INCT-SC
Modelos Magneticos Desordenados

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- Principais Temas de Interesse:

i) Sistemas Magneticos Desordenados:

Cols. (INCT-SC): Evaldo M.F. Curado, J. Ricardo de Sousa, Octavio R. Salmon

ii) Mec. Estatistica Nao-Extensiva:

Cols. (INCT-SC): Constantino Tsallis, Evaldo M.F. Curado

Disordered Magnetic Models

$$\mathcal{H} = -\sum_{\text{nn}} J_{ij}^{(1)} \sigma_i \sigma_j - \sum_{\text{nnn}} J_{ij}^{(2)} \sigma_i \sigma_j - \sum_i h_i \sigma_i$$

$$\text{Ising variables} : \sigma_i = \pm 1$$

$$\text{Randomness} : P(J_{ij}^{(1)}), P(J_{ij}^{(2)}), P(h_i)$$

- Important questions:

a) Phase diagrams

b) Universality (Harris criterion)

c) Validity of scaling relations

d) Structure of low-temperature phase

- Competing Random Interactions:

$$\mathcal{H} = -J_1 \sum_{\text{nn}} \sigma_i \sigma_j - \sum_{\text{nnn}} J_{ij}^{(2)} \sigma_i \sigma_j$$

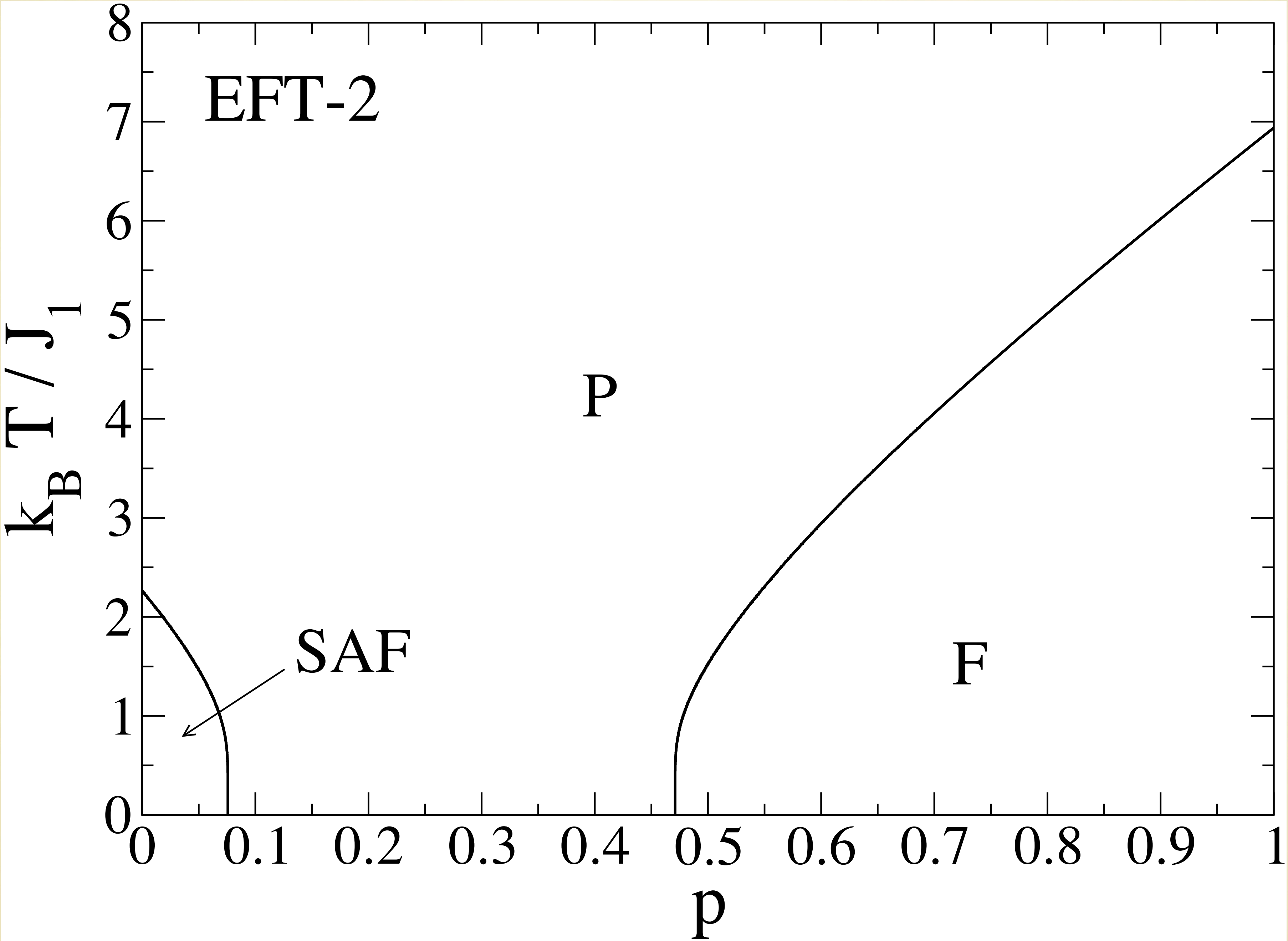
$$P(J_{ij}^{(2)}) = p\delta(J_{ij}^{(2)} - J_2) + (1-p)\delta(J_{ij}^{(2)} + J_2)$$

