T=0 3D EA SG in Field

Enzo Marinari

(SMC-INFM and Roma *La Sapienza*, Italy)

So many (short) acronyms in the title: not a good sign...

Looking for the dAT line in finite D models: it is a difficult task. It is difficult with MC and, we see here, it is also difficult with ground states.

We have strong hints toward the existence of a non-trivial phase in non-zero magnetic field at $T = 0$, but it is not unambiguous evidence. Very strong finite size effects.

Work by F. Krzakala, J. Houdayer, O. C. Martin, G. Parisi and E.M.

Ciocco, September 2001

Spin glasses: problems with numerical simulations. T low enough?

So, maybe, compute ground states. Here you are safe, $T = 0$ fixed point.

Now problem is: is $T = 0$ physics same physics than finite T?

Last two years, many progresses. Answer to last question is yes (very low T simulations and direct connection to ground state physics).

Pal, Rieger, Houdayer and Martin, Palassini and Young, Krzakala and Martin, Parisi and EM.

Model in field: challenging. Very strong finite size effects. Finite T MC simulations not conclusive.

Here ground states in field. Genetic algorithm (not exact, but check with two different algorithms and implementation).

1. PAP computation.

Compute the ground state $\mathcal{G}_0$.

Change the sign of all couplings cutting a given plane Π (this is equivalent to impose antiperiodic boundary conditions across this plane).

Compute the new ground state $\mathcal{G}_1$.

Compute the $\{q(i)\}$, overlap of $\mathcal{G}_0$ and $\mathcal{G}_1$ at site i. Look at sites where the ground state differs. (note for expert conference goers: in $B \neq 0$ this is not gauge invariant).

2. Sponges.

Replica Symmetry Breaking: for $B < B_{AT}$ there exists macroscopically distinct valleys differing by energies of $O(1)$. They disappear for $B > B_{AT}$.

These valleys differ by excitations that span the whole system.

They wind around the lattice.

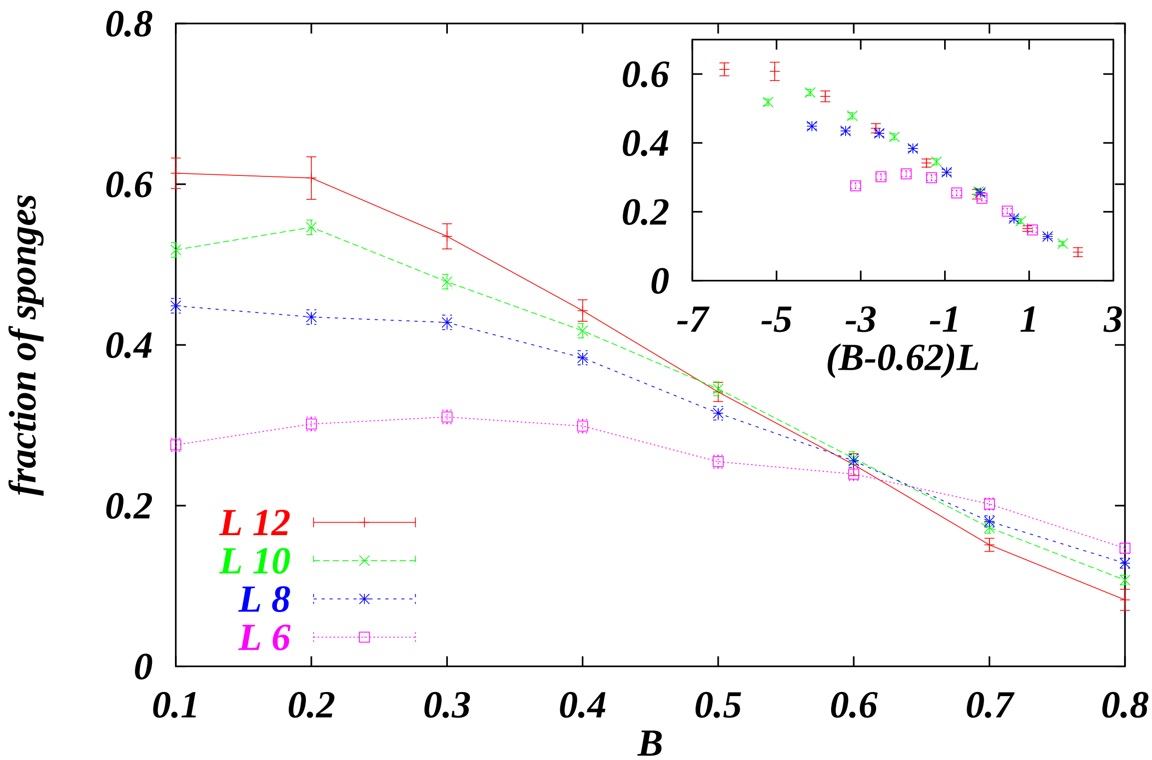
We define them to be sponge-like when the cluster and the complement wrap around the lattice in all three directions (Houdayer, Krzakala, Martin).

