Growth Law and Superuniversality in Disordered Ferromagnets

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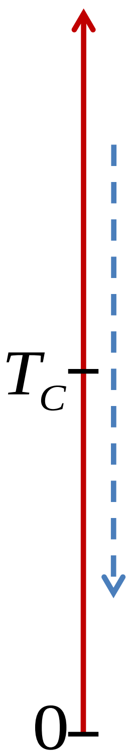
- S.Puri - JNU Delhi
- M.Zannetti - Salerno

pure ferromagnet

$$H = -J \sum_{<ij>} \sigma_i \sigma_j$$

relaxation via domain coarsening



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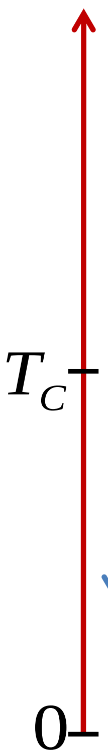
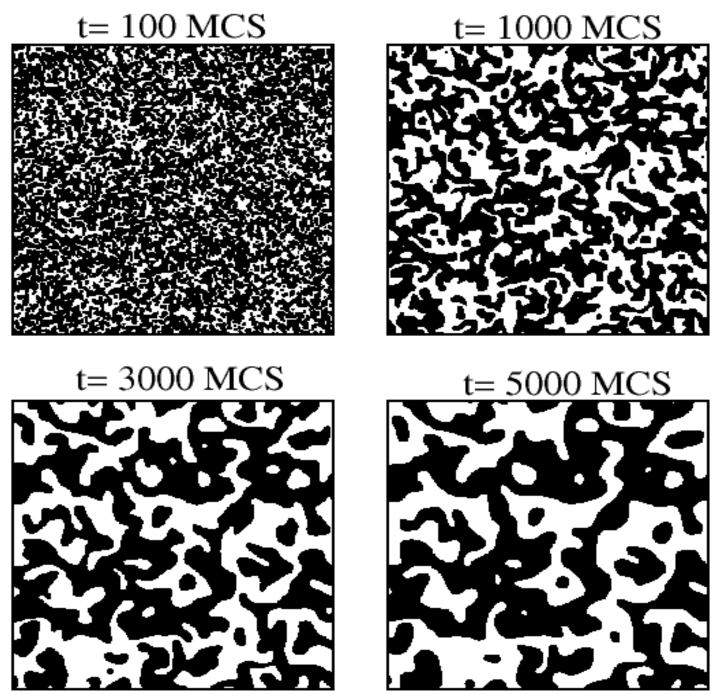
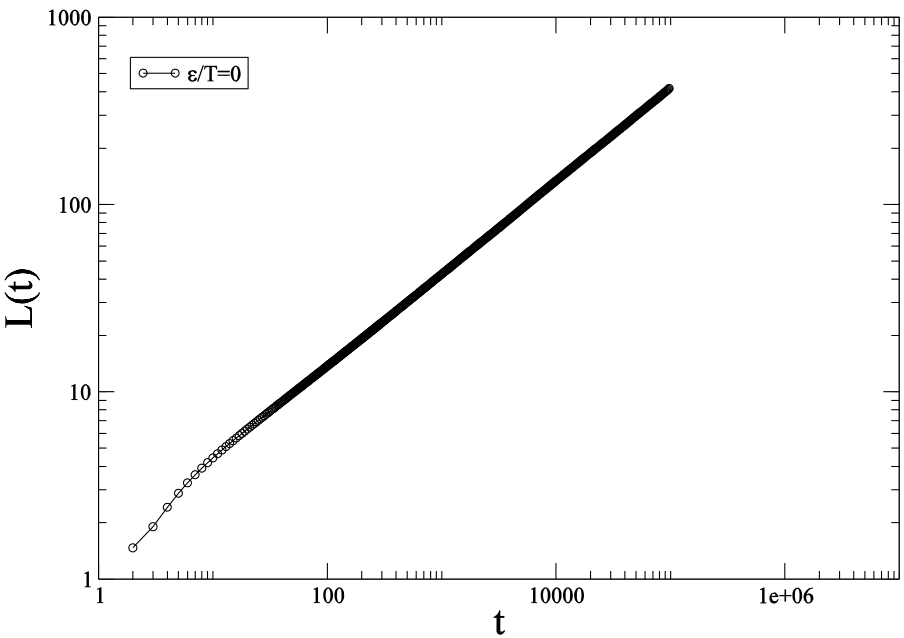




