Statistical Field Theory and Applications

M2 - Theoretical Physics

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What are we aiming at describing?

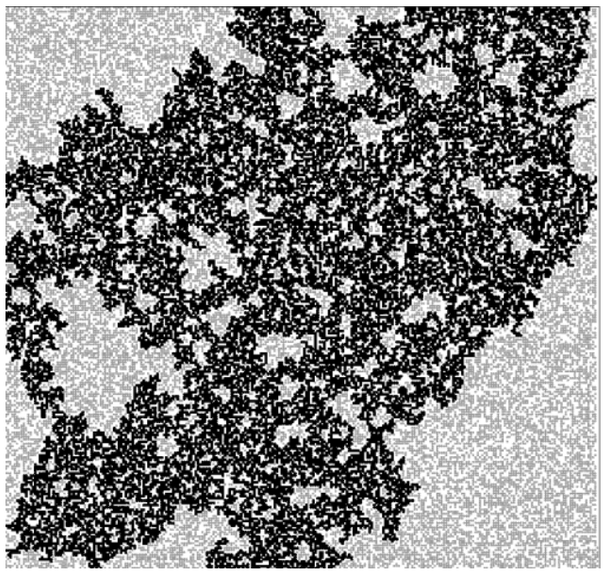
*** Systems with infinitely many degrees of freedom (d.o.f.) :**

—> Collective phenomena, collective modes, geometrical (random) patterns,....

*** Typical (stat. mech.) examples :**

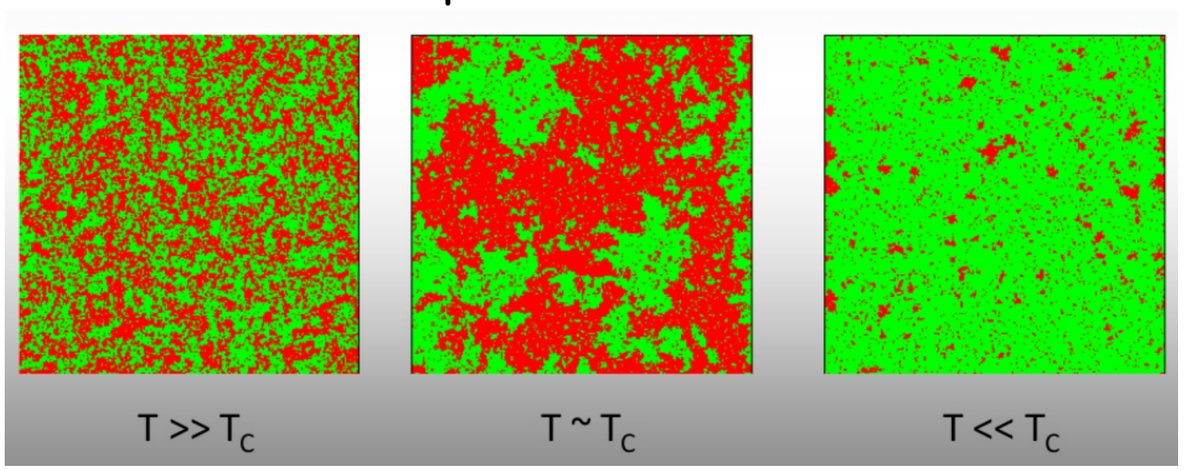
Percolation: the simplest local model

- black = filled
- white = empty

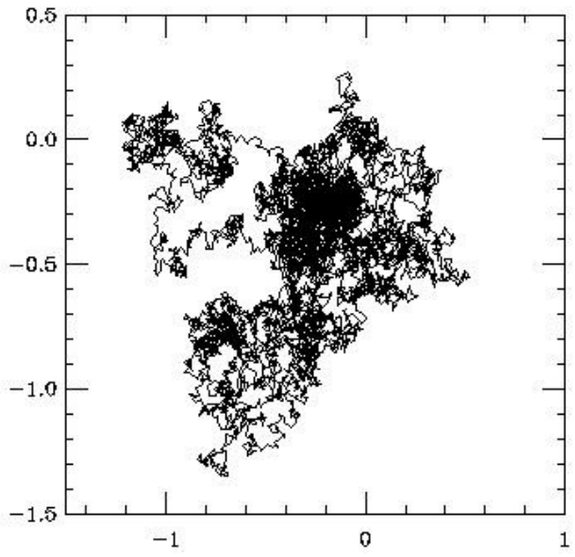


Ising spin clusters:

- green = spin up
- red = spin down.

