

# KITP Program “Non-Equilibrium Universality: From Classical to Quantum and Back”

Online informal discussion  
“Open problems in classical non-  
equilibrium criticality and scaling”

Juan Garrahan, Nigel Goldenfeld, Itamar Procaccia,  
Gilles Tarjus, Uwe C. Täuber

Moderator: Jamir Marino  
Friday 29 October 2021

# Dynamic scaling away from thermal equilibrium

- **Generic scale invariance in non-equilibrium steady states / phases**
  - Driven diffusive systems: (T)ASEP lattice gas variants
  - Stochastic growth models: Kardar-Parisi-Zhang equation and variants
  - Absorbing states in certain diffusion-limited reactions
  - Broken-symmetry phases: Goldstone modes induce coexistence singularities
- **Critical scaling near non-equilibrium phase transitions**
  - Standard critical dynamics phenomenology, but absence of detailed balance / FDT  
e.g., purely relaxational kinetics: model A prominent
  - Driven lattice gases: Katz-Lebowitz-Spohn model
  - Active-to-absorbing transitions: directed percolation, dynamic isotropic percolation, parity-conserving universality class, ...

# Dynamic scaling away from thermal equilibrium

- **Aging scaling in non-equilibrium relaxation**

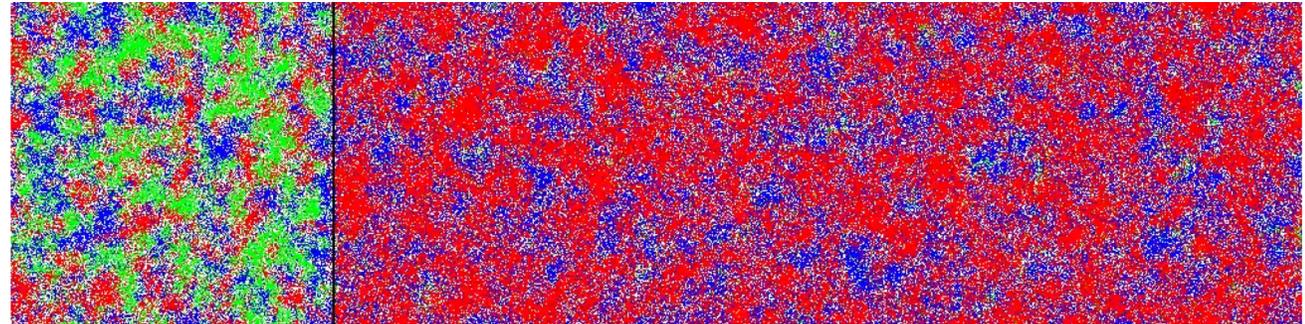
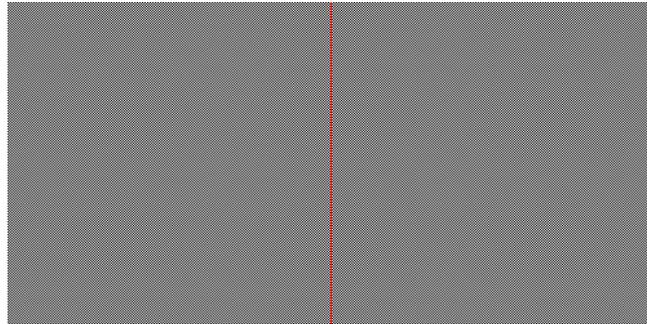
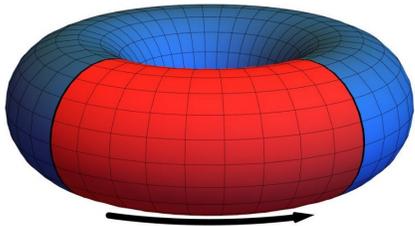
- “initial” relaxation after quenches from initial states that differ from stationary states, especially prominent for long / infinite relaxation times
- (mostly) universal critical aging scaling, initial-slip scaling
- scale-invariant coarsening after quenches into ordered phases
- aging scaling, history dependence, rejuvenation... in disordered / glassy systems: aging properties depend on various control parameters, more system-specific

# Current research focus (subset): UCT

## (1) Generic scale invariance and non-equilibrium phase transitions in spatially inhomogeneous systems

- how do boundaries / interfaces affect non-equilibrium scaling ?
- competition between different scale-invariant behavior ?  
e.g., two-temperature Katz-Lebowitz-Spohn driven lattice gas

[R.I. Mukhamadiarov, Priyanka, U.C.T., Phys. Rev. E **100**, 062122 (2019); J. Stat. Mech. **2020**, 113207 (2020)]



May-Leonard cyclic predation with symmetric / strongly asymmetric rates

[S.R. Serrao, U.C.T., Eur. Phys. J. B **94**, 175 (2021)]

- can (non-equilibrium) critical dynamics be controlled ?  
e.g., roughness in the Kardar-Parisi-Zhang stochastic growth process

[Priyanka, U.C.T., M. Pleimling, Phys. Rev. E **101**, 022101 (2020); J. Phys. A **54**, 154002 (2021)]

# Current research focus (subset): UCT

## (2) Universality classes for (diffusion-limited) reactions

- accomplished for multi-species directed percolation and pair annihilation
- generally still open issue for both high-order and multi-species reactions
- may well be related – high-order processes can be rewritten in terms of single- and particle pair quasi-species; e.g., pair contact process with diffusion:

original single-species PCPD:  $B + B \rightarrow B + B + B$ ,  $B + B \rightarrow \emptyset$

coupled two-species model:  $B + B \rightarrow A$ ,  $A \rightarrow B + B$ ,  $A \rightarrow A + B$ ,  $A \rightarrow \emptyset$

[S. Deng, W. Li, U.C.T., Phys. Rev. E **102**, 042126 (2020)]

