Issues with Ordering Kinetics in 3D Glauber Ising Model at T=0

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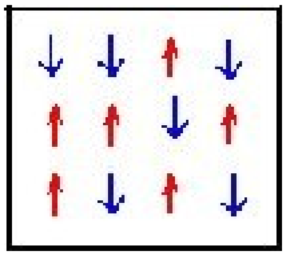
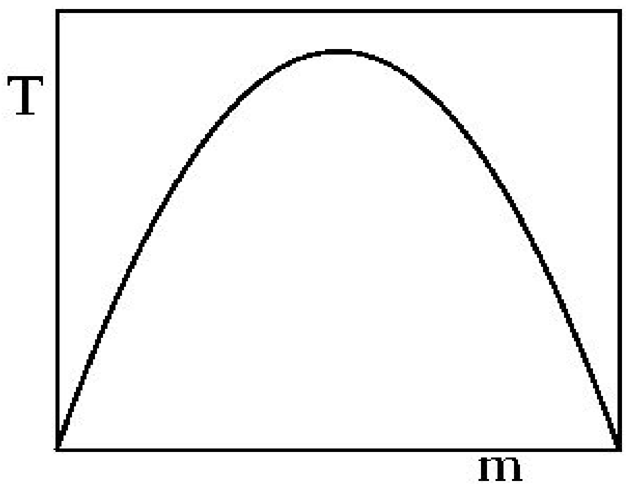
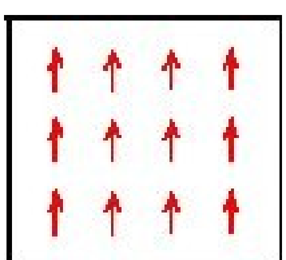
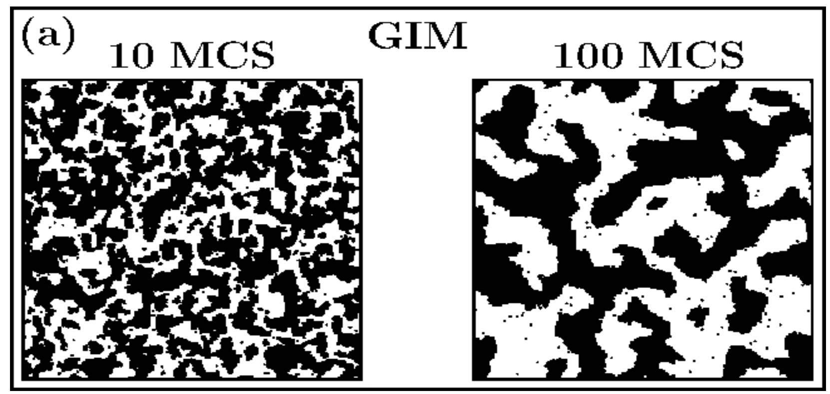


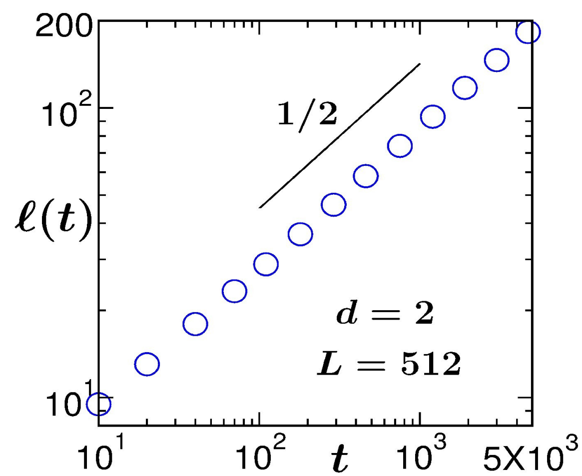




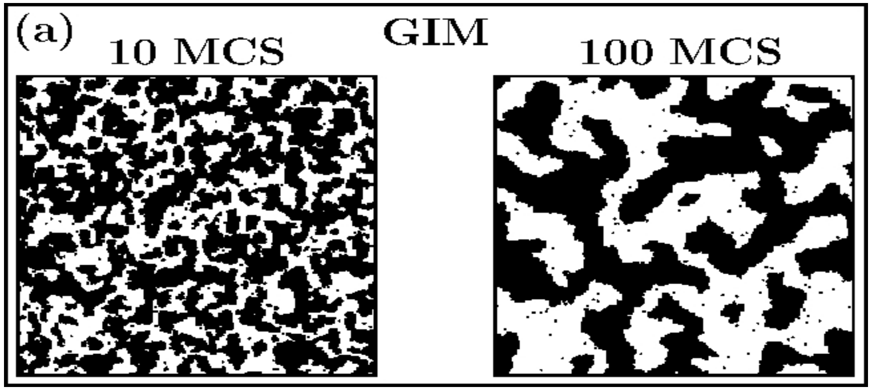


$\ell \sim t^{\alpha}$

Curvature driven growth: $\frac{d\ell}{dt} \sim \frac{1}{\ell}$ $\alpha = 1/2$



Other important aspects: Pattern, Aging, Persistence



Pattern:

Two-point equal time correlation function.