This is maybe our best evidence for $B_c \simeq 0.65$.

Scaling:

$$\text{fraction} \simeq (B - B_c)\, L^{\frac{1}{\nu}}$$

$(\nu \simeq 1,\ B_c \simeq 0.62)$



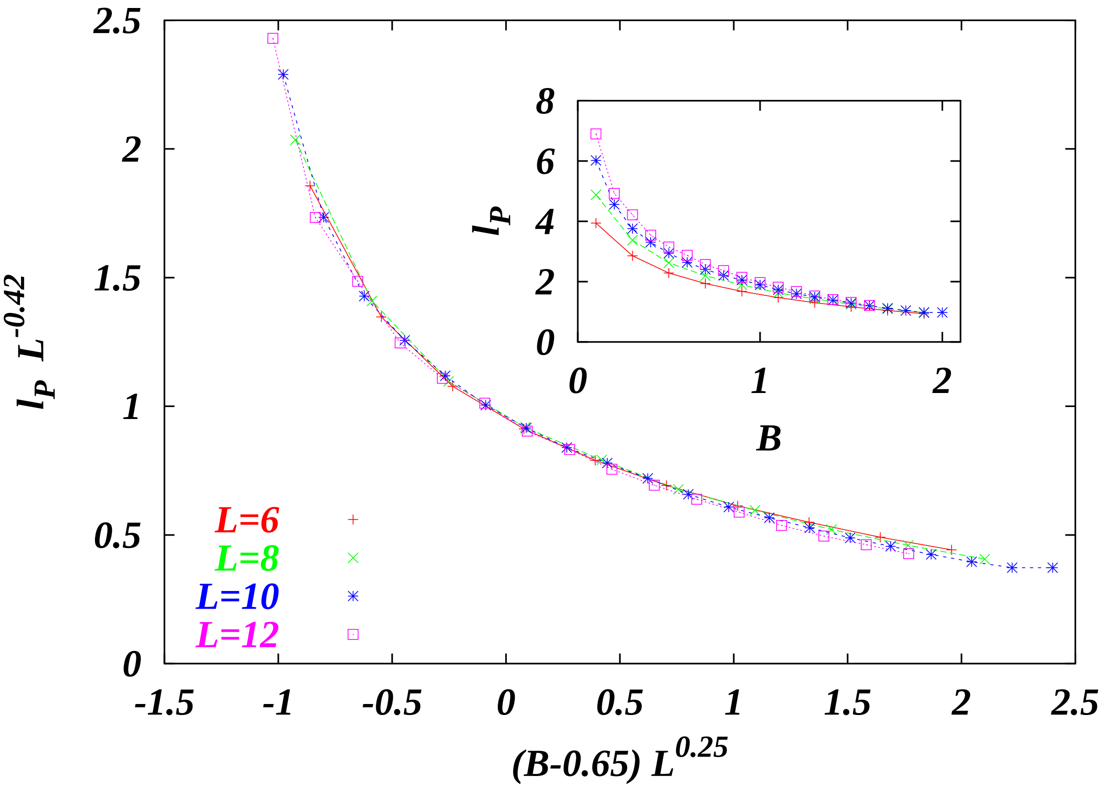
Orthogonally to the plane where we change the couplings we define

$$Q(d) \equiv \sum_{x,y,z=d} q(x,y,z)$$

For $B > B_c$ we expect $Q(d) \simeq 1 + e^{-\frac{d}{\xi}}$.

