

# Modelo de Ising

$$H = - \sum_{(i,j)} J_{ij} \sigma_i \sigma_j - B \sum_i \sigma_i$$

# Modelo de Ising 2D: Simulação

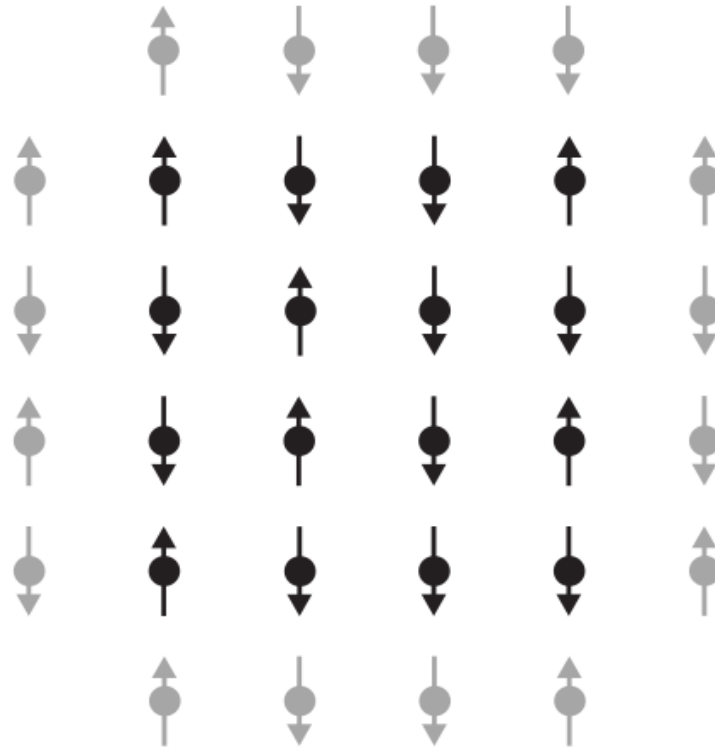
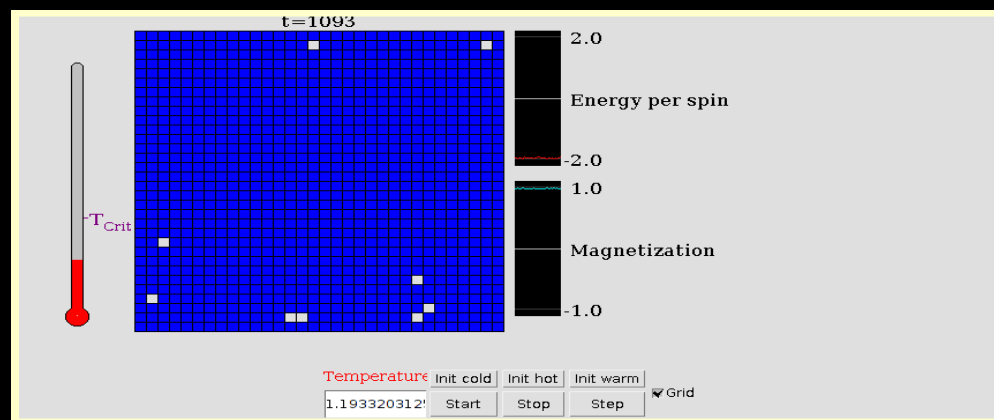
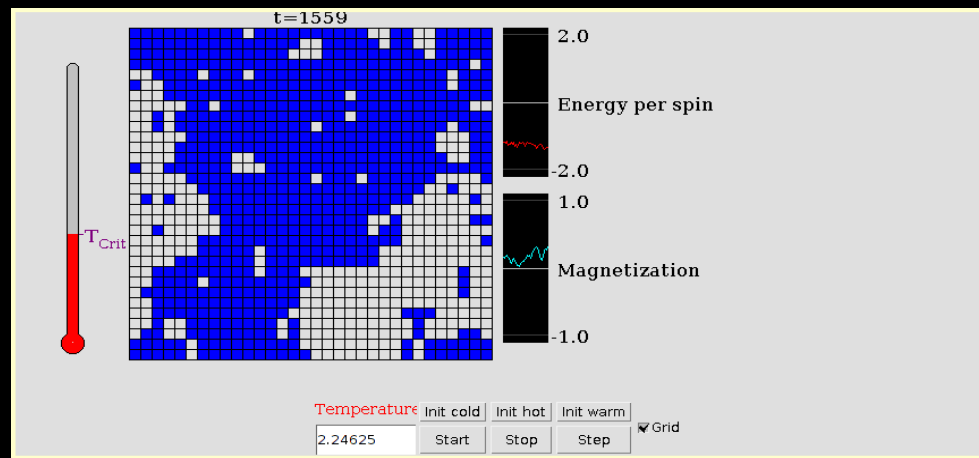
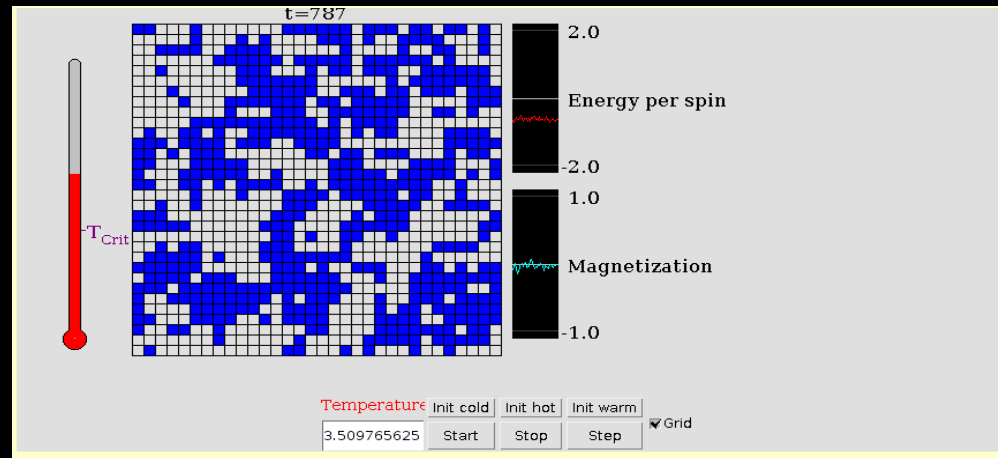
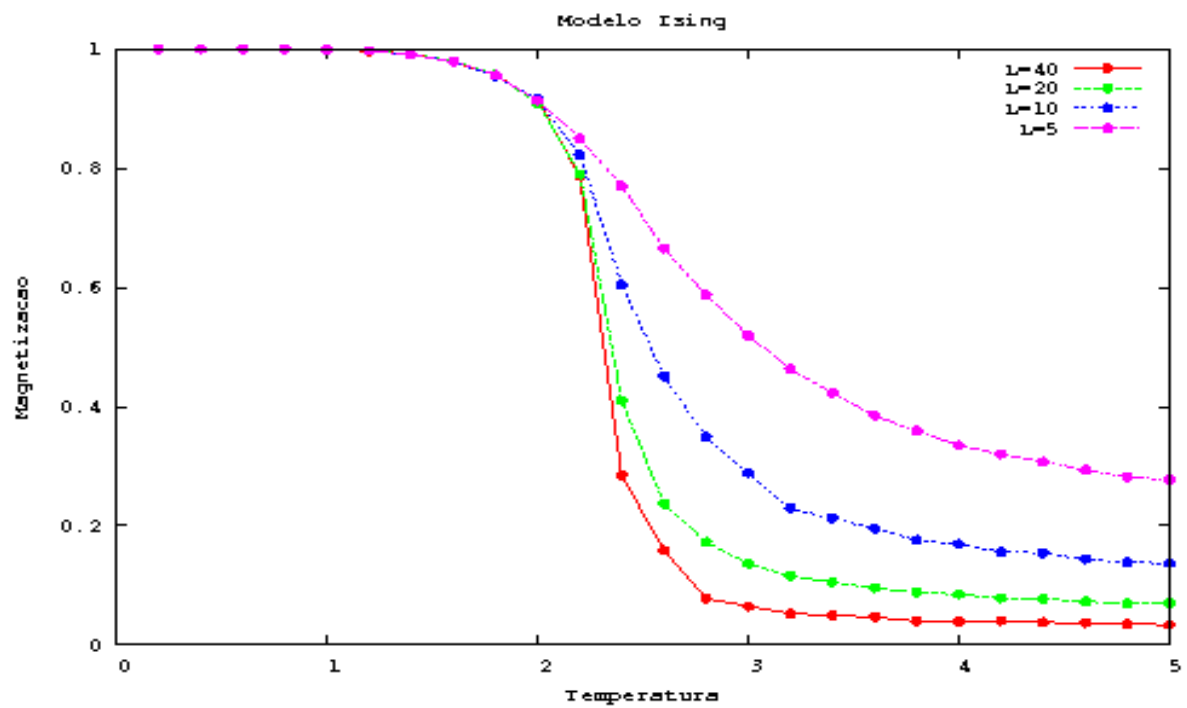