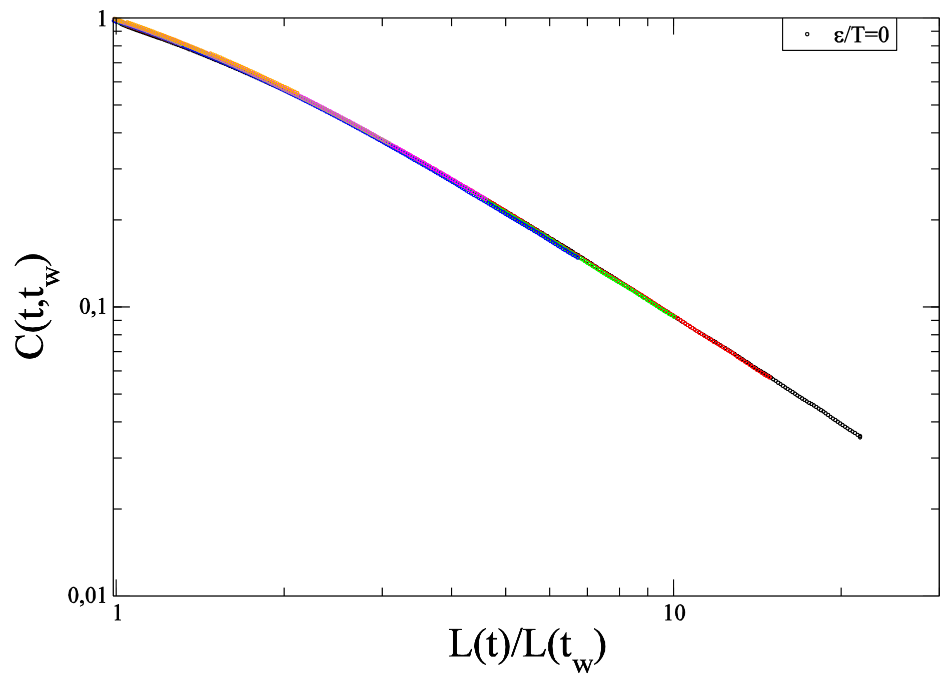
growth law

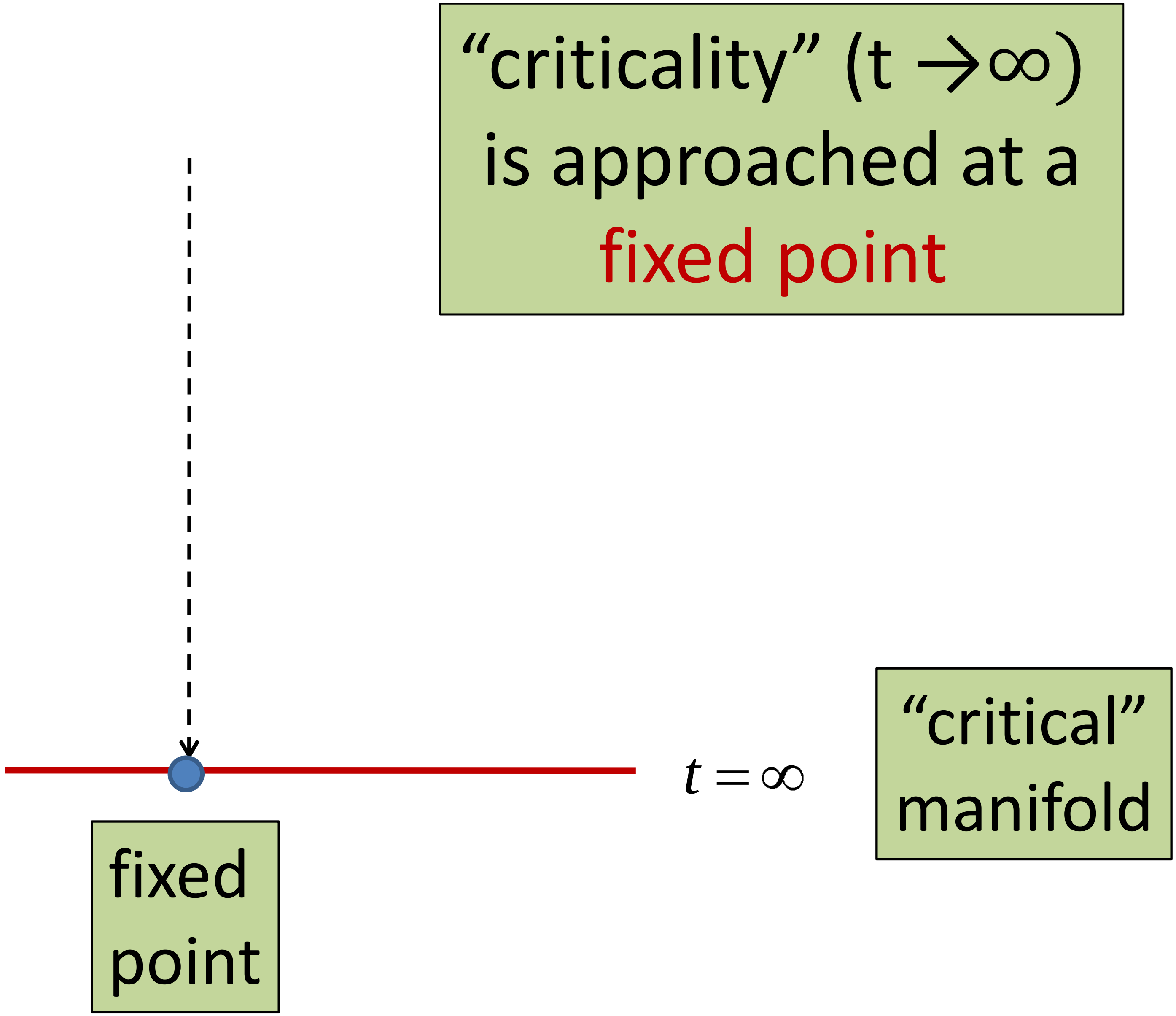
$$L(t) \approx t^{1/z}, z = 2$$



scaling-aging

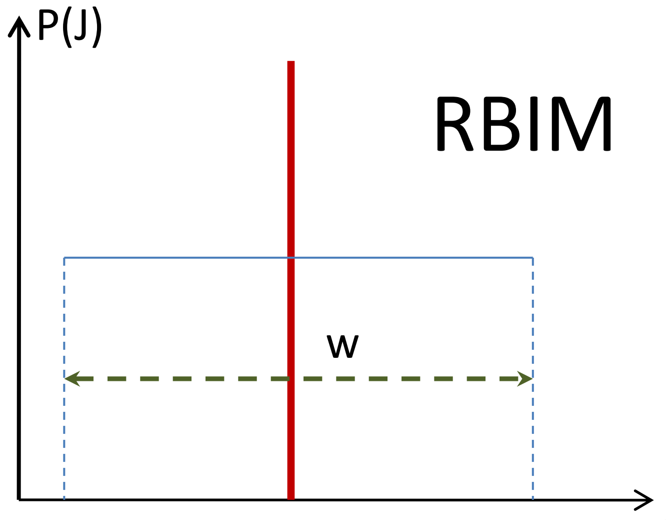
$$C(t, t_w) = F\left({L}/{L_w} \right)$$



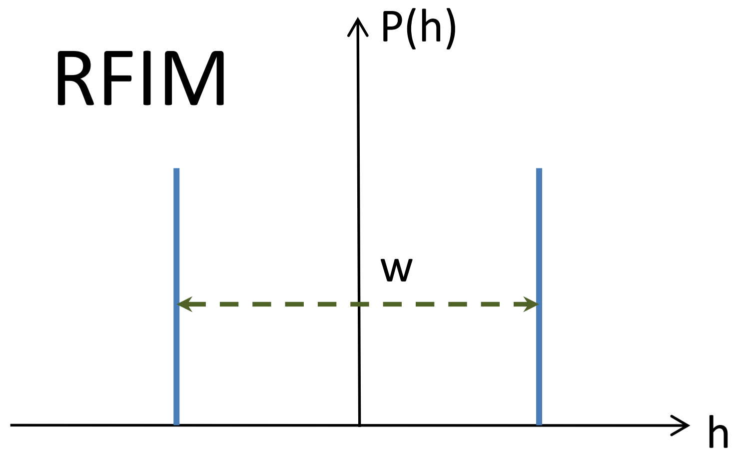

"criticality" (t →∞)
is approached at a
fixed point
t = ∞
"critical"
manifold
fixed
point