$$J_1, J_2 > 0; \quad R = (J_2/J_1)$$

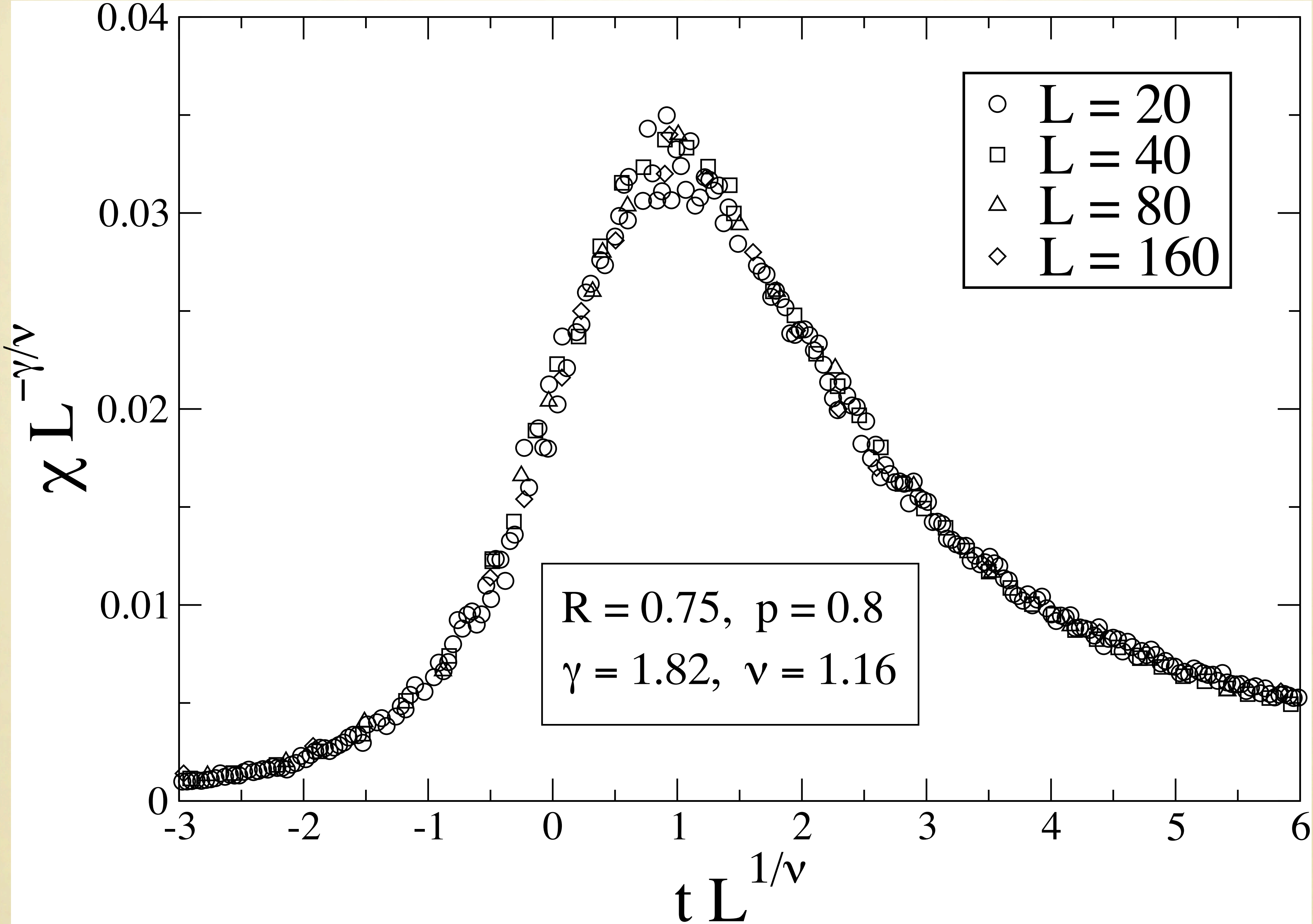
$$p = 1: \text{ Ising universality class}$$