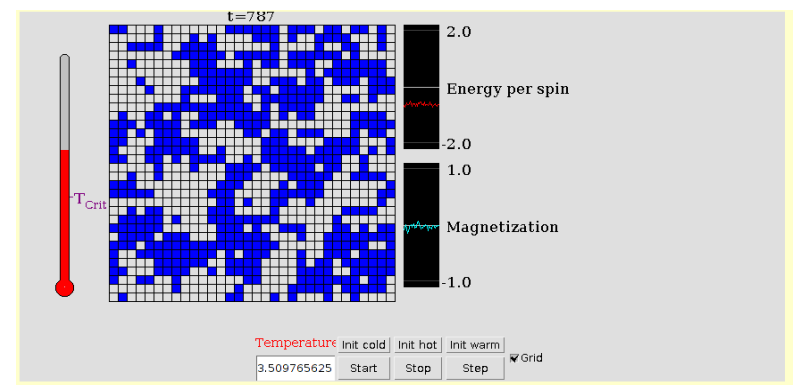
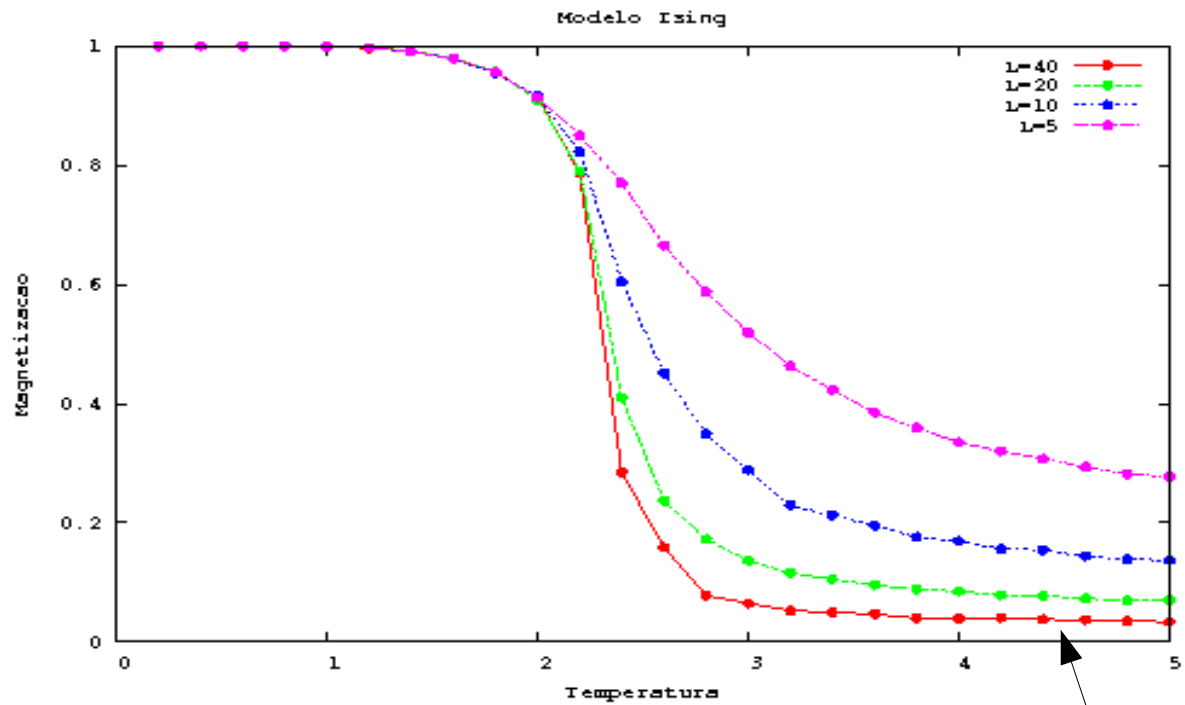
Figura 1: os elementos em cinza são apenas imagens das bordas para o cálculo da energia.

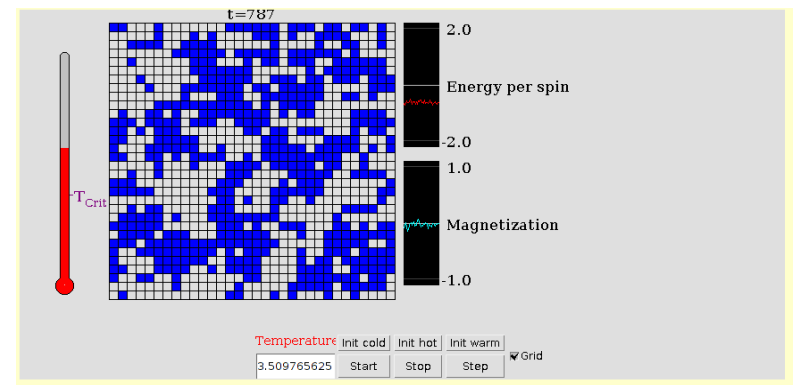
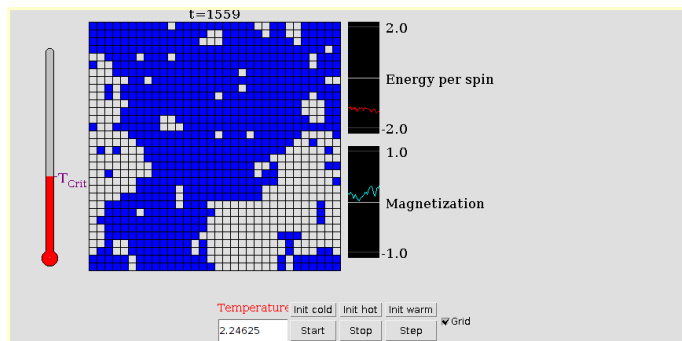
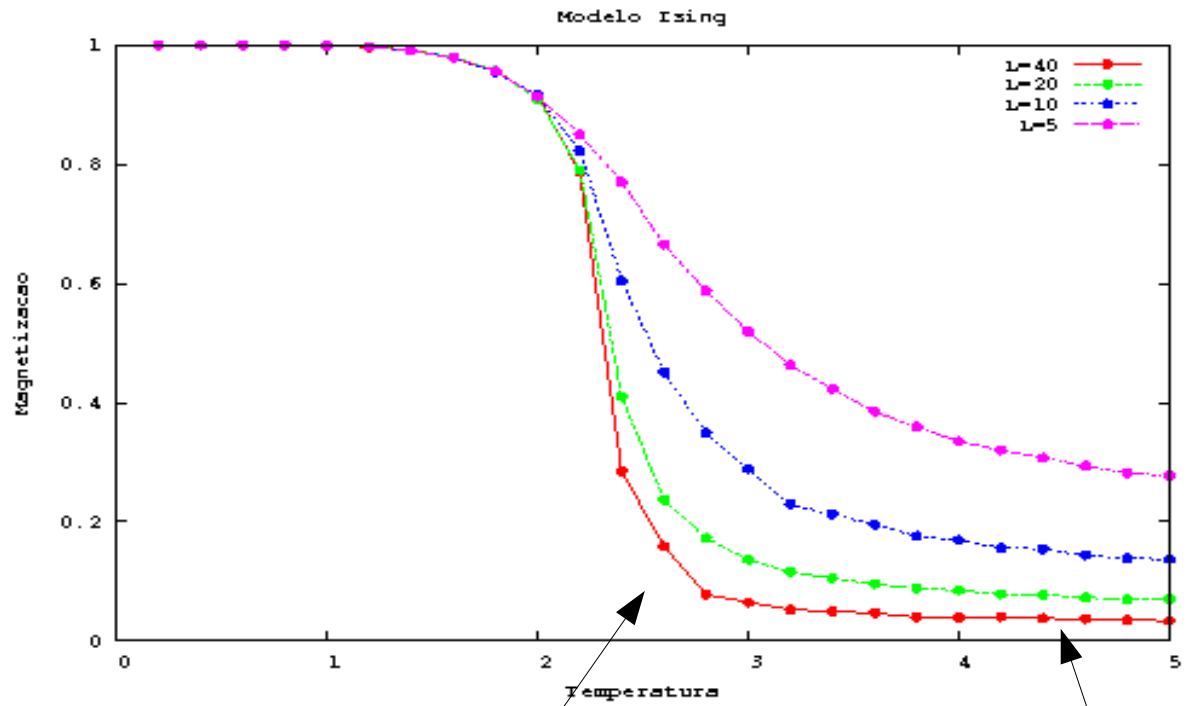
Site “Prisma, à Luz da Física”:

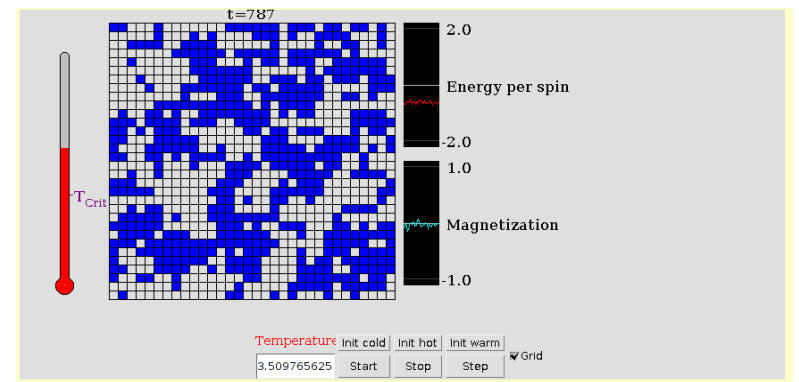
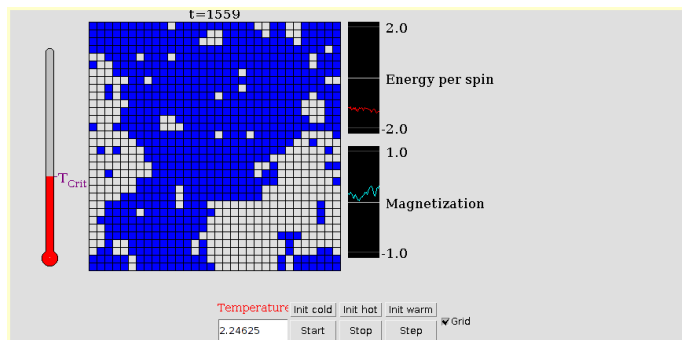
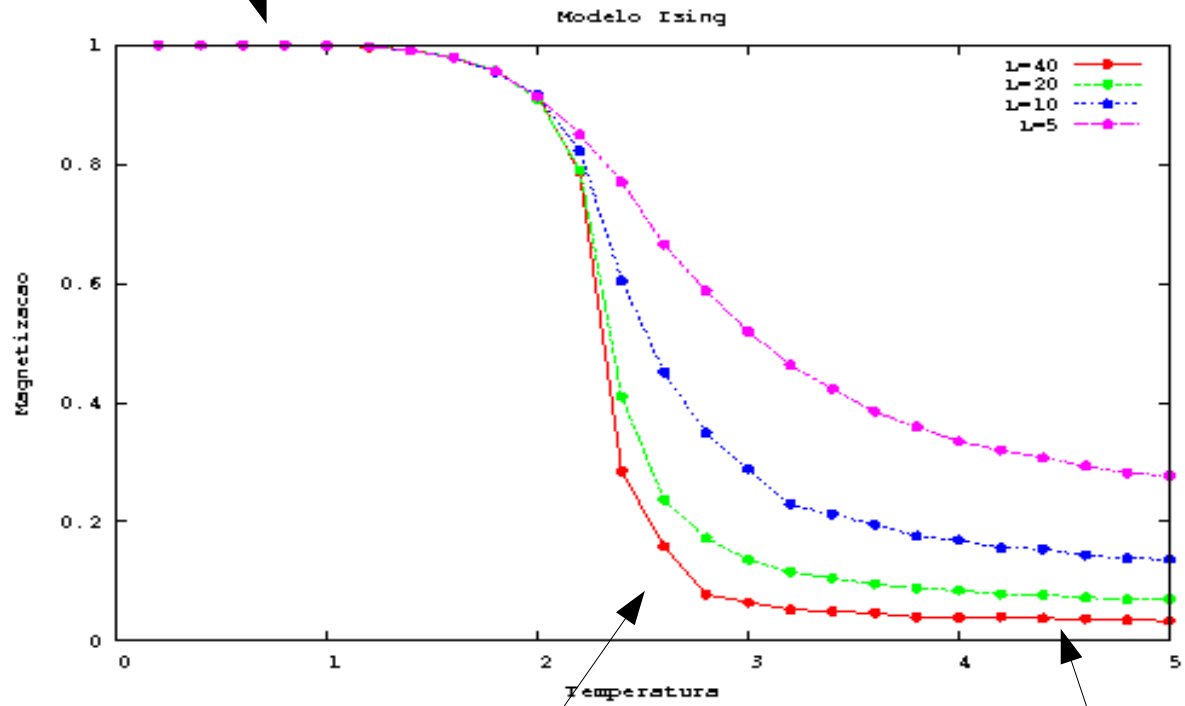
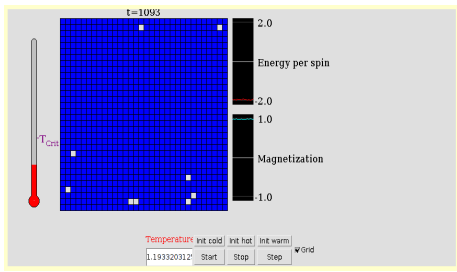
<http://cftc.cii.fc.ul.pt/PRISMA/capitulos/capitulo3/modulo8/topico6.php>