disordered ferromagnet

$$H = -\sum_{<ij>} J_{ij}\sigma_i\sigma_j$$

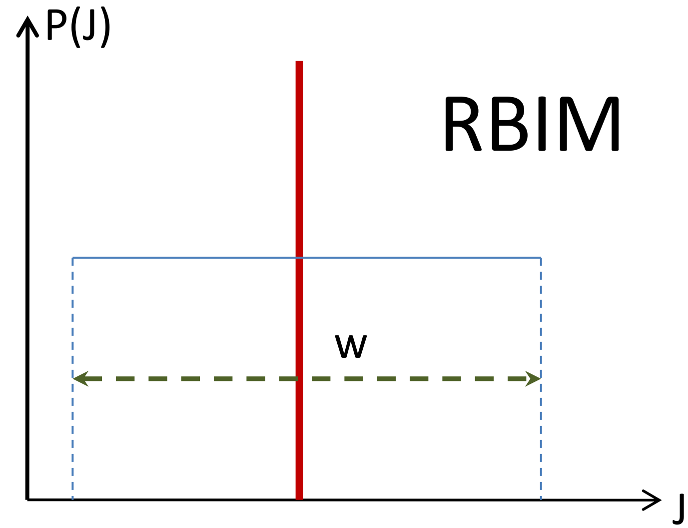


$$H = -J\sum_{<ij>} \sigma_i\sigma_j - \sum_i h_i\sigma_i$$

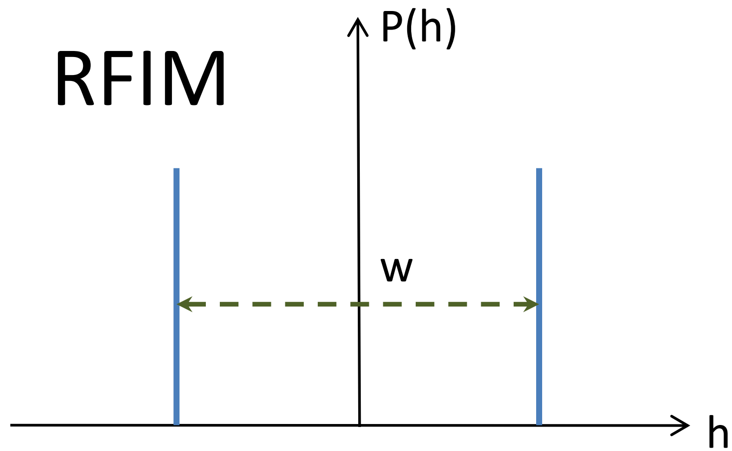


disordered ferromagnet

$$H = -\sum_{<ij>} J_{ij}\sigma_i\sigma_j$$



$$H = -J\sum_{<ij>}\sigma_i\sigma_j - \sum_i h_i\sigma_i$$



quench to T=0

$$w/T = \varepsilon$$

PROBLEM

how is the pure system phenomenology modified by $\varepsilon \neq 0$

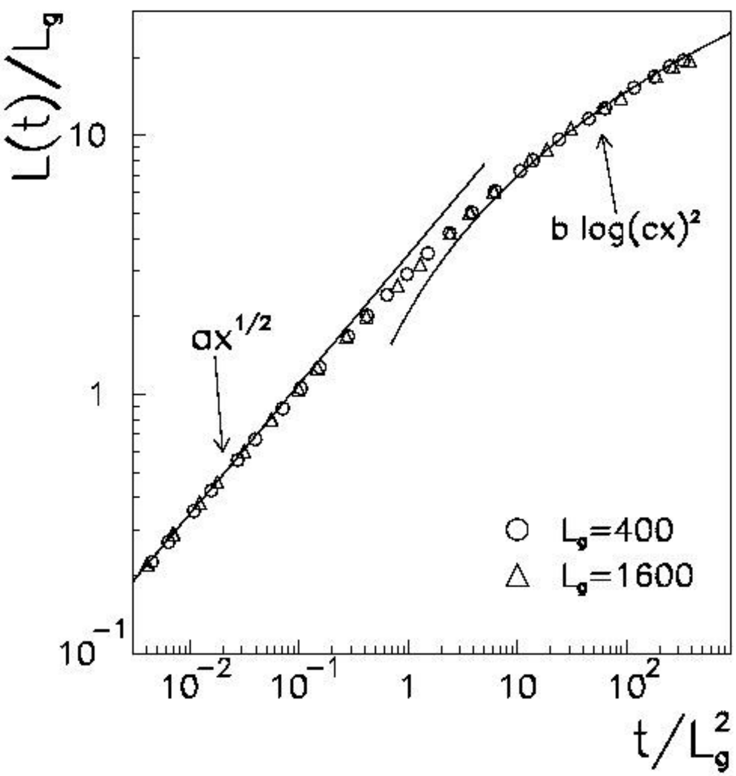
1d-RFIM Corberi et al . PRE 2002

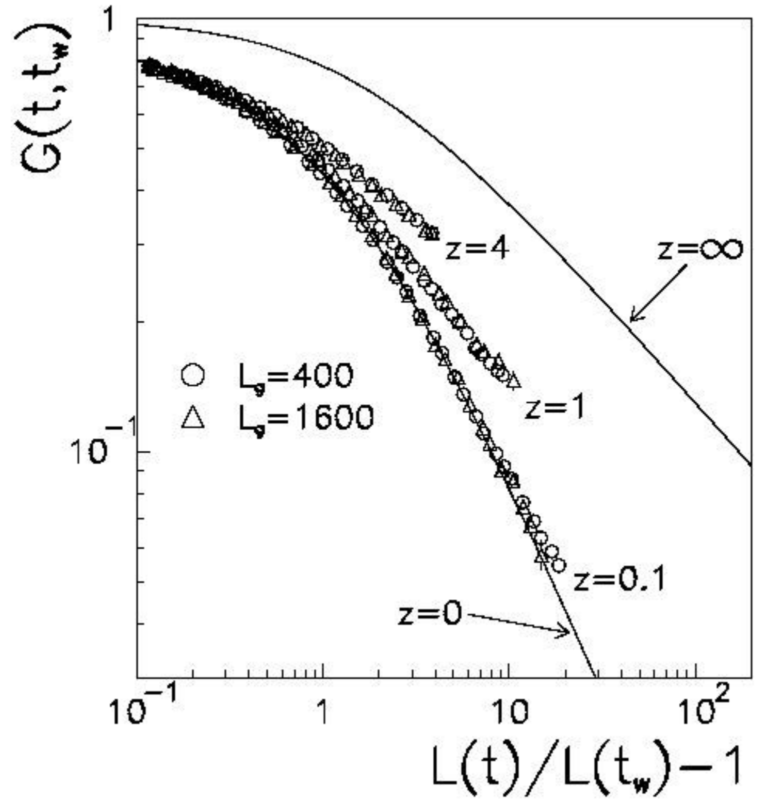
$$\lambda \approx \varepsilon^{-2}$$

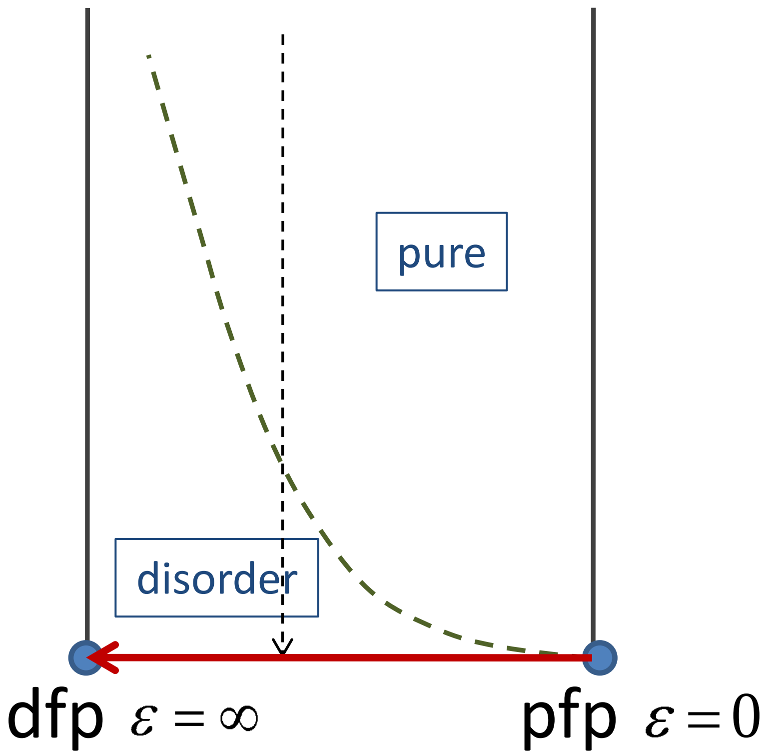
$$L(t,\varepsilon) = \lambda f\left(t/\lambda^{z}\right)$$

$$C(t,t_w,\varepsilon) = F_C\left(L/L_w , L_w/\lambda \right)$$

crossover



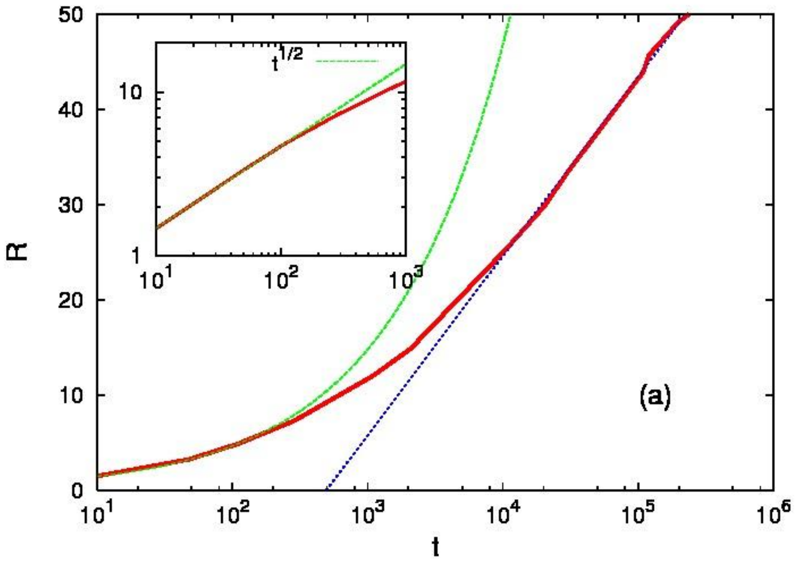


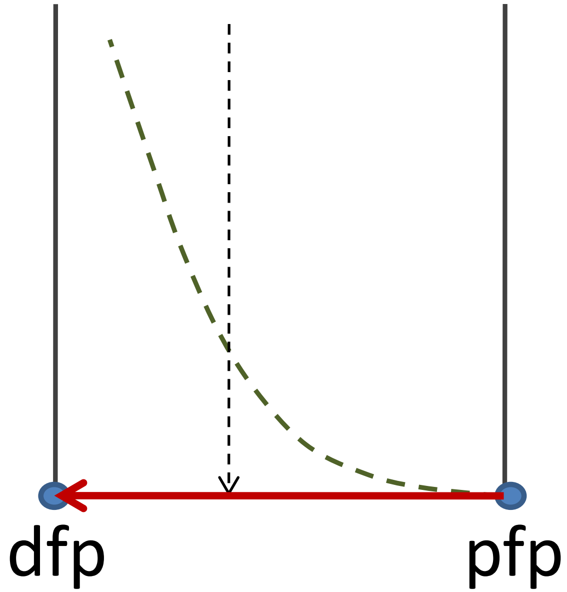

pure
disorder
dfp $\varepsilon = \infty$
pfp $\varepsilon = 0$

$d > 1$ partially understood

2d-3d RFIM

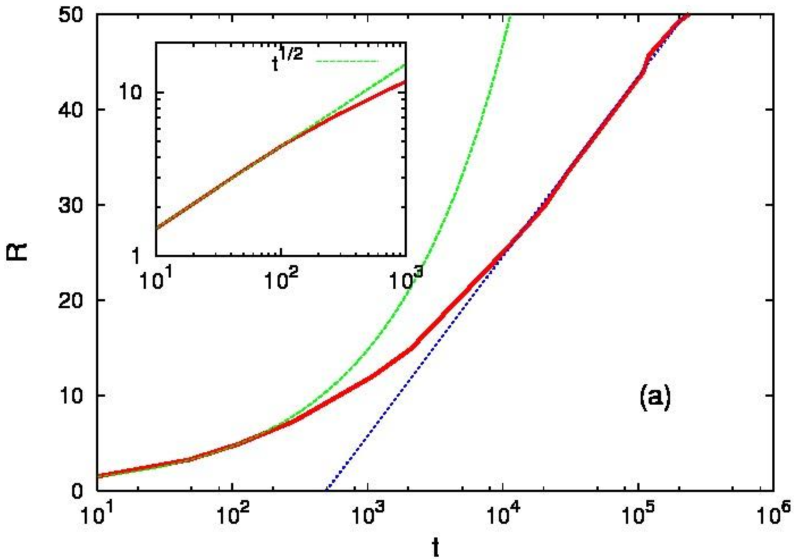
Puri et al. J.Phys.A 1993
Rao et al. PRL 1993
Aron et al. JSTAT 2008