$$p = 0: \text{ Universality class changes with } R$$

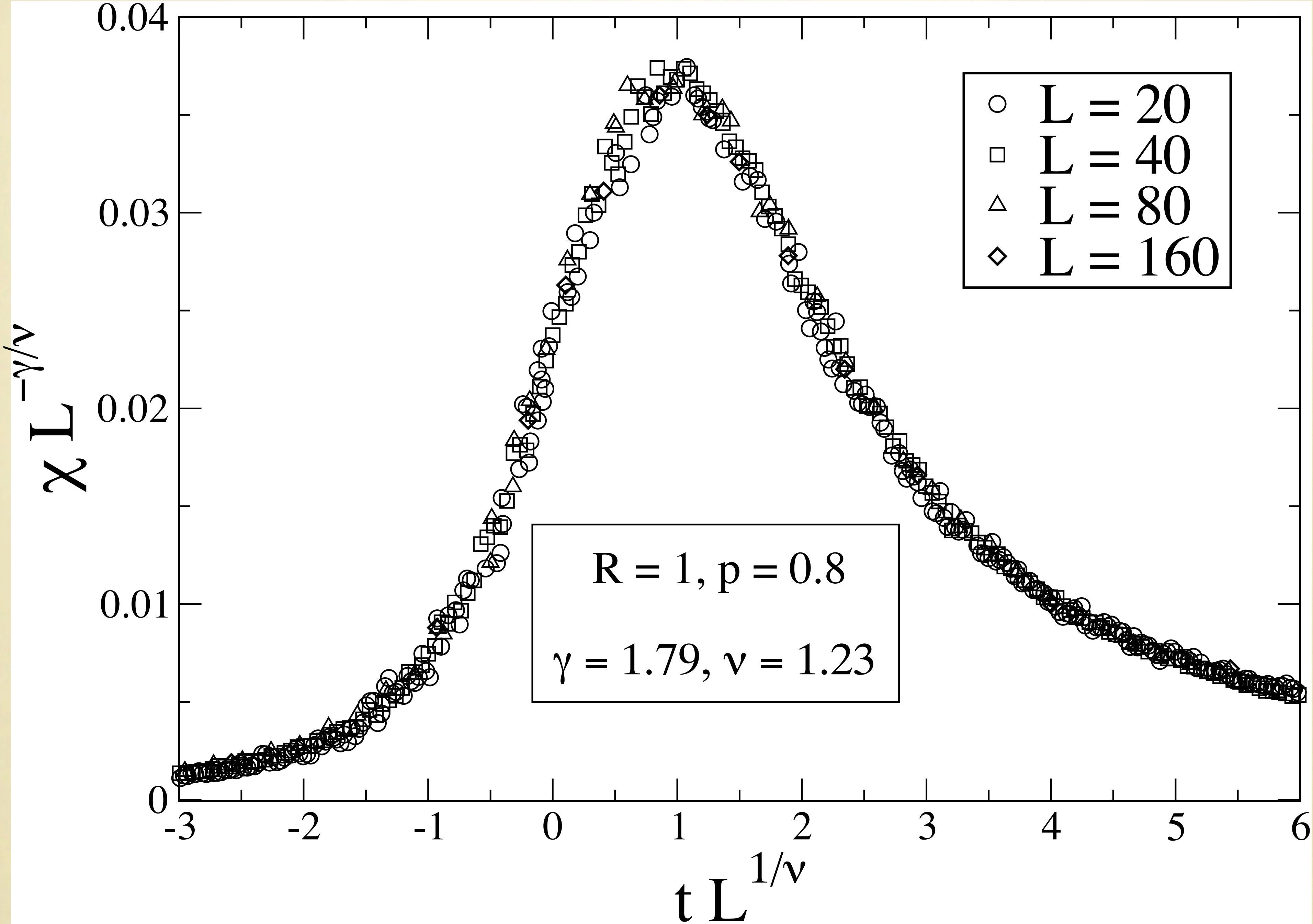
2d: $\alpha(p=1) = 0$ → Harris criterion ??