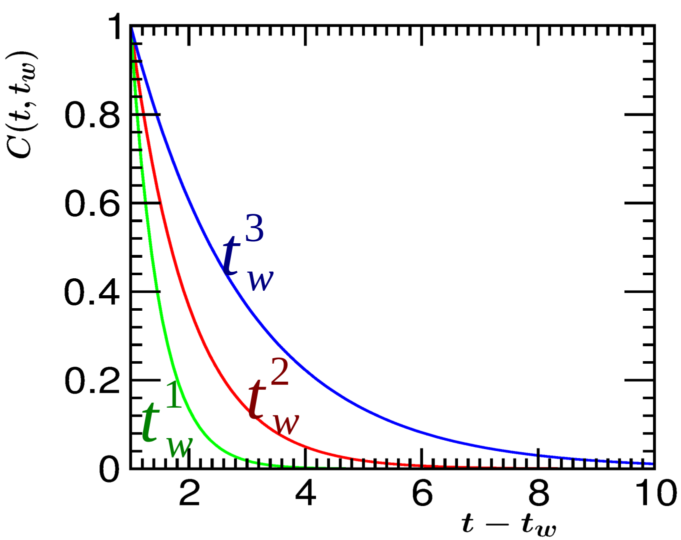
$$C(r,t)=\langle \varphi(\vec{r},t)\varphi(\vec{0},t)\rangle-\langle \varphi(\vec{r},t)\rangle\langle \varphi(\vec{0},t)\rangle$$

$$C(r,t)\equiv C(r/\ell(t))$$

Aging: Related to the relaxation in a non-eqilibrium system.

Two time correlation (autocorrelation):

$$C_{ag}(t,t_w)=\langle \varphi(\vec{r},t)\varphi(\vec{r},t_w)\rangle-\langle \varphi(\vec{r},t)\rangle\langle \varphi(\vec{r},t_w)\rangle$$



As opposed to equilibrium, time translation invariance violated

$t_w^3 > t_w^2 > t_w^1$ → Younger system relaxes faster

Scales with $\frac{\ell}{\ell_w} \sim \frac{t}{t_w}$ $\quad \ell \sim t^{\alpha}$

Long time limit: Power law scaling $\quad C_{ag}(t,t_w) \sim \left(\frac{\ell}{\ell_w}\right)^{-\lambda} \sim \left(\frac{t}{t_w}\right)^{-\alpha\lambda}$

D.S. Fisher and D.A. Huse (1988)

Model and Properties

- Atomistic: Ising Model $H=-J\sum_{\langle i\ j\rangle} S_i S_j;\ \ S_i=+1(-1);$ J (>0)

  --- spin flip Glauber Monte Carlo simulations

Pattern and growth: dimension independent

$$\alpha = 1/2 \qquad\qquad C(r,t)=\frac{2}{\pi}\sin^{-1}\left[\exp\left(\frac{-r^2}{At}\right)\right]$$

Allen-Cahn law   Ohta-Jasnow-Kawasaki (OJK) function

Aging: dimension dependence $C_{ag}(t,t_w)\sim\left(\frac{\ell}{\ell_w}\right)^{-\lambda}$