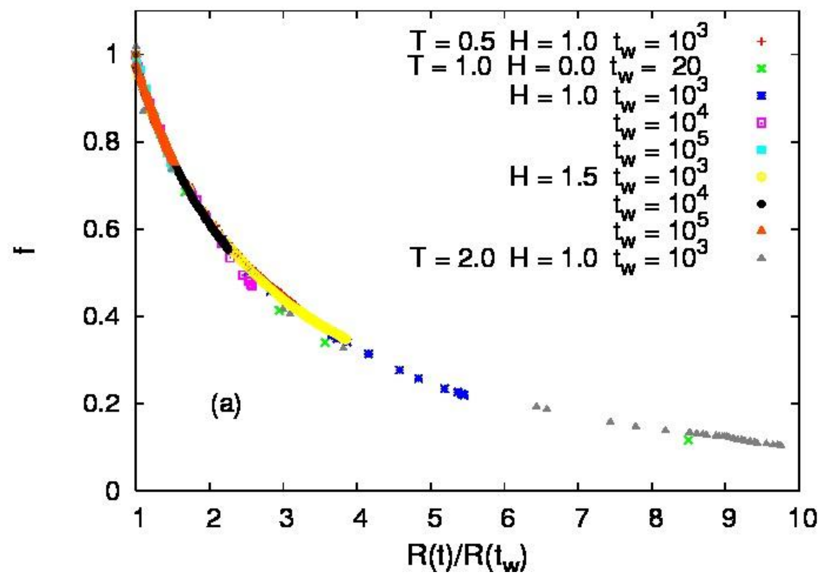


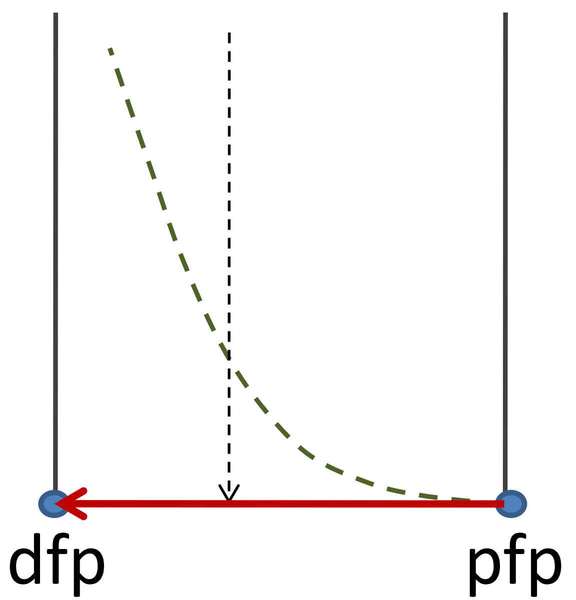


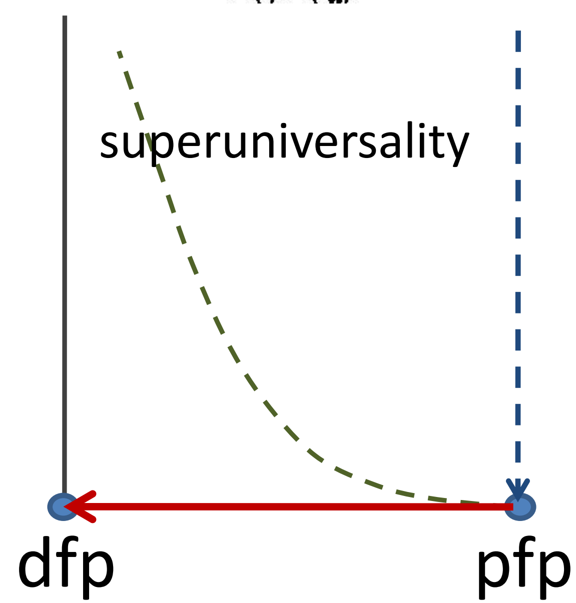
2d-3d RFIM

$$C(t, t_w, \varepsilon) = F_C\left(L / L_w , L_w / \lambda \right)$$





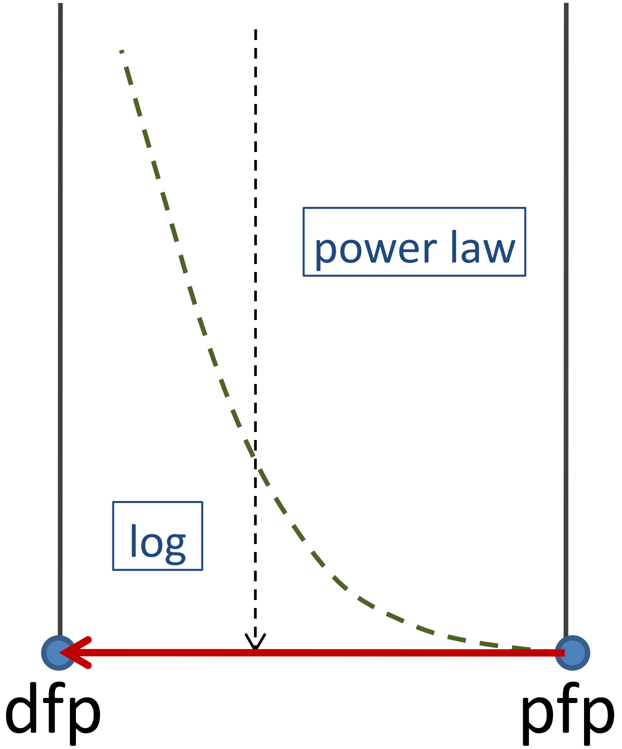




2d-RBIM controversial case

Huse-Henley

$$t^{1/z} \to (\ln t)^{1/\varphi}$$

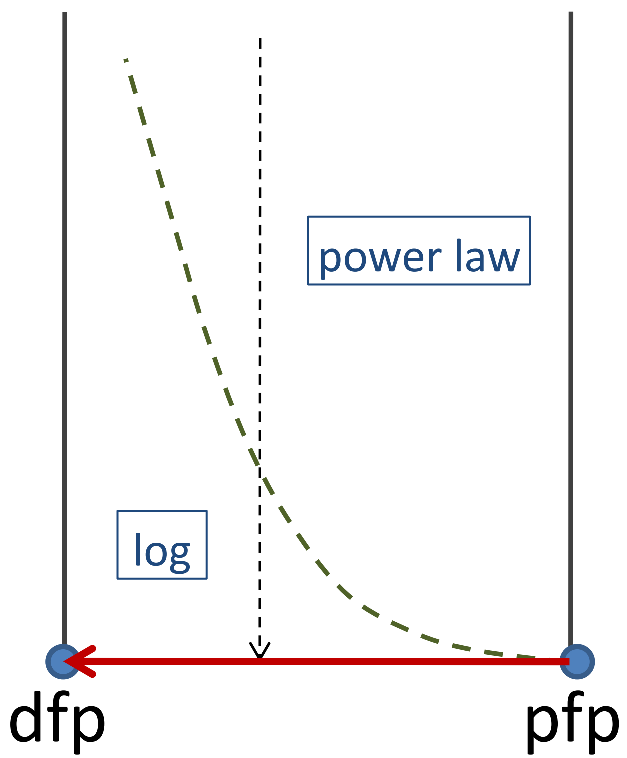


2d-RBIM

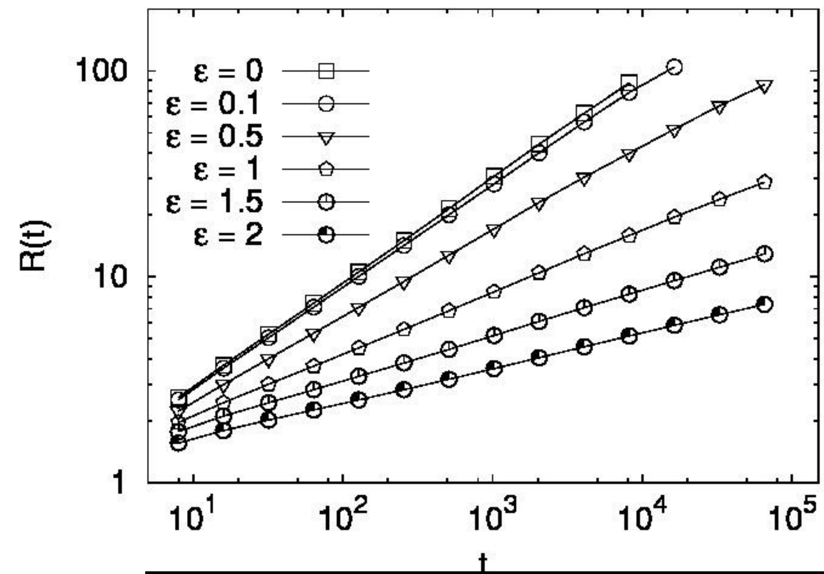
controversial case

Huse-Henley

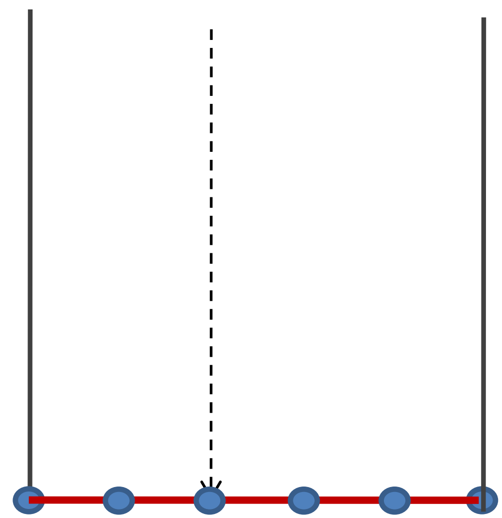
$$t^{1/z} \to (\ln t)^{1/\varphi}$$



Paul et al. EPL 2004

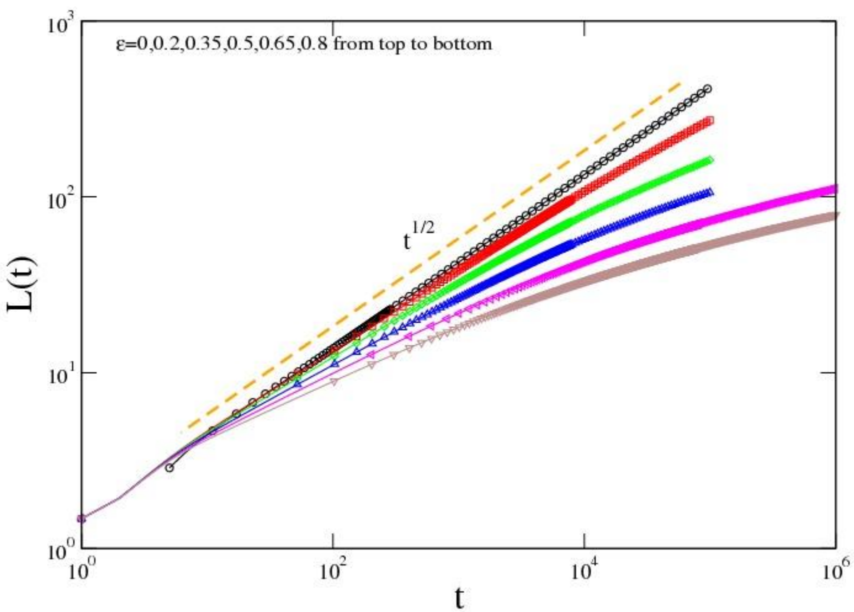


$$L(t,\varepsilon) \approx t^{1/z(\varepsilon)}$$

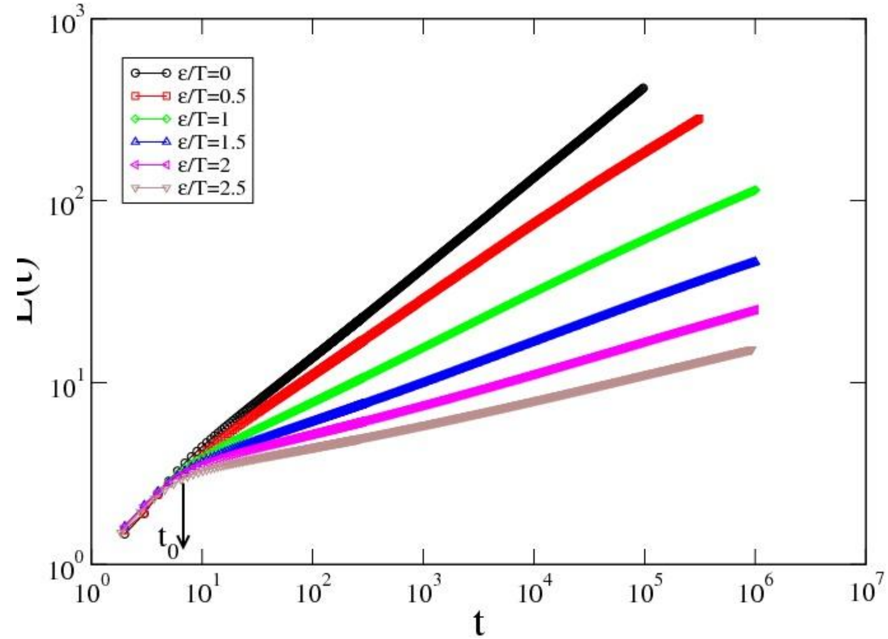


large scale simulations
2d-RBIM (Corberi et al. JSTAT 2011)
2d-RFIM (current work)