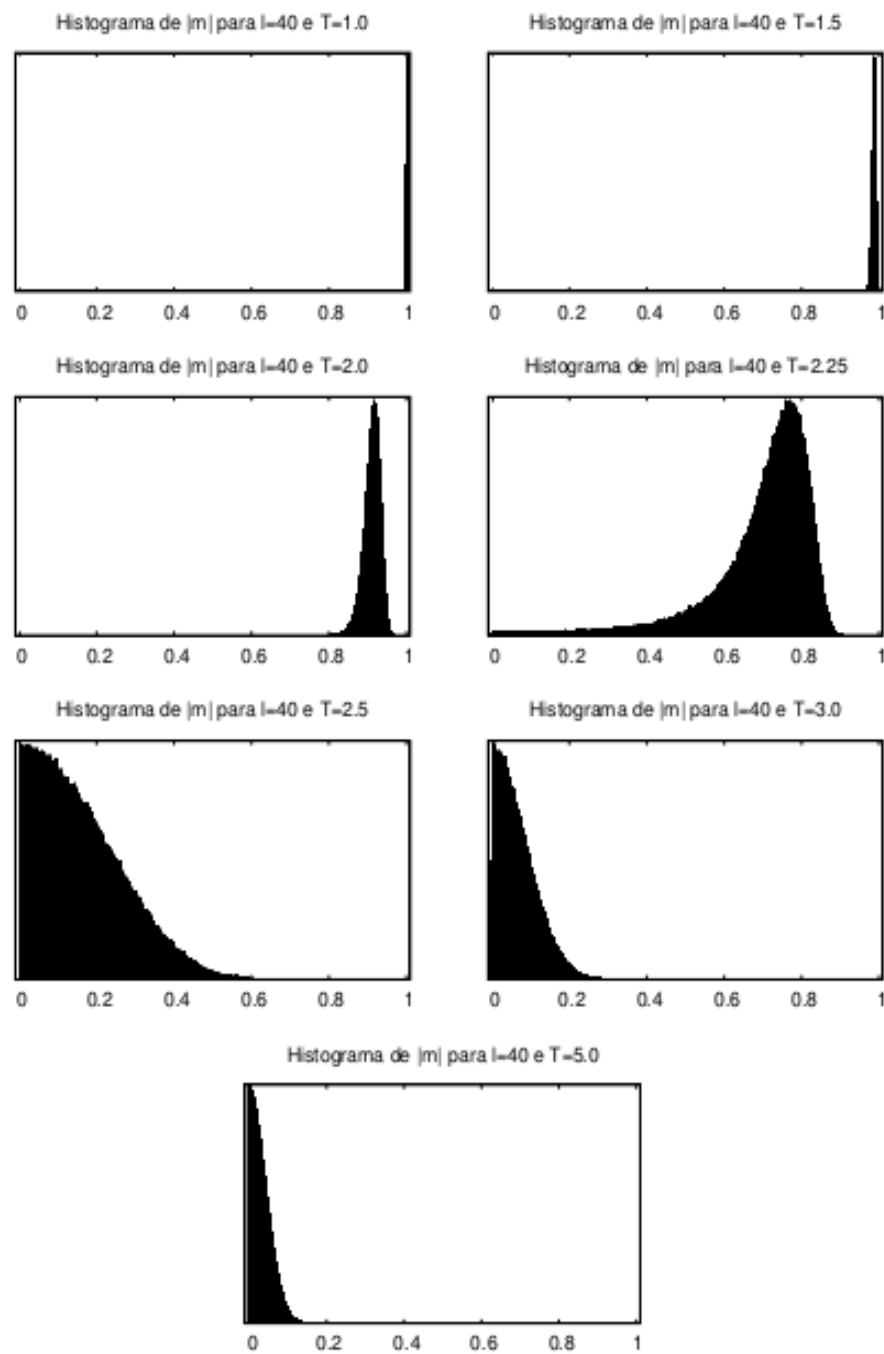
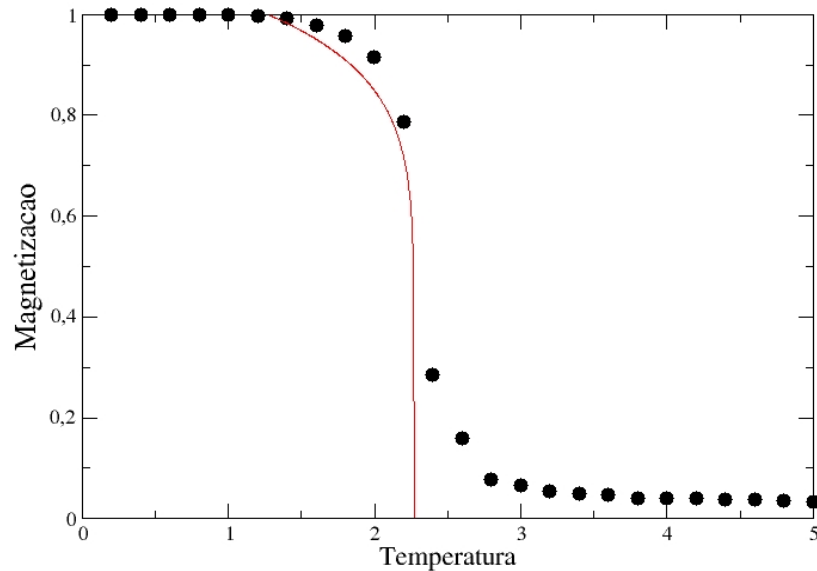


Figura 4: histogramas para diferentes temperaturas na rede de spins com  $N = 1600$ .



# Modelo de Ising 2D: Simulação



Para  $L$  suficientemente grande, temos

$$m \sim (T_c - T)^\beta$$

Valores obtidos por simulação:

- $\beta = \frac{1}{8}$
- $T_c = 2,269$

# Analogia com Fluidos

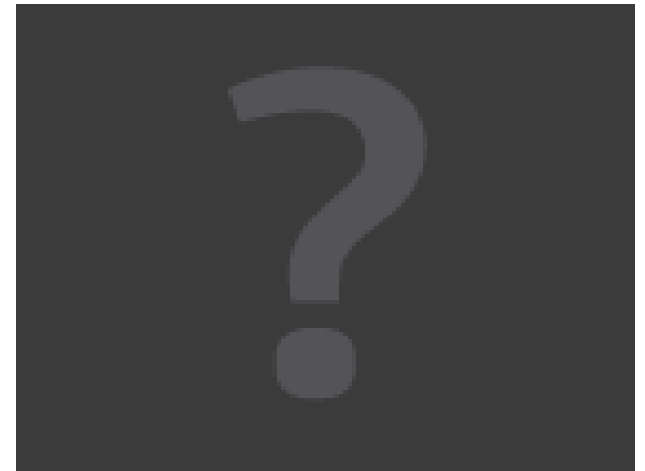
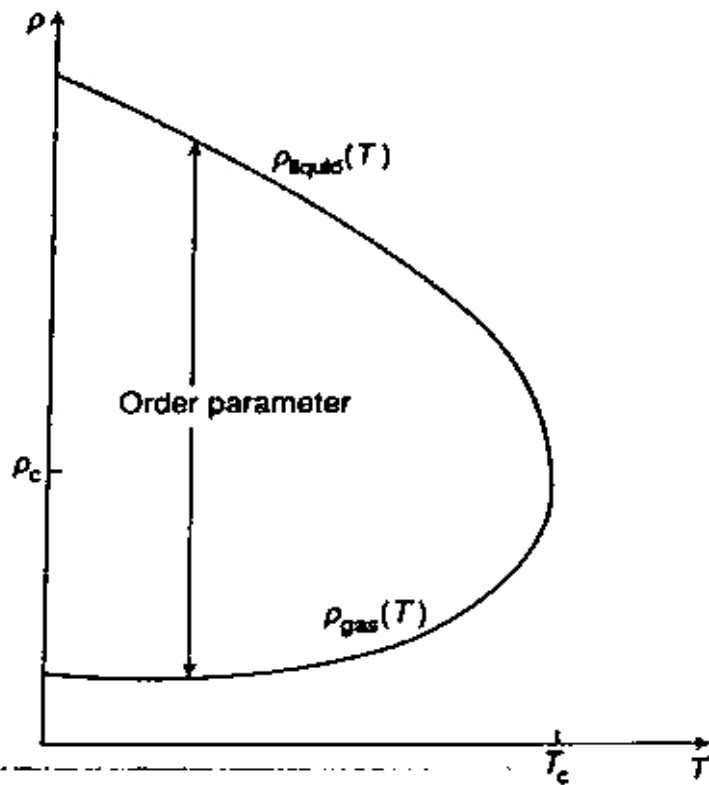