$$\lambda \simeq 1.29\,(d=2)$$

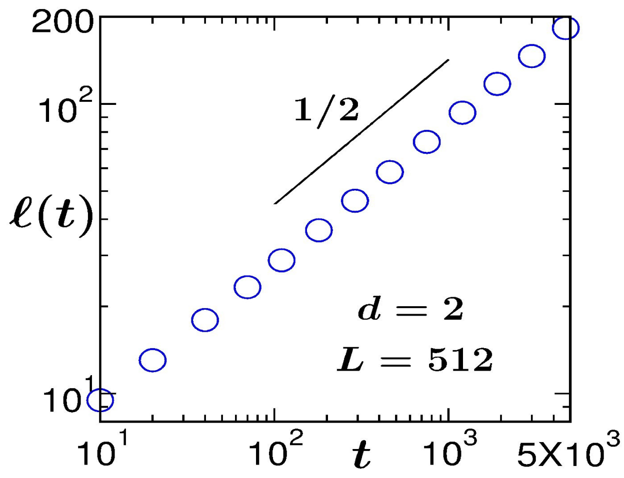
$$\lambda \simeq 1.67\,(d=3)$$

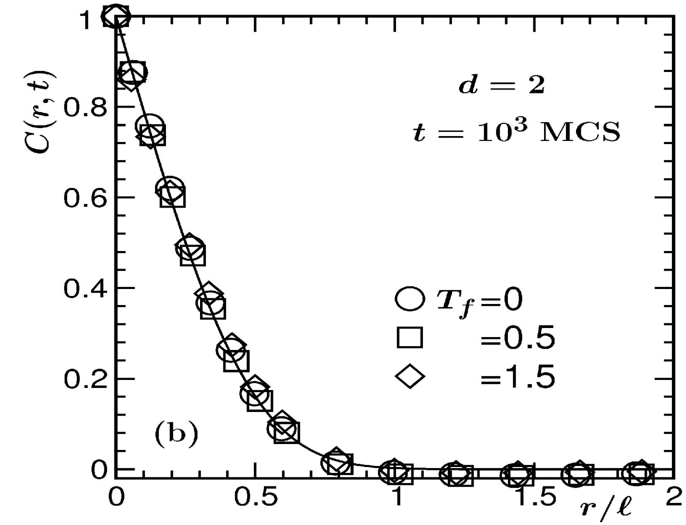
Liu and Mazenko

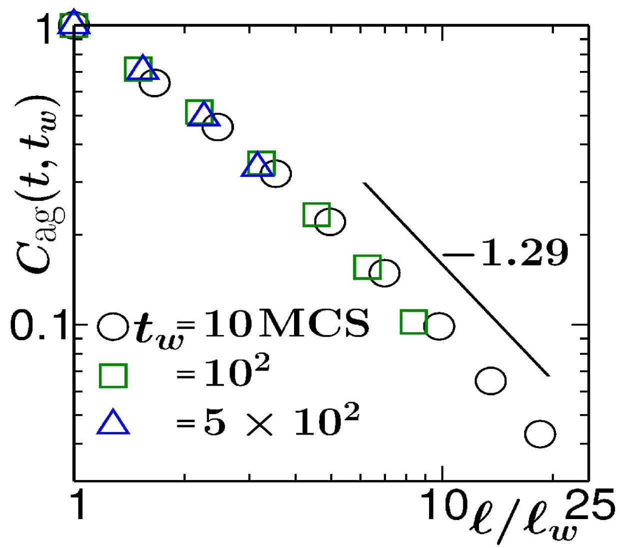
Satisfy Fisher-Huse bound: $\lambda \geq \frac{d}{2}$

No temperature dependence is expected

d=2: everything is fine at all temperatures

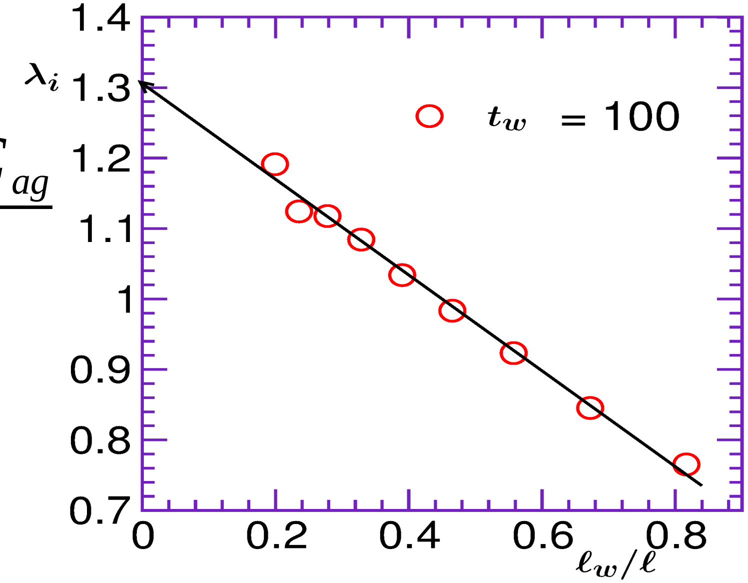






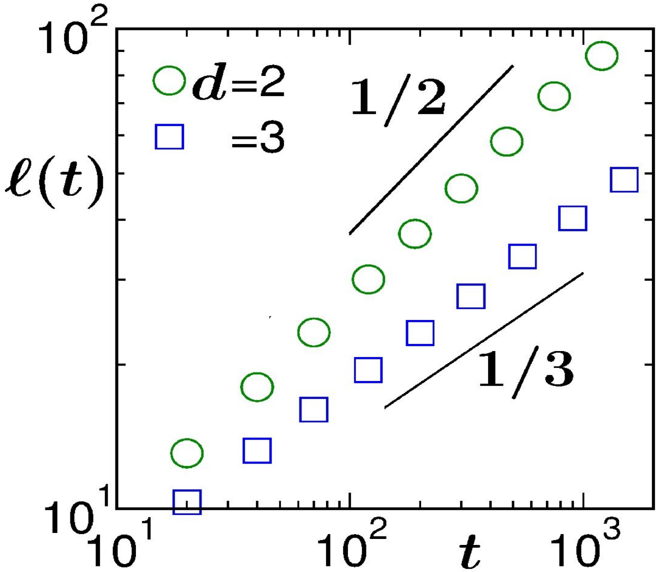
$$\lambda_i = \frac{-d\log C_{ag}}{d\log x}$$