2d-RFIM

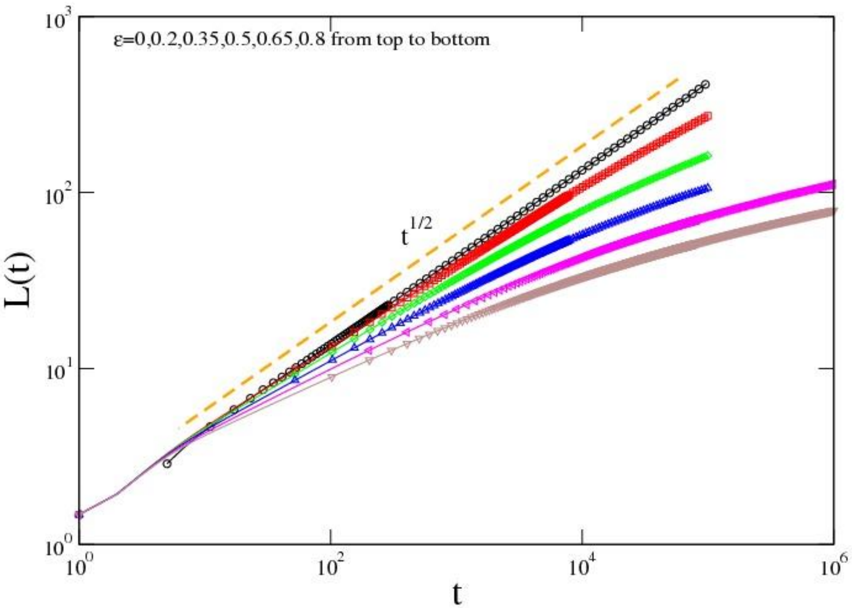


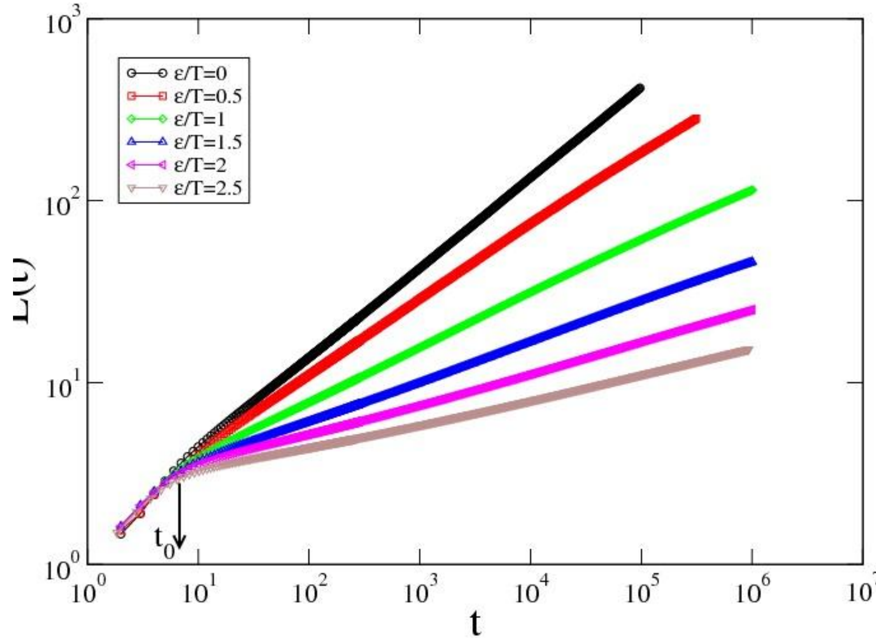
2d-RBIM



2d-RFIM

2d-RBIM

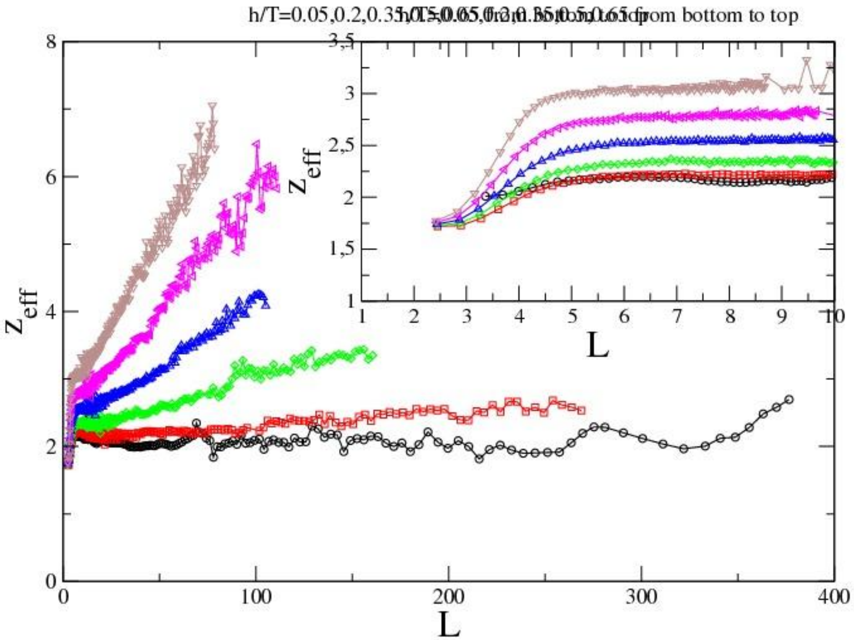




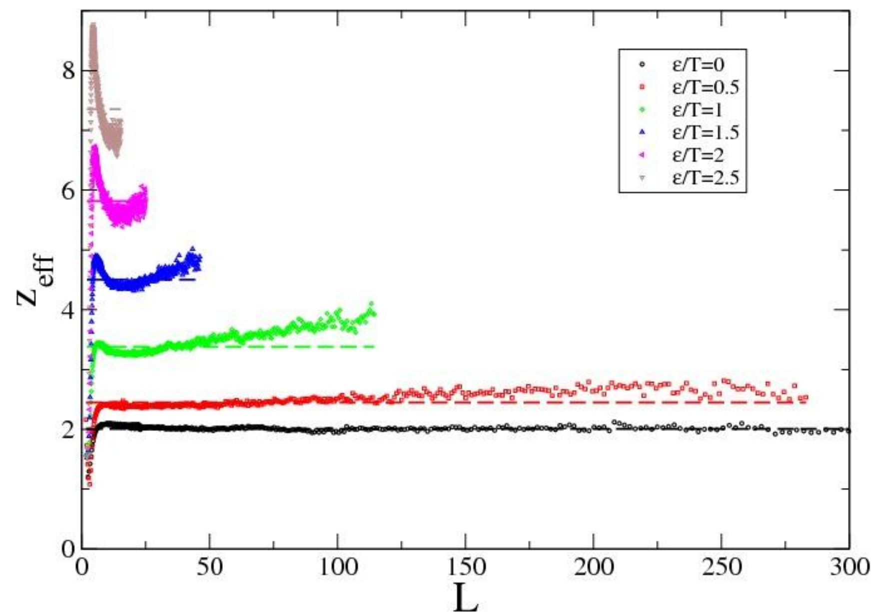
data analysis

$$z_{eff}(L,\lambda)=\frac{\partial \ln t}{\partial \ln L}$$

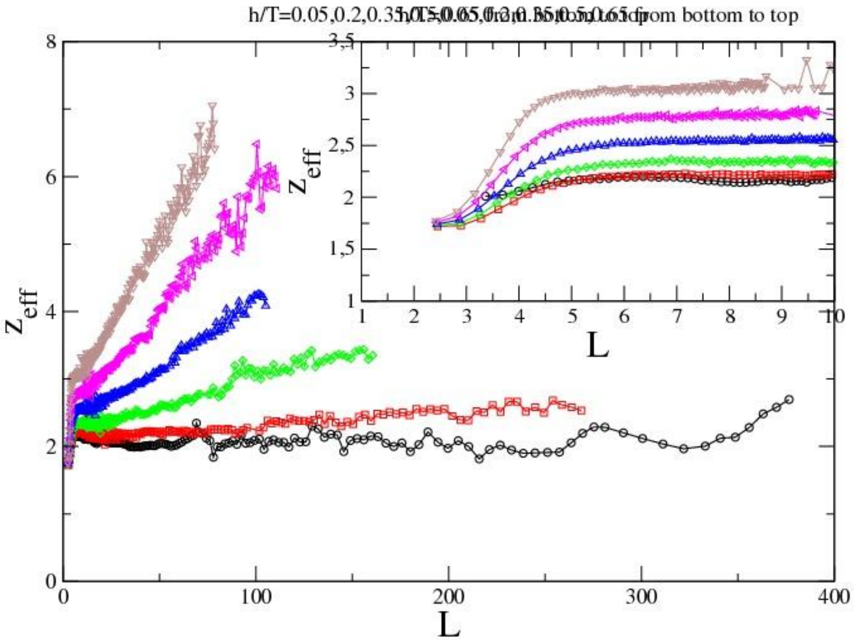
2d-RFIM



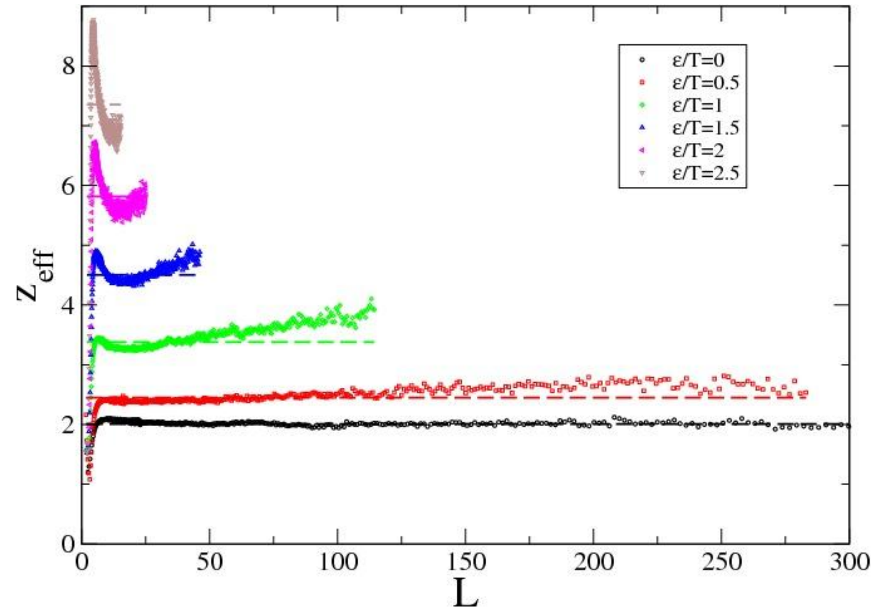
2d-RBIM



2d-RFIM



2d-RBIM

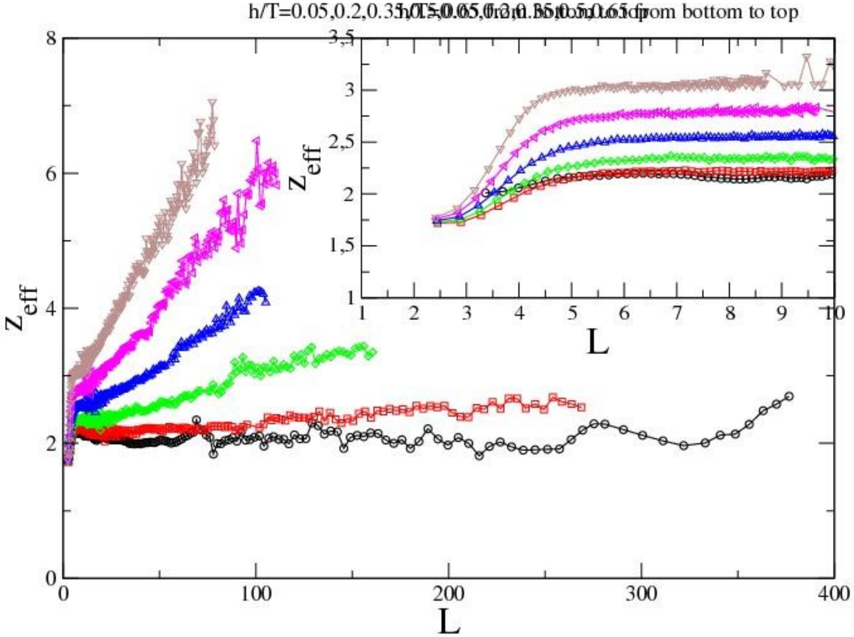


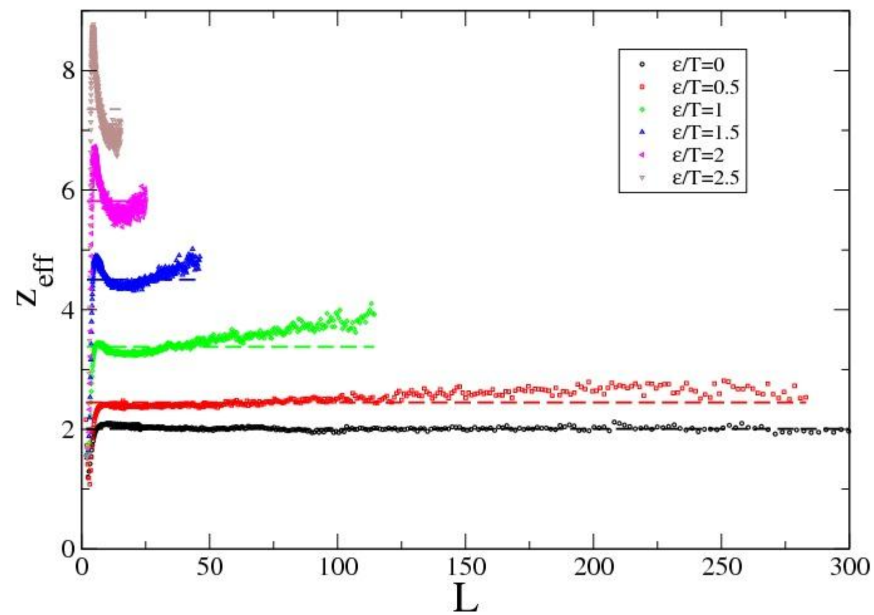
scaling hypothesis

$$t = L^{z(\varepsilon)} g(L/\lambda)$$

2d-RFIM

2d-RBIM



