# GINO DEL FERRARO

From Italy - (Rome)

KTH Royal Institute of Technology
- Department of Computational Biology -
Stockholm

Supervisor
Prof. ERIK AURELL

Universitary studies:

Università degli studi di Roma
"La Sapienza

Rome, Italy

PhD studies:

KTH Royal Institute of Technology

Stockholm, Sweden

Academic Studies:                    Università degli studi di Roma
                                     "La Sapienza"

Academic Studies:

Università degli studi di Roma
"La Sapienza"

- Bachelor Degree: → "Regular and Chaotic Motion in Hamiltonian Systems"

- Supervisor: Angelo Vulpiani

## Academic Studies:

Università degli studi di Roma
"La Sapienza"

- <u>Bachelor Degree:</u> → "Regular and Chaotic Motion in Hamiltonian Systems"

  - Supervisor: Angelo Vulpiani

- <u>Master Degree</u> → "Models for self non-self discrimination in the immune system"

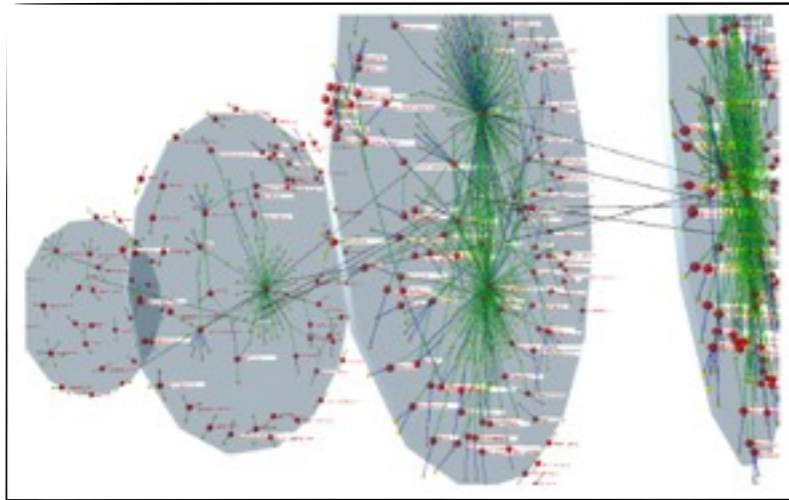  - Supervisors:

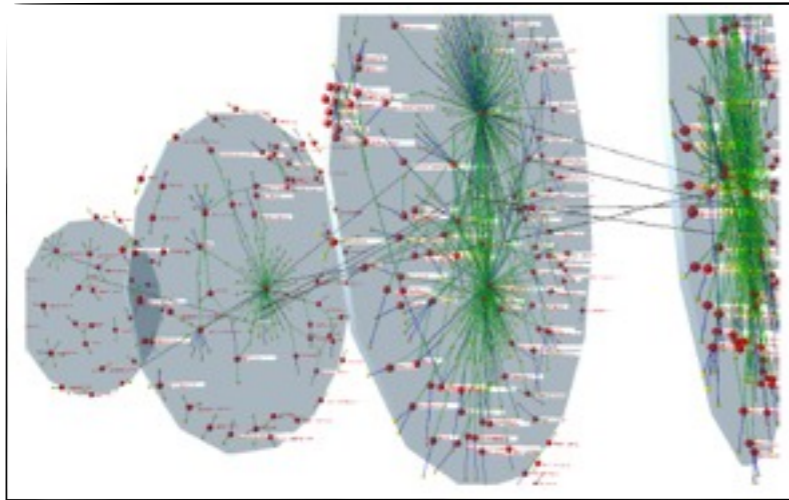    Francesco Guerra

    Adriano Barra

# Dynamics on Networks

Dynamics of Complex Systems
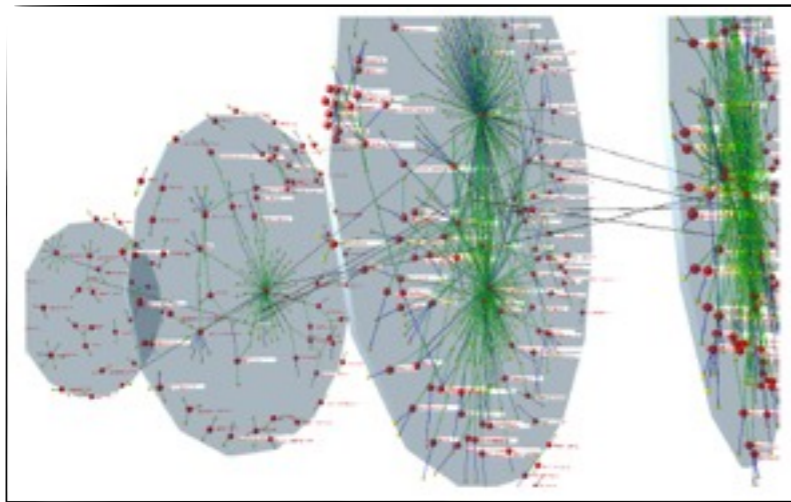
# Dynamics on Networks

## Dynamics of Complex Systems



● Supervisor: Erik Aurell

# Dynamics on Networks

## Dynamics of Complex Systems



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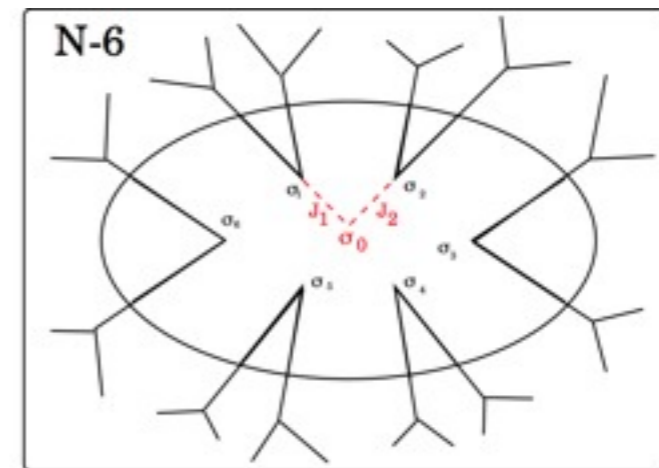
**"Cavity Method for non-equilibrium states"**



Develop **dynamic BP (Belief Propagation) methods** to give a description of **non-equilibrium states**

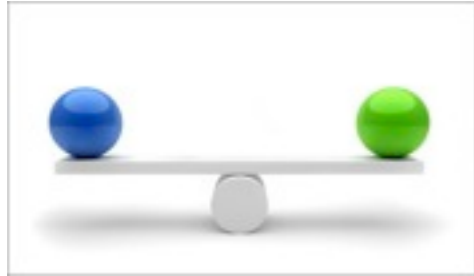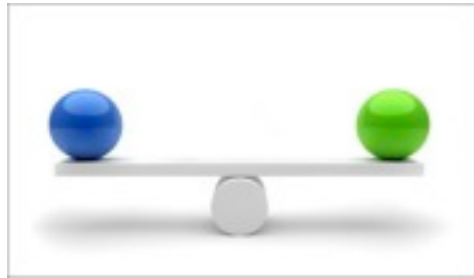Compare the results with **naive mean field** and **dynamic TAP methods**

# Why is so interesting to study dynamics on networks?
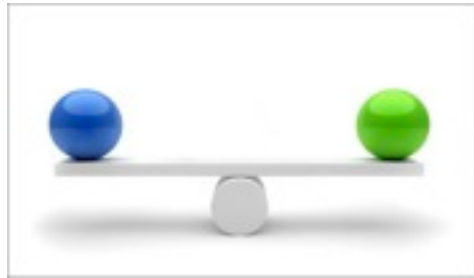
Thursday, January 23, 14

**Equilibrium** state on networks **has been studied** for decades

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⬇

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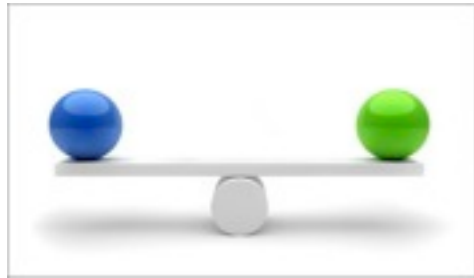
**Dynamics description**

**Equilibrium** state on networks **has been studied** for decades

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By using a thermodynamic description
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**Dynamics description**

Some characteristic are not caught by the thermodynamic description

(dynamical phase transitions, aging, trapping in metastable states, ....)