$$x = \ell / \ell_w$$

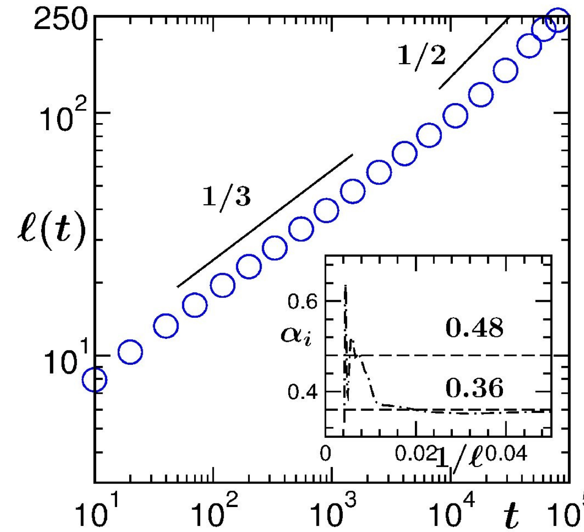


Same good story is true in d=3 for nonzero temperature.

<u>But different story was told for zero temperature quench in d=3.</u> $\alpha = 1/3$

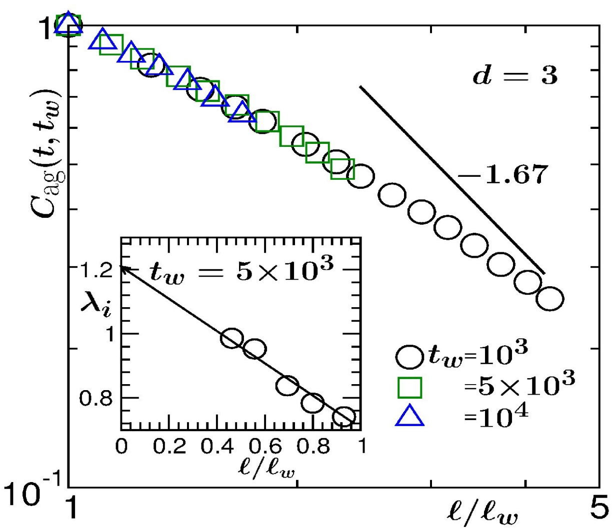


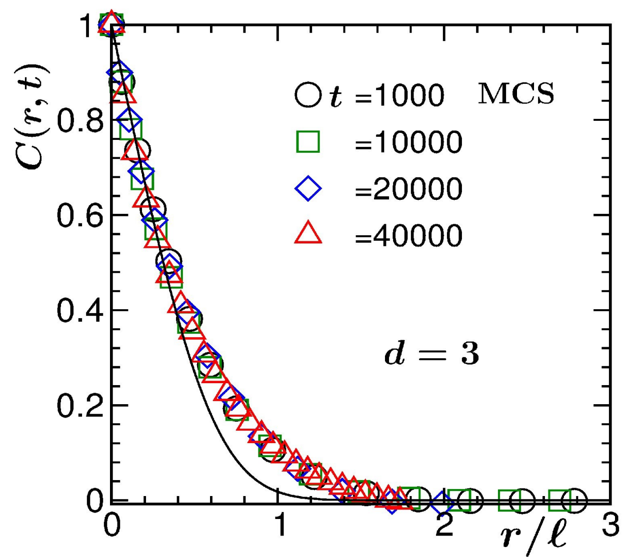
Appears $\alpha = 1/3$ in d=3 at T=0



Very long transient.

$$\alpha_i = \frac{-d\log \ell}{d\log t}$$





λ obeys another bound

Yeung, Rao and Desai

$$\lambda \geq \frac{d+\beta}{2}$$

β is related to long distance behavior of $C(r,t)$

$$S(k \to 0, t) \sim k^{\beta}$$

OJK: $\beta = 0$

Violates Fisher-Huse bound $\lambda \geq \frac{d}{2}$

OJK function does not describe the pattern.

Conclusion:

- Expected growth exponent is observed.
- Different aging exponent can be explained by the structure.

??But Questions remain:

Why is the structure different?

Why there exists such a long transient in the growth?