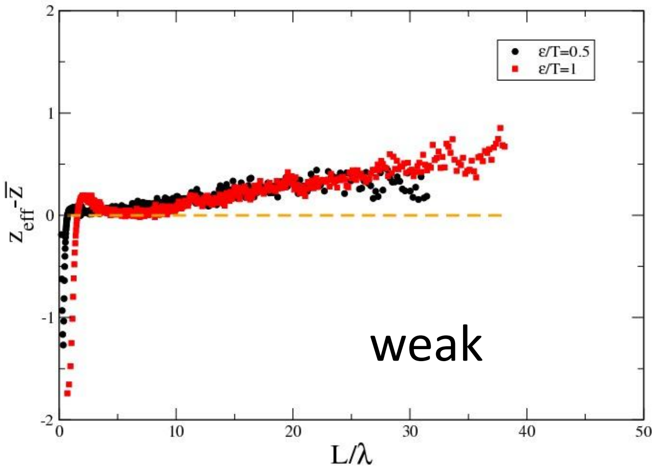


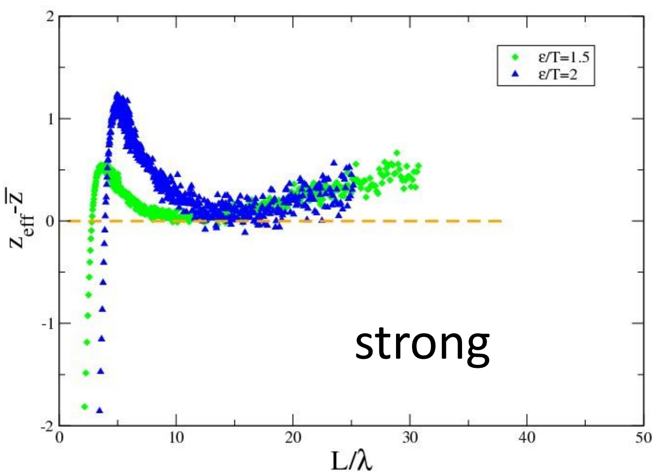
scaling hypothesis

$$t = L^{z(\varepsilon)} g(L/\lambda)$$

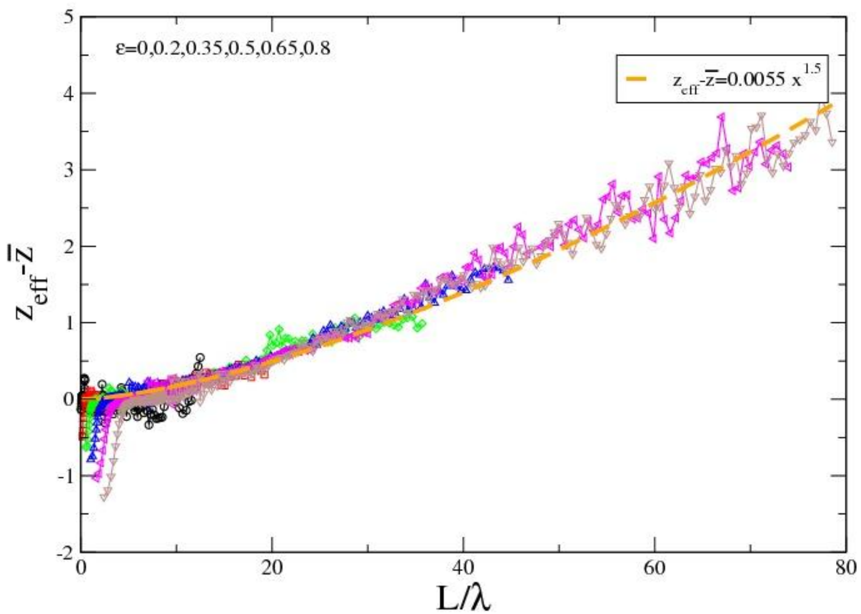
$$z_{eff} - z(\varepsilon) = \frac{d \ln g(y)}{d \ln y}, y = L/\lambda$$

2d-RBIM





2d-RFIM



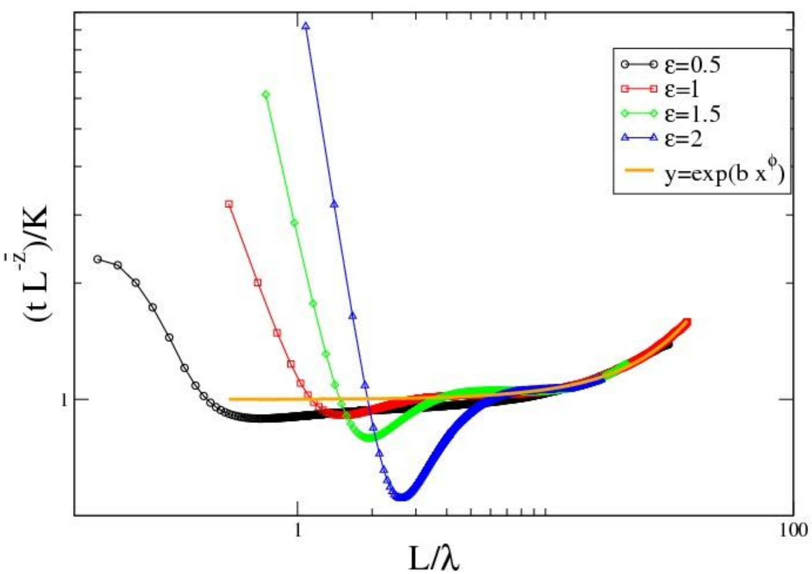
$$z_{eff} - z(\varepsilon) = by^{\varphi} \Rightarrow g(y) = e^{(L/c\lambda)^{\varphi}}, c = (\varphi/b)^{1/\varphi}$$

$$z_{eff} - z(\varepsilon) = by^{\varphi} \Rightarrow g(y) = e^{(L/c\lambda)^{\varphi}}, c = (\varphi/b)^{1/\varphi}$$

