge configuration



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- Future work
  - Investigate spatial chaos
  - Link mixing properties to this transition



# Question