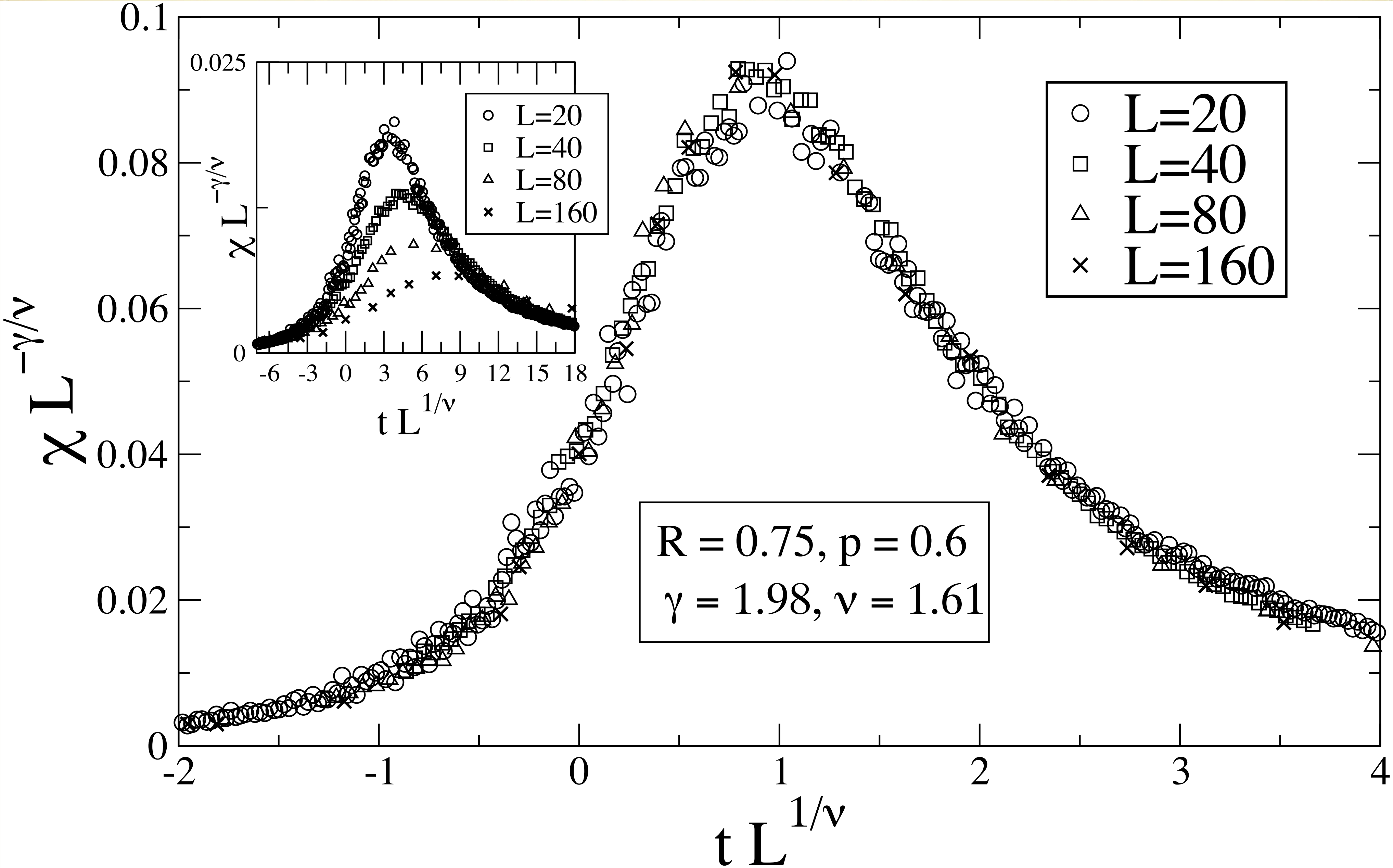


$R = 1$

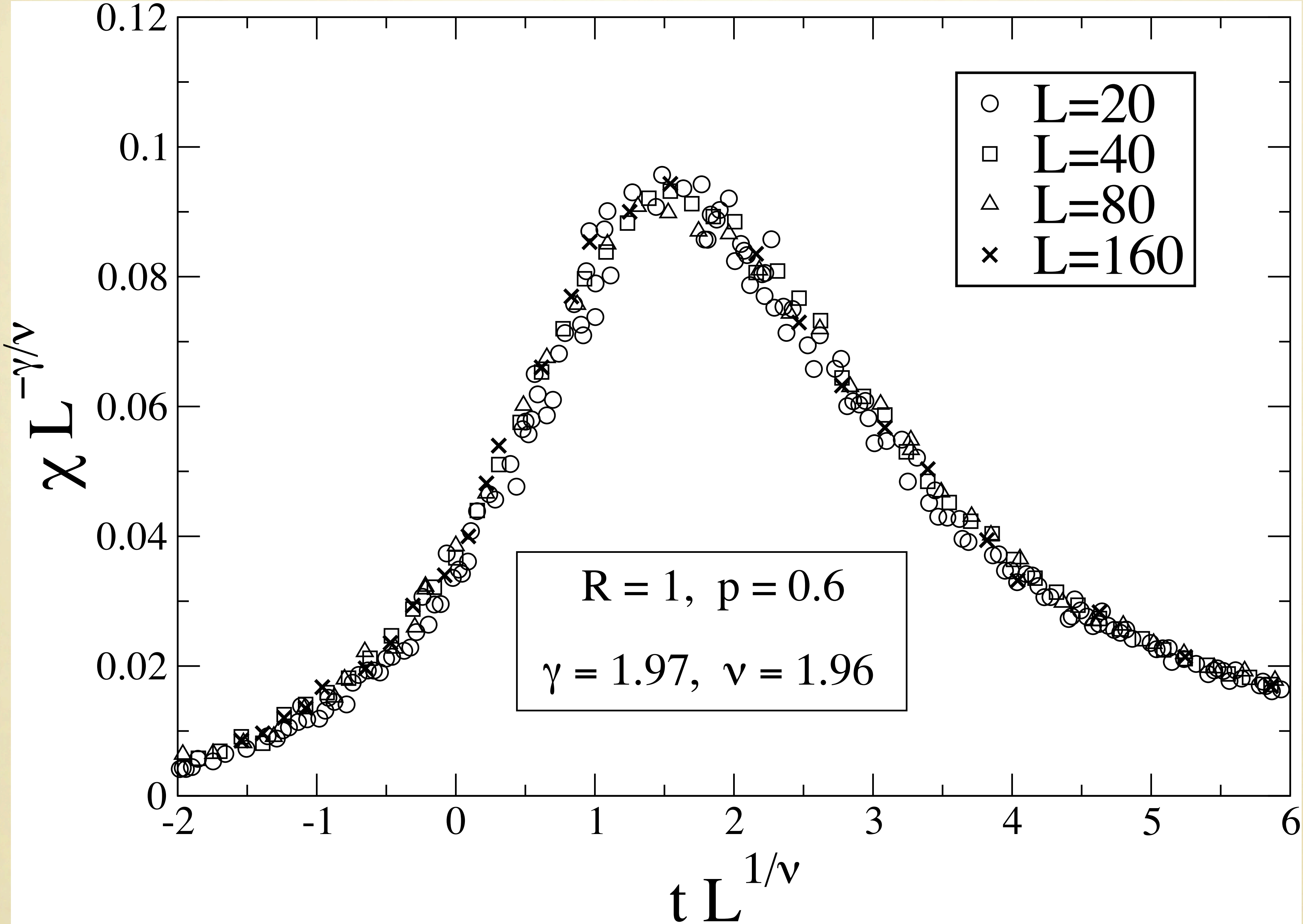


L = 20
L = 40
L = 80
L = 160
R = 0.75, p = 0.8
γ = 1.82, ν = 1.16
$\chi L^{-\gamma/\nu}$
$t L^{1/\nu}$
0
0.01
0.02
0.03
0.04
-3
-2
-1
0
1
2
3
4
5
6