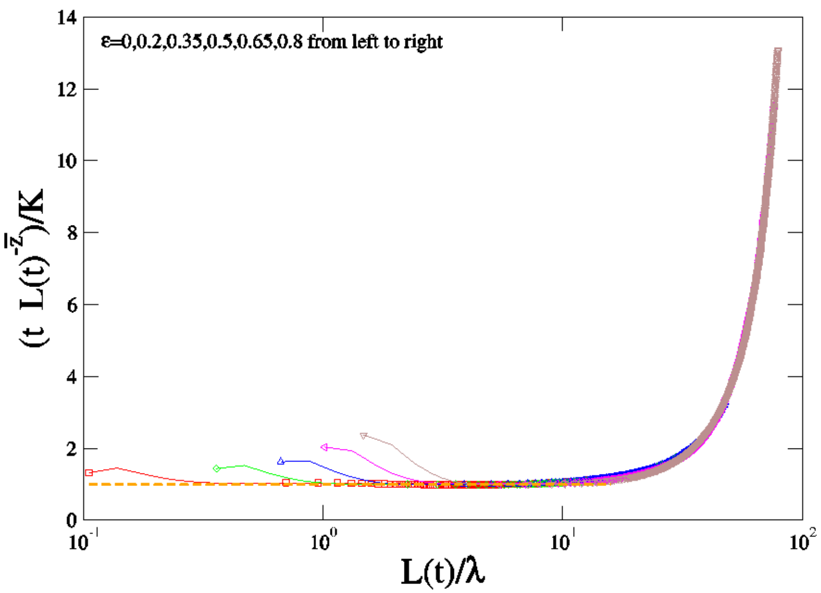
$$t = L^{z(\varepsilon)} e^{(L/c\lambda)^{\varphi}}$$

$$t^{1/z(\varepsilon)} \rightarrow (\ln t)^{1/\varphi}$$

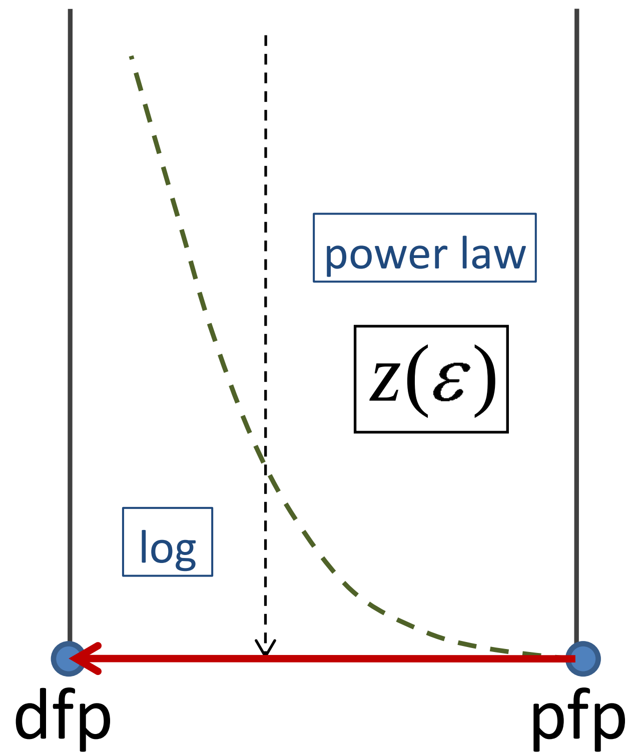
2d-RBIM



2d-RFIM

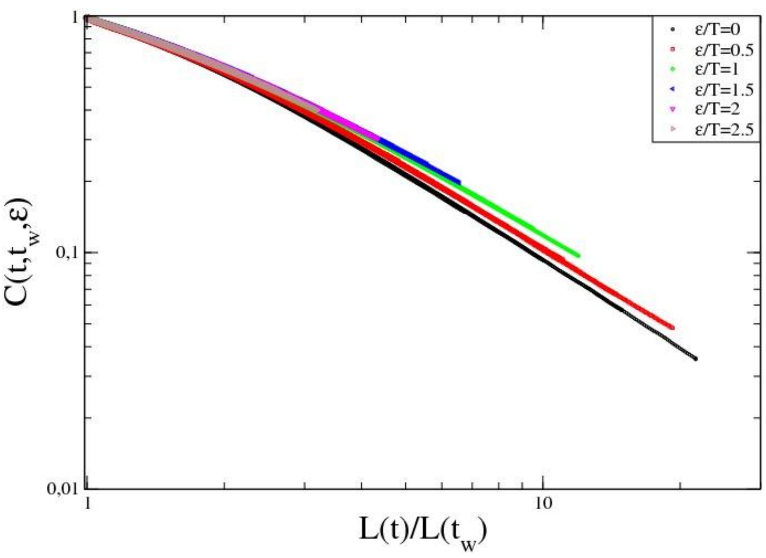


2d-RFIM and 2d-RBIM

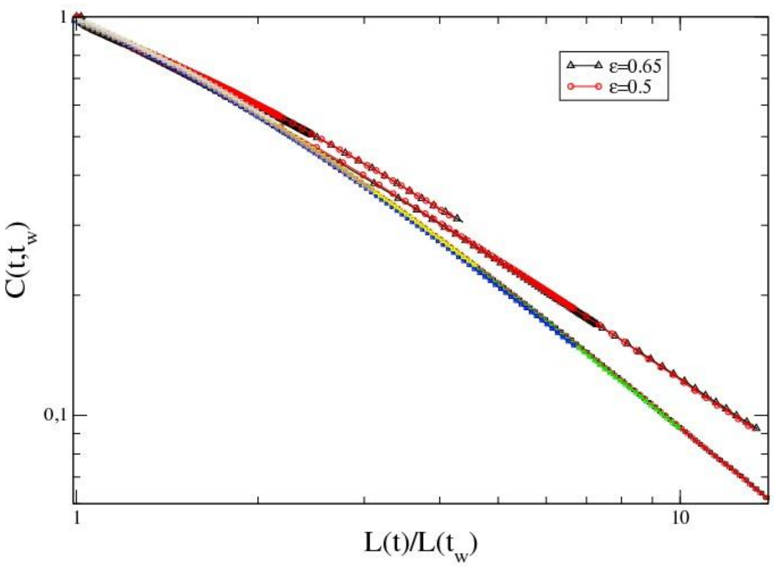


$$C(t, t_w, \varepsilon) = F_C\left(L/L_w , L_w/\lambda \right)$$

2d-RBIM



2d-RFIM



NO superuniversality

CONCLUSIONS

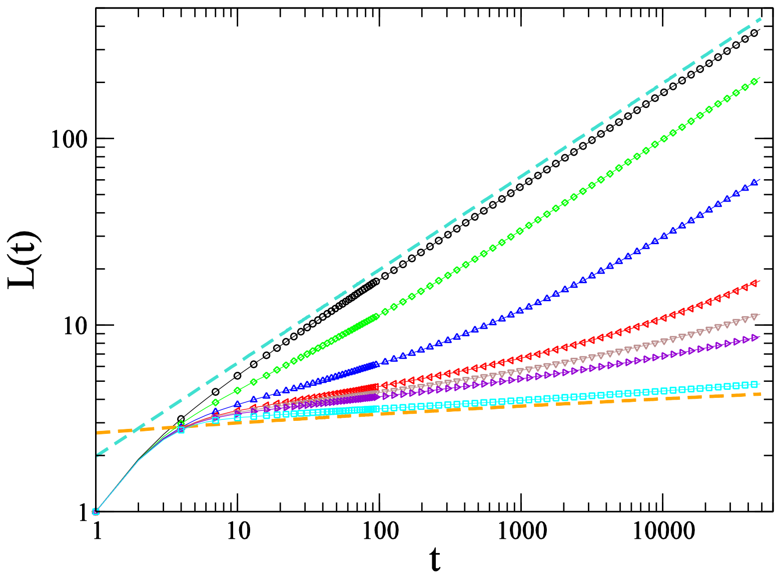
- 2d RFIM and 2d RBIM display similar behaviour
- crossover from ε-dependent power law to logarithmic growth
- no superuniversality of the autocorrelation function

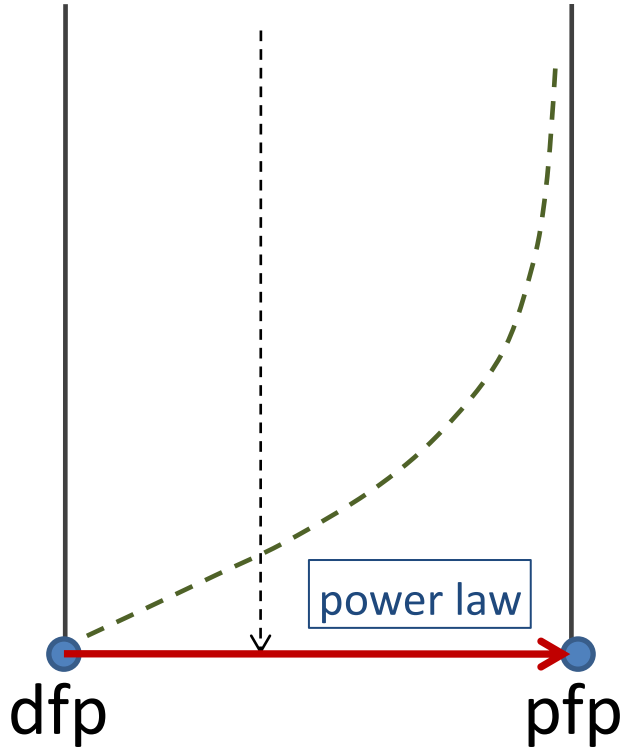
references

- F.Corberi, A.De Candia, E.Lippiello, M.Zannetti Phys.Rev.E 65, 046114 (2002)
- S.Puri and N.Parekh J.Phys.A 26, 2777 (1993)
- M.Rao and A.Chakrabarti Phys.Rev.Lett. 71, 3501 (1993)
- C.Aron, C.Chamon, L.F.Cugliandolo and M.Picco, JSTAT P05016 (2008)
- D.A.Huse and C.Henley, Phys.Rev.Lett. 54, 2708 (1985)
- F.Corberi, E.Lippiello, A.Mukherjee, S.Puri and M.Zannetti, JSTAT P03016 (2008)