For $B \leq B_c$ we expect a power law decay, and the effective length ξ increases with the lattice size.

Good fit with $B_c = 0.65$.



A different method: one spin flip.

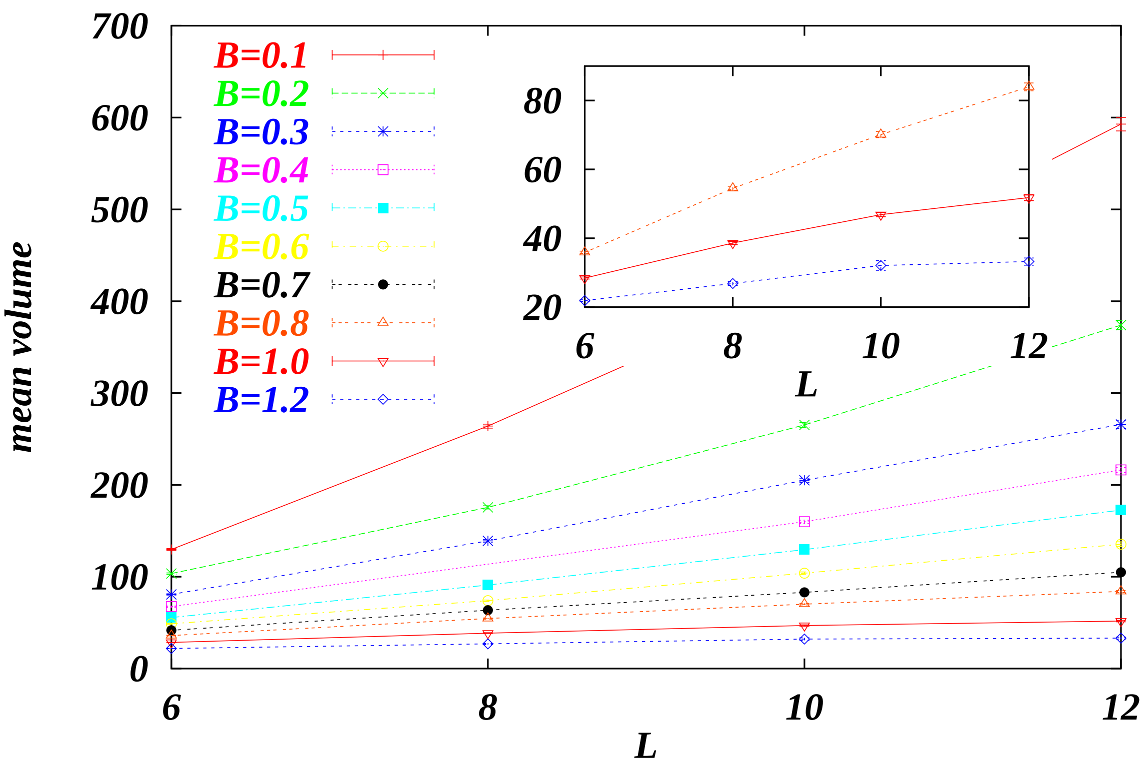
Given the spins belonging to the ground state G_0 randomly select the spin S_k, and flip it.

Now compute the new ground state G_1 keeping S_k fixed.

The difference between G_0 and G_1 is a connected cluster of spins of volume V.

Spin glass phase: $V \to \infty$ for $L \to \infty$. Paramagnetic phase: bounded V.

In the figure. Clear saturation of V for $B \geq 1$. V grows for smaller B.



Sponge like excitation fraction as before. It looks clear that for small field it is not going to zero.