Fig. 1.2. Values of the densities of the coexisting liquid and gas along the vapour pressure curve.  $(\rho_{liquid}(T) - \rho_{gas}(T))$  is the order parameter for the liquid-gas transition.

$$|\rho_+ - \rho_-| \sim |T - T_c|^{1/3}$$

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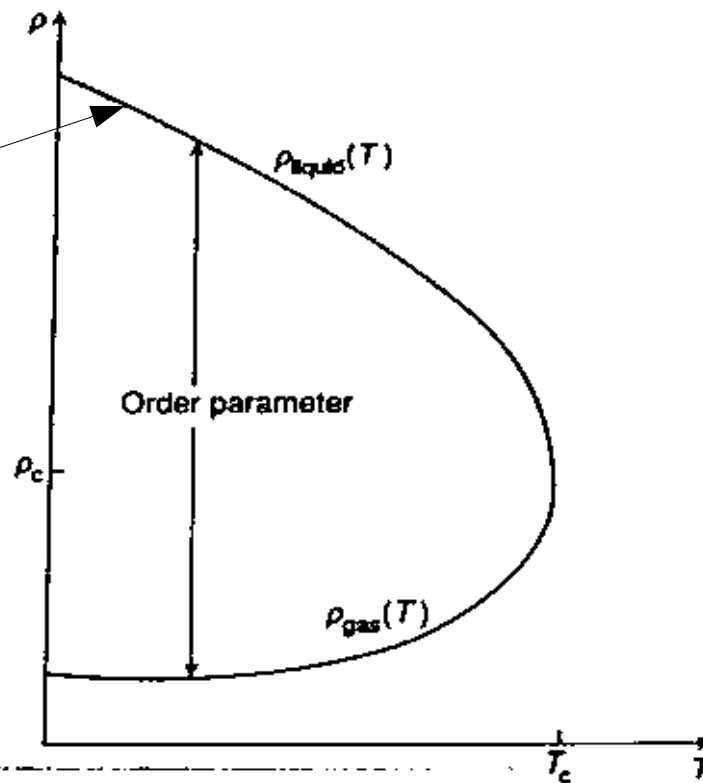
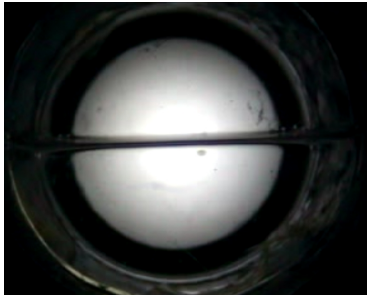


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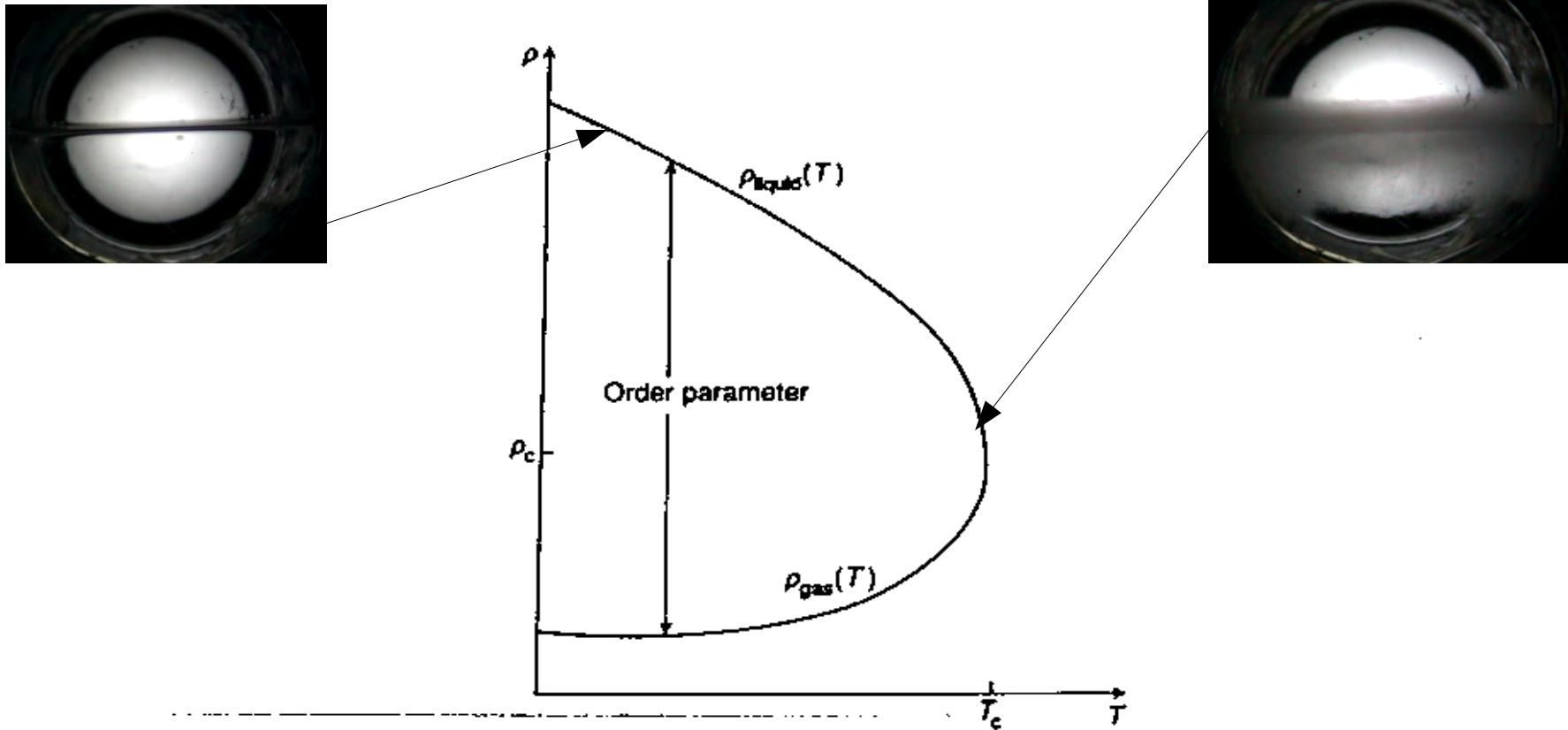