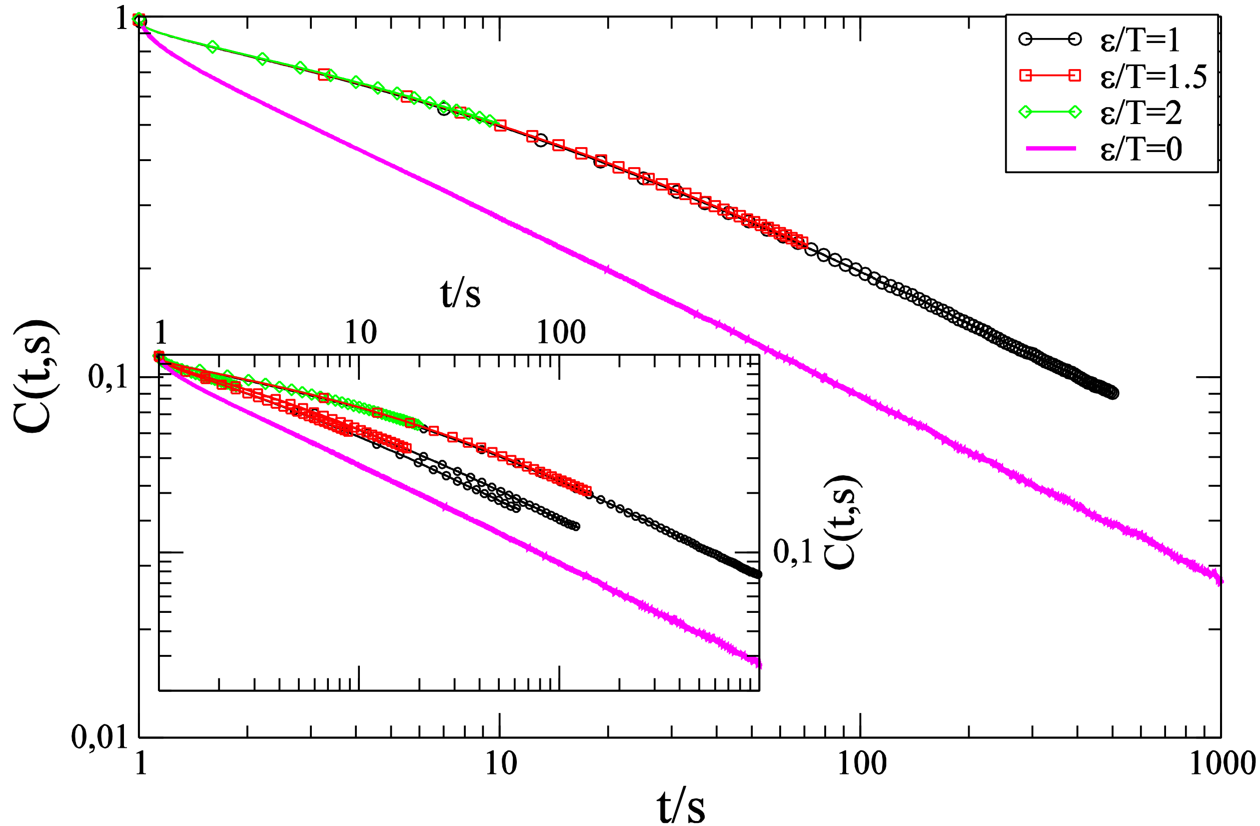
1d-RBIM Lippiello et al. EPL 2010

opposite crossover to pure behavior



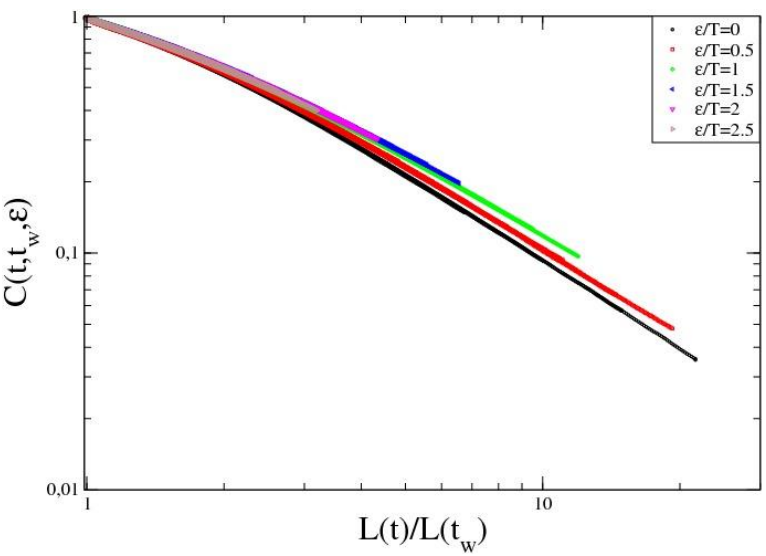


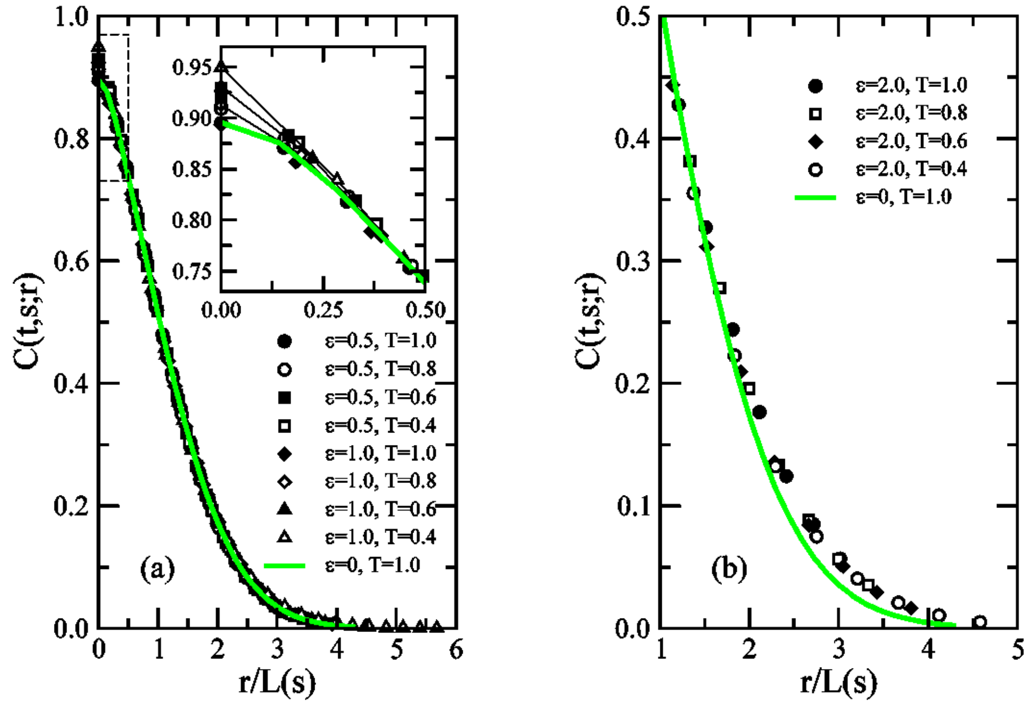
$$C(t, t_w, \varepsilon) = F_C\left(L/L_w , L_w/\lambda \right)$$



$$C(r,t,t_w,\varepsilon) = F_C\left(r/L_w , L/L_w , L_w/\lambda \right)$$

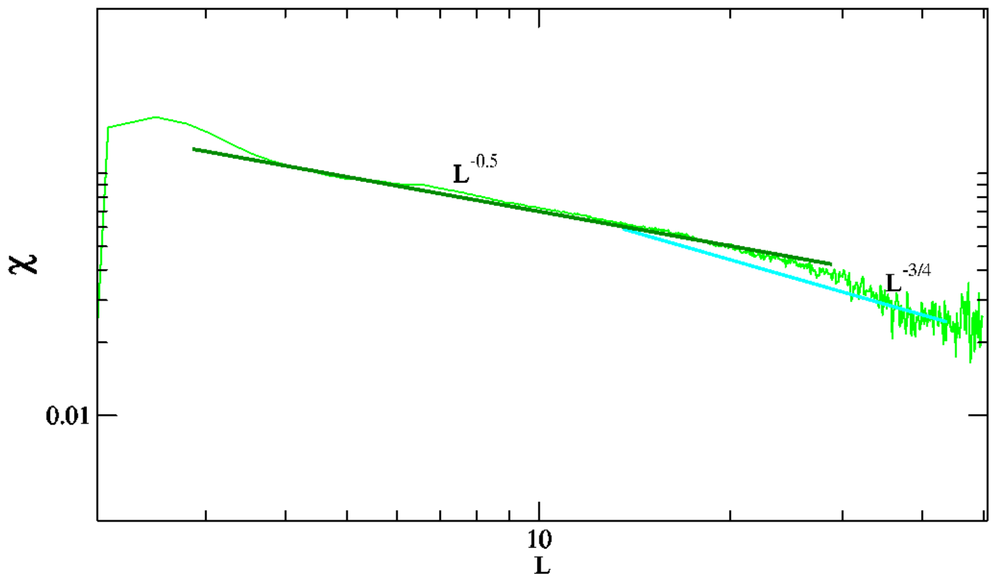
2d-RBIM





NO superuniversality

response function



$L^{-0.5}$
$L^{-3/4}$
χ
0.01
10
L