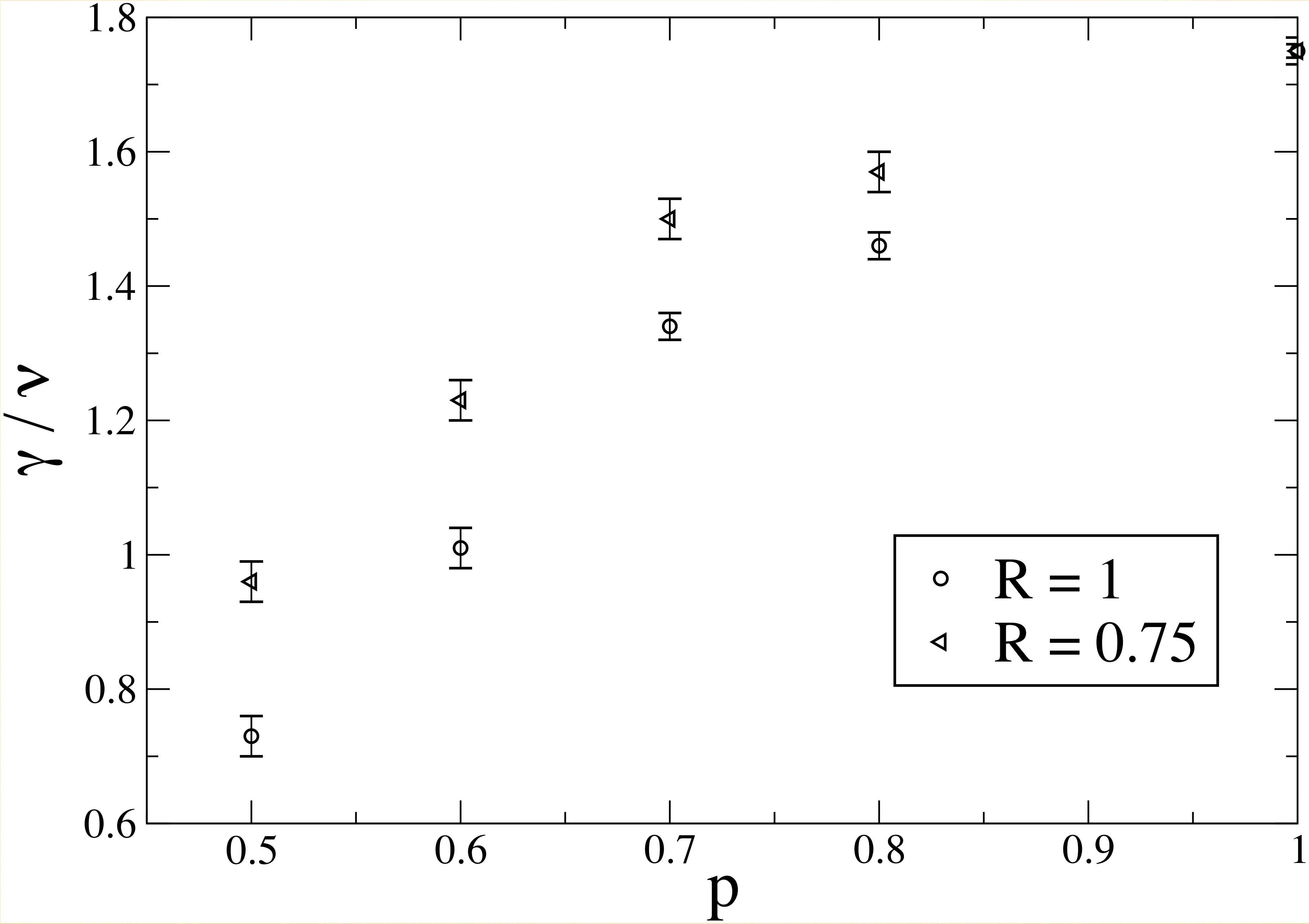

L = 20
L = 40
L = 80
L = 160
R = 1, p = 0.8
γ = 1.79, ν = 1.23
$\chi L^{-\gamma/\nu}$
$t L^{1/\nu}$
0.04
0.03
0.02
0.01
0
-3
-2
-1
0
1
2
3
4
5
6



0.1
0.08
0.06
0.04
0.02
0
-2
-1
0
1
2
3
4
$\chi L^{-\gamma/\nu}$
$t L^{1/\nu}$
L=20
L=40
L=80
L=160
R = 0.75, p = 0.6
γ = 1.98, ν = 1.61
0.025
0
-6
-3
0
3
6
9
12
15
18



0.12
0.1
0.08
0.06
0.04
0.02
0
-2
-1
0
1
2
3
4
5
6
$\chi L^{-\gamma/\nu}$
$t L^{1/\nu}$
L=20
L=40
L=80
L=160
R = 1, p = 0.6
γ = 1.97, ν = 1.96



1.8
1.6
1.4
1.2
1
0.8
0.6
γ / ν
0.5
0.6
0.7
0.8
0.9
1
p
R = 1
R = 0.75

Proper-Dynamics Spin Glass (Rotors):

$$\mathcal{H} = \frac{1}{2}\sum_{i=1}^{N}\sum_{\mu} L_{i\mu}^2 + \sum_{(ij)} J_{ij}(1 - \vec{S}_i.\vec{S}_j)$$

$$\dot{\vec{L}}_i = \vec{S}_i \times \sum_{j(i)} J_{ij}\vec{S}_j \; ; \qquad \dot{\vec{S}}_i = \vec{L}_i \times \vec{S}_i$$

$$J_{ij} \to P(J_{ij}), \;\; \mathrm{RKKY}$$

$$J_{ij}(R_{ij}) = \frac{J_0 \cos(2k_{\mathrm{F}}R_{ij} + \phi_0)}{(k_{\mathrm{F}}R_{ij})^{\alpha}} \qquad (\mathrm{RKKY} : \alpha = 3)$$

Motivation: recent experiments on some canonical (RKKY) spin glasses

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Generalized Spin-Glass Relaxation

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Spin relaxation close to the glass temperature of CuMn and AuFe spin glasses is shown, by neutron spin echo, to follow a generalized exponential function which explicitly introduces hierarchically constrained dynamics and macroscopic interactions. The interaction parameter is directly related to the normalized Tsallis nonextensive entropy parameter q and exhibits universal scaling with reduced temperature. At the glass temperature $q = 5/3$ corresponding, within Tsallis' q statistics, to a mathematically defined critical value for the onset of strong disorder and nonlinear dynamics.

$\Psi[P(x,t)]$ and $\Omega[P(x,t)]$: positive, finite, integrable, differentiable (at least once)