We are interested in the dynamic behavior of some relevant observables

(magnetization, correlations, density of some physical variable, ...)

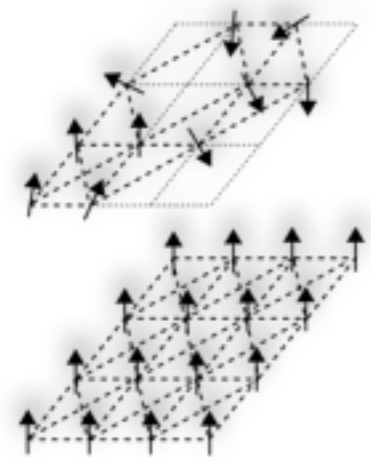**- - Many interesting aspects emerge only during dynamics and not at equilibrium - -**

# Possible Applications:

Metastability in the brain

   Neurodynamics
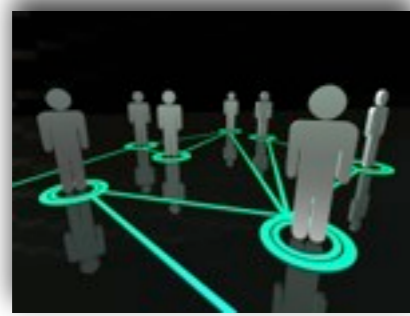
Social networks

Spreading diseases

Dynamics of spin glasses

Communicate systems

# Other formative experiences so far:

Thursday, January 23, 14

**Trieste - ICTP, SISSA**

the end of October - the end of December, 2013          School and courses in ICTP and SISSA

Matteo Marsili

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Silvio Franz

Static and Dynamics of spin glasses

breaking ergodicity in p spin model

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breaking ergodicity in p spin model

**Formative collaborations:**

Helsinki, Aalto University

Alexander Mozeika

Macroscopic analysis of dynamics

## Courses:

Information Theory (KTH)

Mathematical method for equilibrium statistical mechanics of spin glasses (KTH)

General Relativity (KTH)

Advanced topics in probability theory (SISSA)

Technical English course (KTH)

## Schools:

Winter school in "Quantitative System Biology" (ICTP)

Netadis summer school May - June 2013 (ICTP)

Netadis summer school Sept - Oct 2013 (Hillerod)

Winter school on "Statistical physics, optimization, inference and message-passing algorithms" (École de Physique des Houches)

**Tutoring:**    EuSYSBIO Program at KTH

Course on Spin Glasses at KTH in
Stockholm

Adriano Barra

Course on Spin Glasses at KTH in Stockholm

⬇

Adriano Barra

● Project on interpolating techniques applied on Spin Glasses

**"Mean field spin glasses treated with PDE techniques"**

Adriano Barra, GDF, Daniele Tantari --- Eur. Phys. J. B (2013) 86: 332

Course on Spin Glasses at KTH in
Stockholm

Adriano Barra

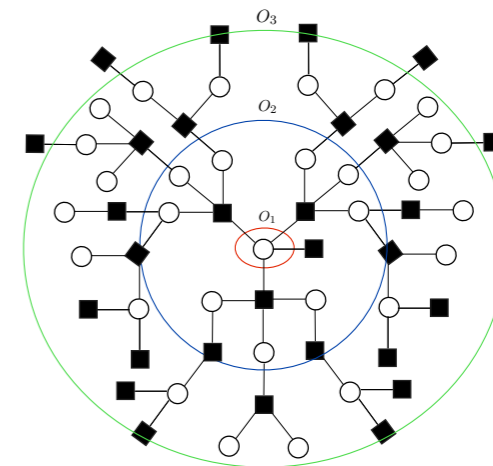- Project on interpolating techniques
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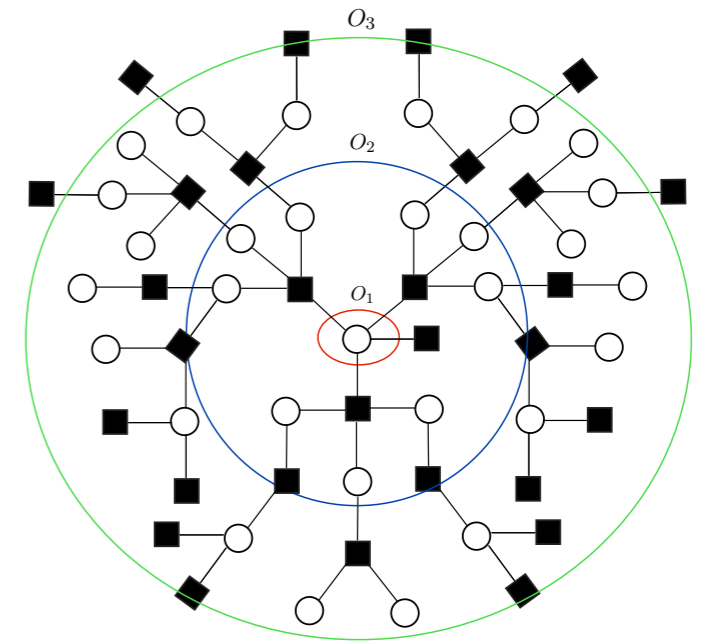- Construction of a large deviation theory for
  off-equilibrium processes