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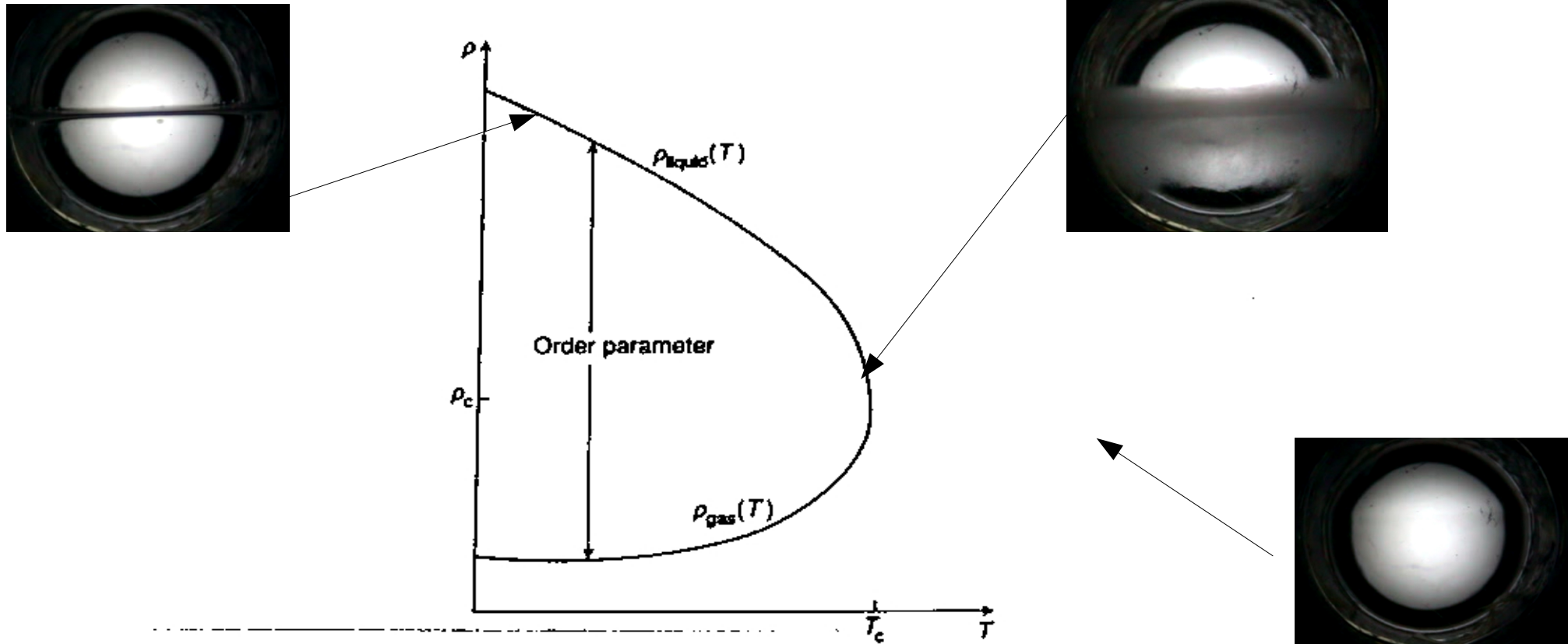
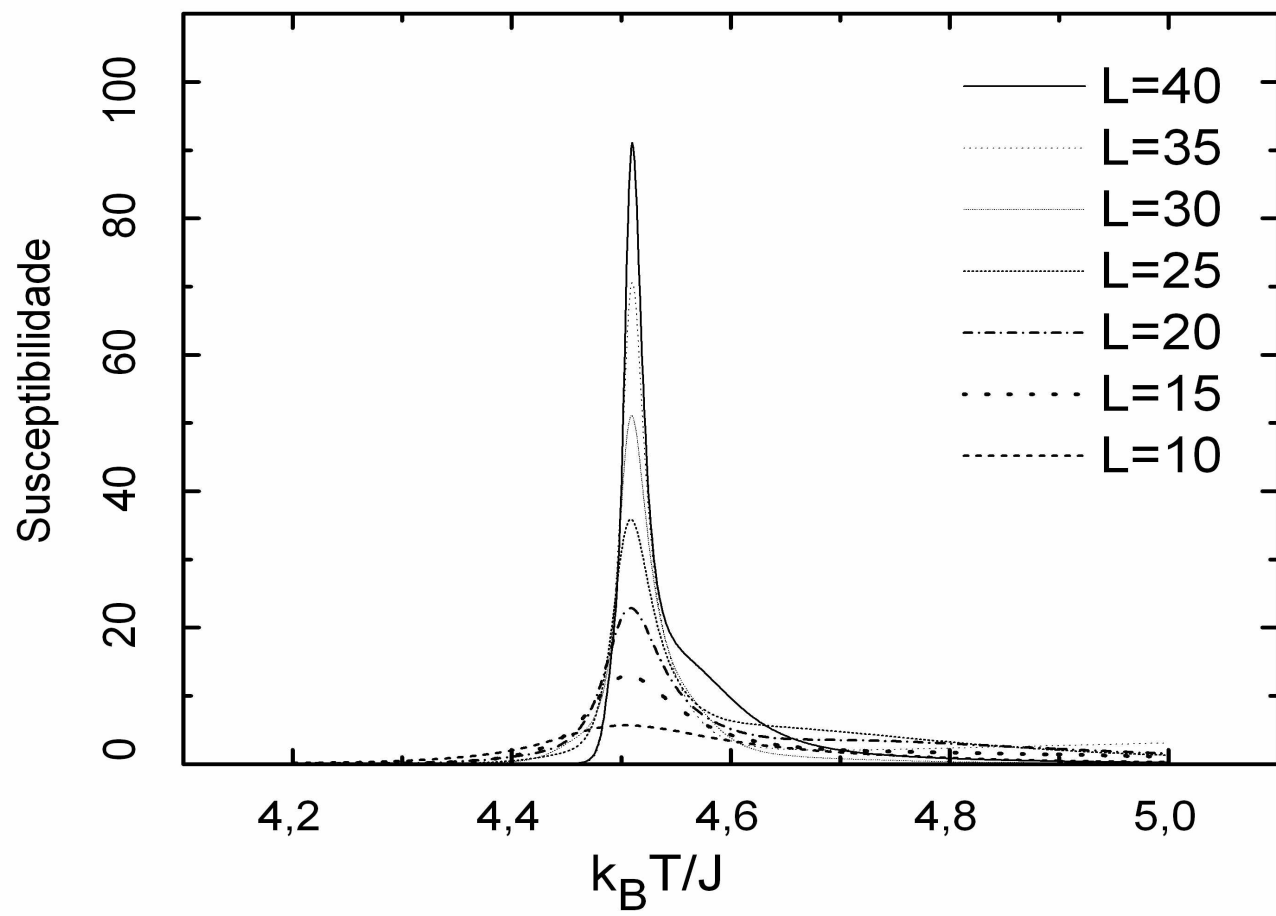