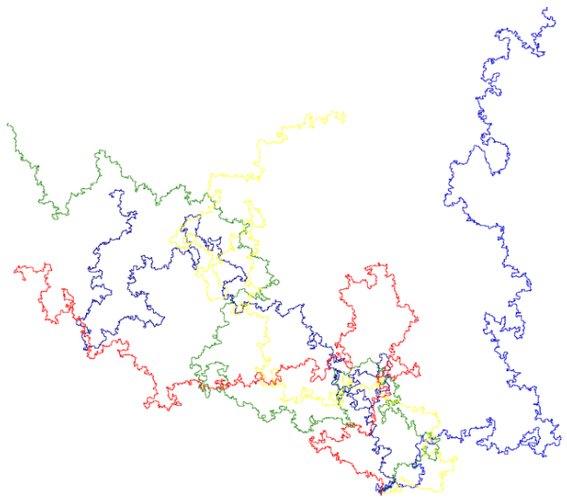


* More (geometrical) examples:



Brownian motion (2D).

Self-avoiding walks,
alias « polymers »



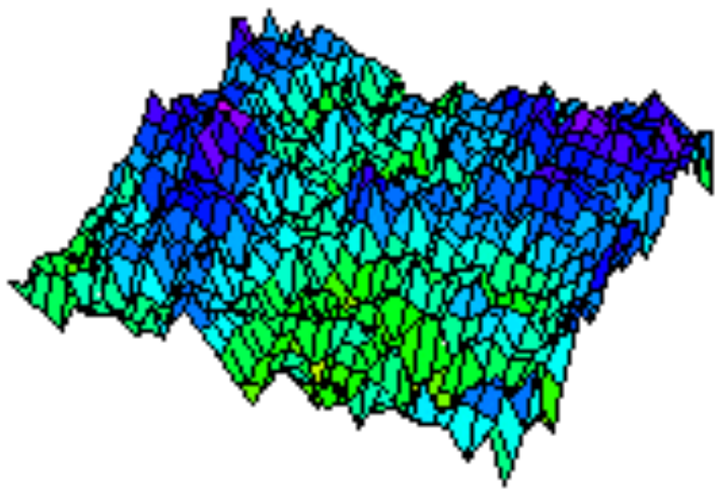
→ **Critical phenomena, universality,…**
Renormalisation group,…
Aspects of random geometry,…

How are we describing them?

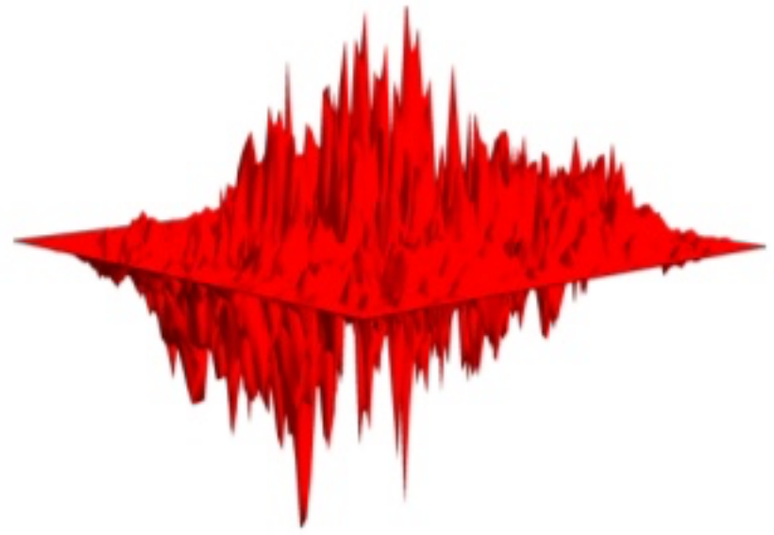
* **Statistical Field Theory :**

— Part of statistical physics (at equilibrium or not)…
with ramifications in other domains (say Condensed Matter, QFT,…)

— An important tool of theoretical physics with deep math connections,…
(probability theory, representation theory, geometry, RG,…)



Samples of a
(discretized)
Gaussian free field



→ **Statistical physics with infinitely many (geometrical… singular) degrees of freedom.**

Plan : (order different from the lecture notes)

— Brownian motions, random paths.
— Statistical lattice models and field theory.
— Renormalization group and universality.

} criticality & universality

— Statistical field theory: free theory.
— Statistical field theory: interactions.
— Conformal field theory: basics.

} field theory : (objects, tools & techniques)

— Scaling limits, field theory and the renormalization group.

} scaling limits & RG

— 12+1 sessions: 3h-lecture + 1h-exercises.
Exercises (1 week after the lectures).

— Lecture notes : see https://www.phys.ens.fr/~dbernard/
« Statistical field theory and applications: an introduction for (and by) amateurs »
— Exercice booklet (with corrections): (address=idem)