application on a one-dimensional Ising model

**"Perturbative large deviation analysis of non-equilibrium dynamics"**

GDF, Erik Aurell --- **arXiv:1401.4685**

Monday, December 16, 13
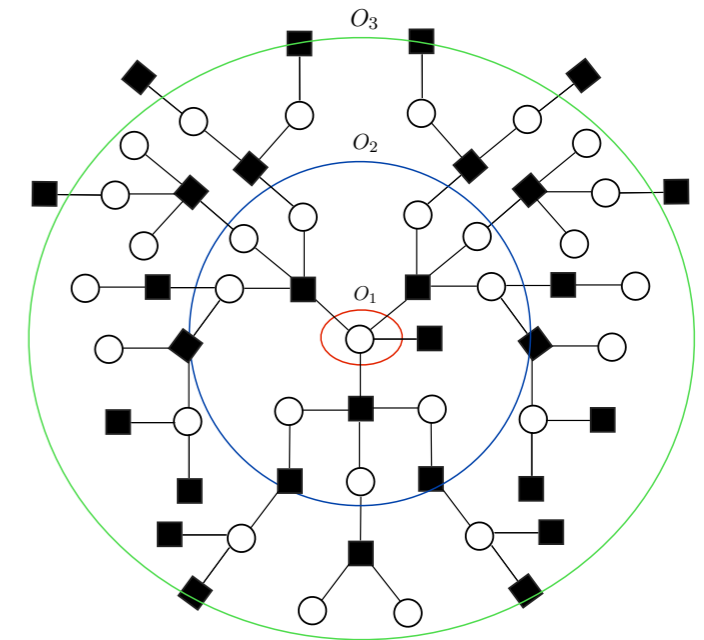
$O_3$

$O_2$

$O_1$

Monday, December 16, 13

Large deviation function for the probability distribution

$$P(s) \propto \exp\left(-NV(s)\right)$$

where $\quad V = \text{Const.} + \beta_1 o_1(s) + \ldots + \beta_L o_L(s)$



Monday, December 16, 13

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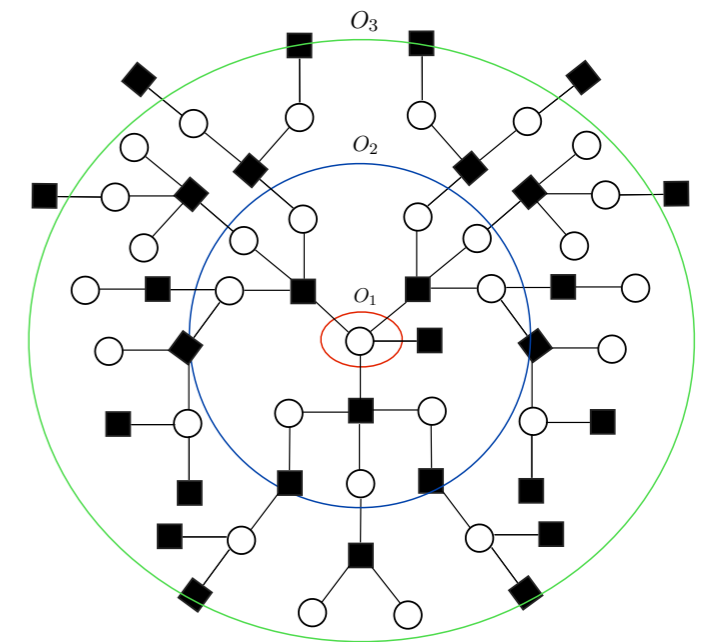
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## Two parameter theory