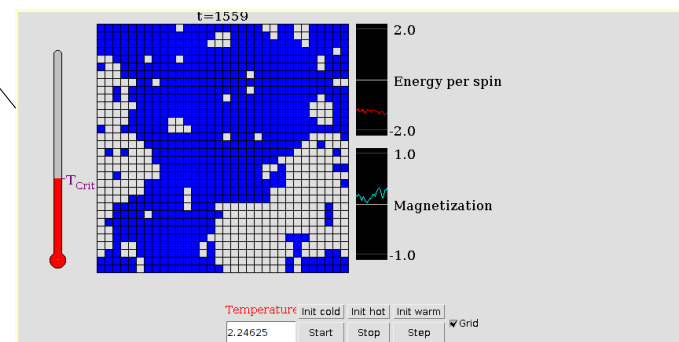
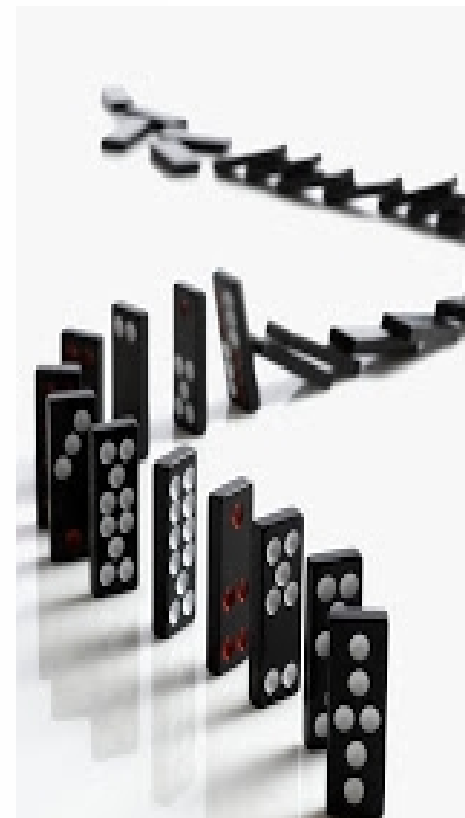
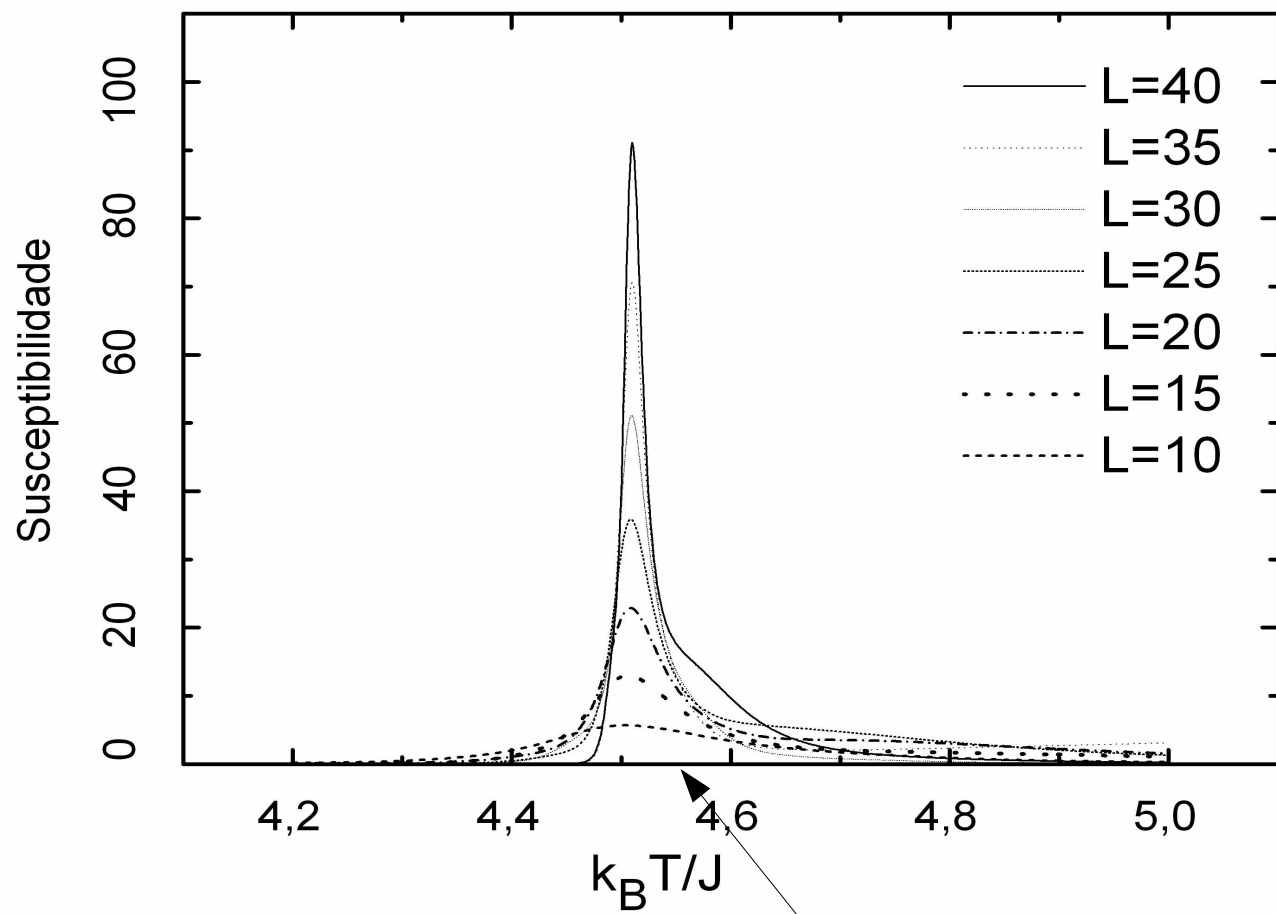
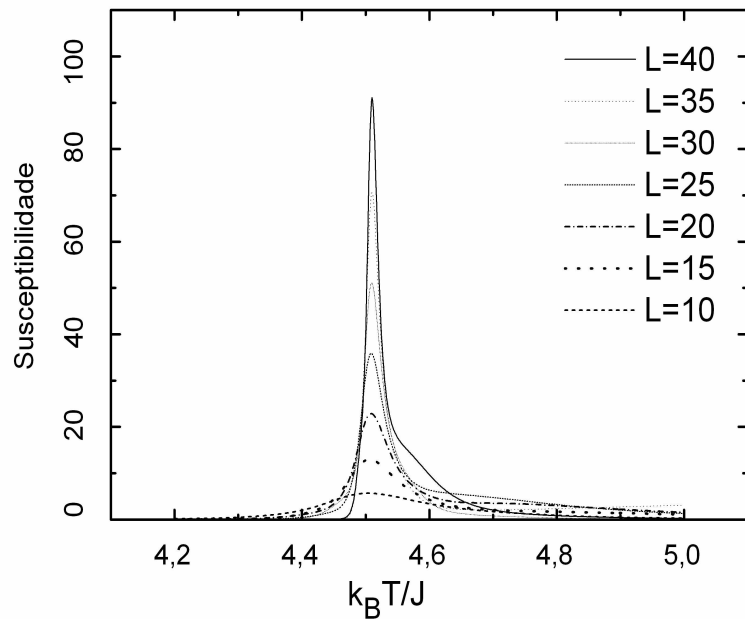