$$P_{\text{Ising-2}}(s) = \exp\left(-\beta_M M(s) - \beta_E E(s) - F\right)$$



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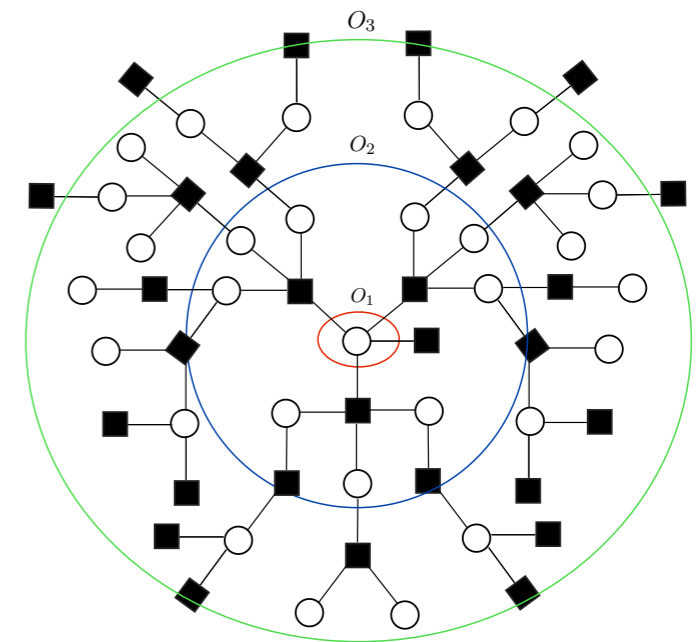
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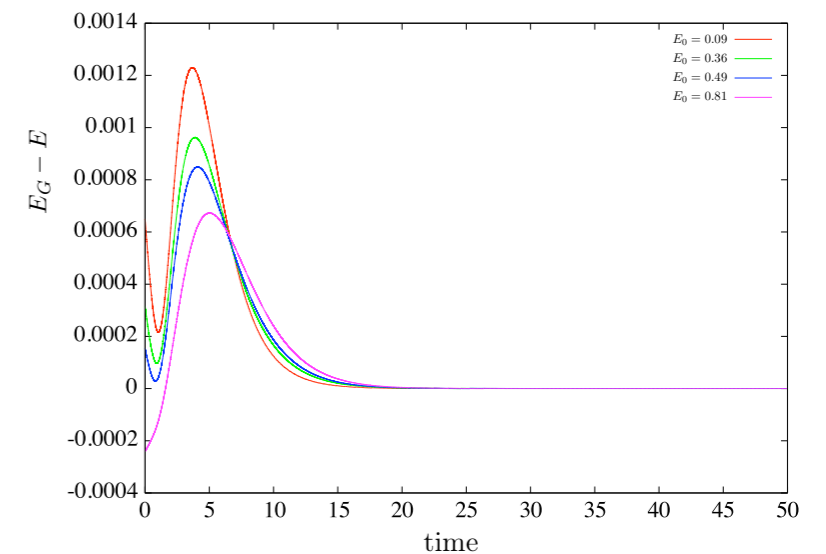
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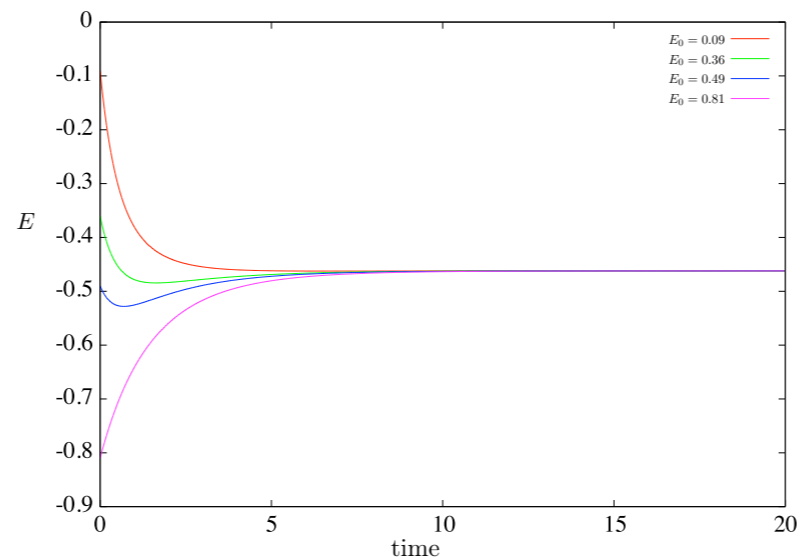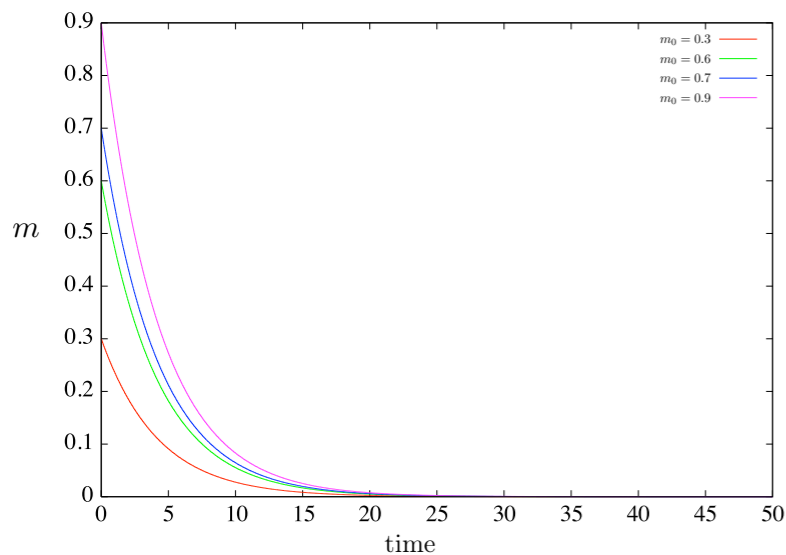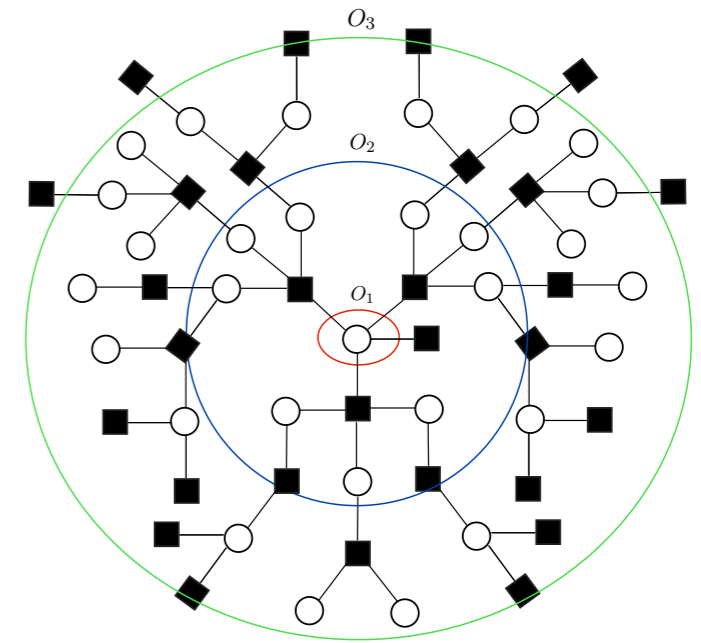
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## Joint spin field theory

$$P^{\text{LCS}} = \exp\left(\sum_{s,h,i} d(s,h) 1_{s_i,s} 1_{h_i,h} - F\right)$$

1

Large deviation function for the probability distribution

$$P(s) \propto \exp\left(-N V(s)\right)$$

where $\quad V = \text{Const.} + \beta_1 o_1(s) + \ldots + \beta_L o_L$

Two parameter theory

$$P_{\text{Ising-2}}(s) = \exp\left(-\beta_1 N \ldots\right)$$

Joint spin field theory

$$P^{\text{LCS}} = \exp\left(\sum_{s,h,i} d(s,h)\right)$$

# Thank you

Thursday, January 23, 14