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# Modelo de Ising 2D: Simulação



Para  $L$  suficientemente grande, temos

$$\chi T \sim (T - T_c)^{-\gamma}$$

Valores obtidos por simulação:

- $\gamma = \frac{7}{4}$
- $T_c = 2,269$



	$\alpha$	$\beta$	$\gamma$	$\alpha + 2\beta + \gamma$	$\delta$	$\nu$	$\eta$
Experimentos para qualquer fluido	$\approx 0,11$	$\approx 1/3$	$\approx 1,3$	$\approx 1,9$	$\approx 4,1 - 4,4$	-	-
Experimentos para qualquer Material Ferromagnético	$\approx 0$	$\approx 1/3$	$5/4$	$\approx 2,3$	-	-	-
Ising $d = 3$	0,104	0,325	1,234	1,988	5,2	0,625	$\approx 0,025$
Heisenberg	-0,1	0,33	1,33	1,89	4,2	0,7	0,067
Van der Waals	0	$1/2$	1	2	-	-	-
Teoria de Landau	0	$1/2$	1	2	3	-	-
Campo Médio	0	$1/2$	1	2	3	$1/2$	0
Ising $d = 2$ (exato)	0	$1/8$	$7/4$	2	15	1	$1/4$

# Mapa da Europa como um Modelo de Ising?

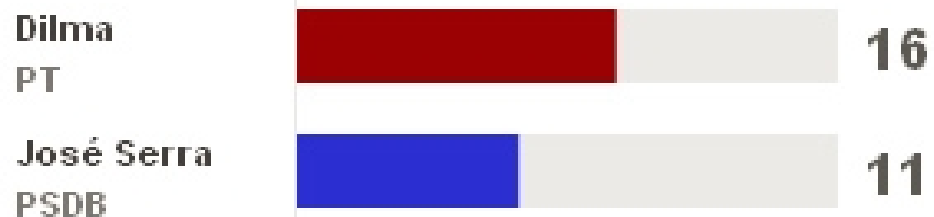
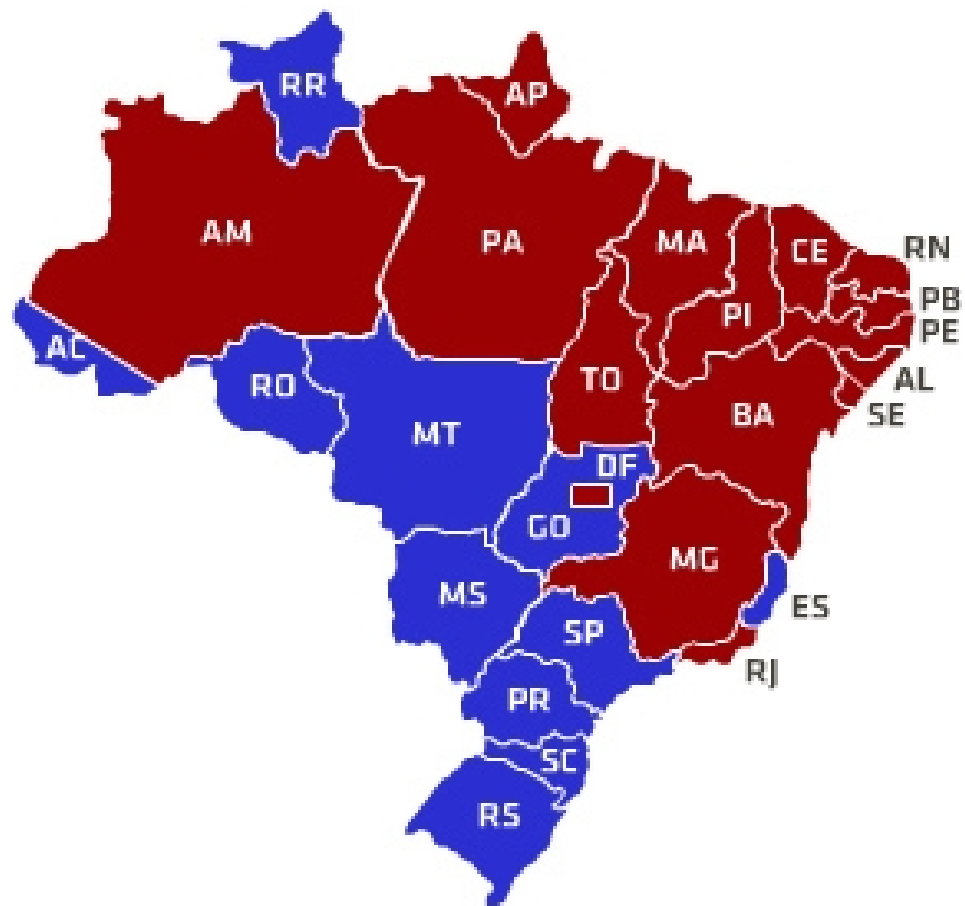




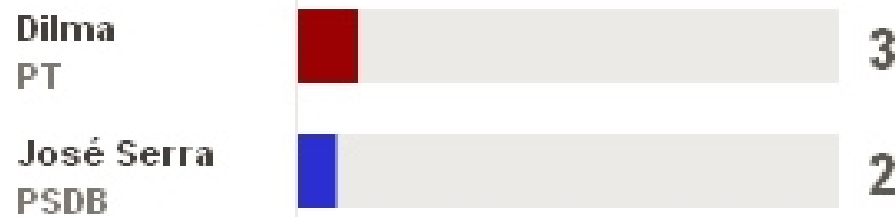


# presidente

## Vencedor por Estado no 2º turno



## Vencedor por Região no 2º turno

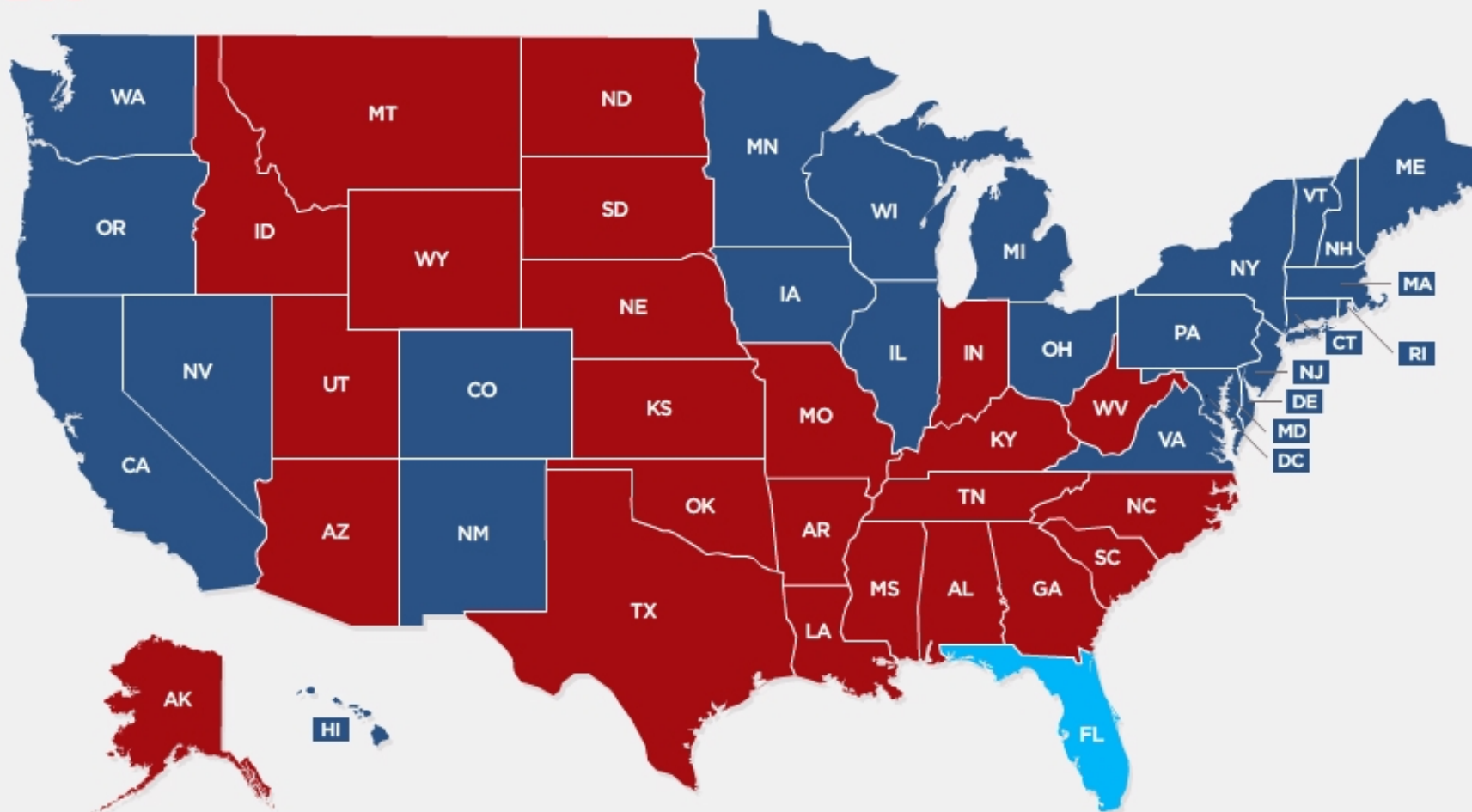


# ELEIÇÃO PRESIDENCIAL NOS EUA

Veja o resultado da votação por estado

■ OBAMA ■ ROMNEY ■ VANTAGEM DE OBAMA

**303** **206**



## VIRAL

● Onda de protestos começou com atos pequenos no centro da capital paulista; em breve, ocupariam centenas de cidades em todos os Estados

### 6 de Junho



Os protestos começam no centro de São Paulo, com cerca de 150 pessoas. Nas quatro manifestações seguintes, atraíram a atenção nacional

### 17 de Junho



Outras capitais aderiram às manifestações. Também começam atos em cidades menores, como Viçosa e Votuporanga

### 20 de Junho



É o auge dos protestos. Logo depois, as autoridades começam a baixar as tarifas de transporte. Variedade de reivindicações fica cada vez maior

### 26 de Junho



As maiores manifestações se concentram nas cidades que receberam jogos da Copa das Confederações, como Belo Horizonte

### Total



353 municípios tiveram algum tipo de manifestação. Elas abrangem todos os Estados e o Distrito Federal

### Legenda

● NÚMERO DE MANIFESTAÇÕES

■ MENÇÕES NO TWITTER E FACEBOOK

(MONITORAMENTO FEITO PELA EMPRESA SCUP, QUE BUSCA NAS REDES SOCIAIS PALAVRAS-CHAVE RELACIONADAS AOS PROTESTOS)

