

# 宇宙の進化と素粒子模型

宇宙線研理論グループ

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富山大：松本、兼村

青山学院大：山口

神奈川大：粕谷

佐賀大：高橋

国内旅費：30万円

# Gravitational Waves from Decay of Domain Walls

東大宇宙線研：平松、川崎、斎川

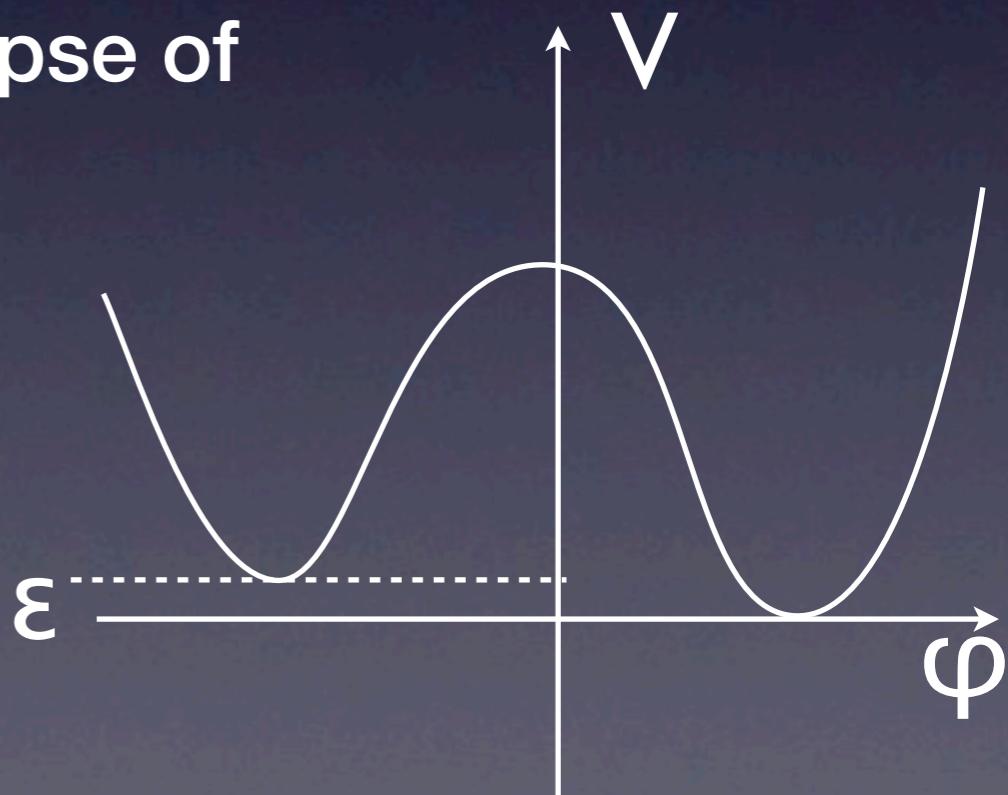
# GW from decay of domain walls

- Domain Walls 2 dim Topological defect
- scaling solution  $\rho_w \sim t^2/t^3 \sim 1/t$   
soon dominates the Universe
- Decay due to small potential difference between two vacua
- Gravitational Waves from collapse of domain walls



3D Lattice Simulation

Hiramatsu, MK, Saikawa (2010)



# Domain Wall Evolution

$$\epsilon = 0$$

$t = 11t_i$

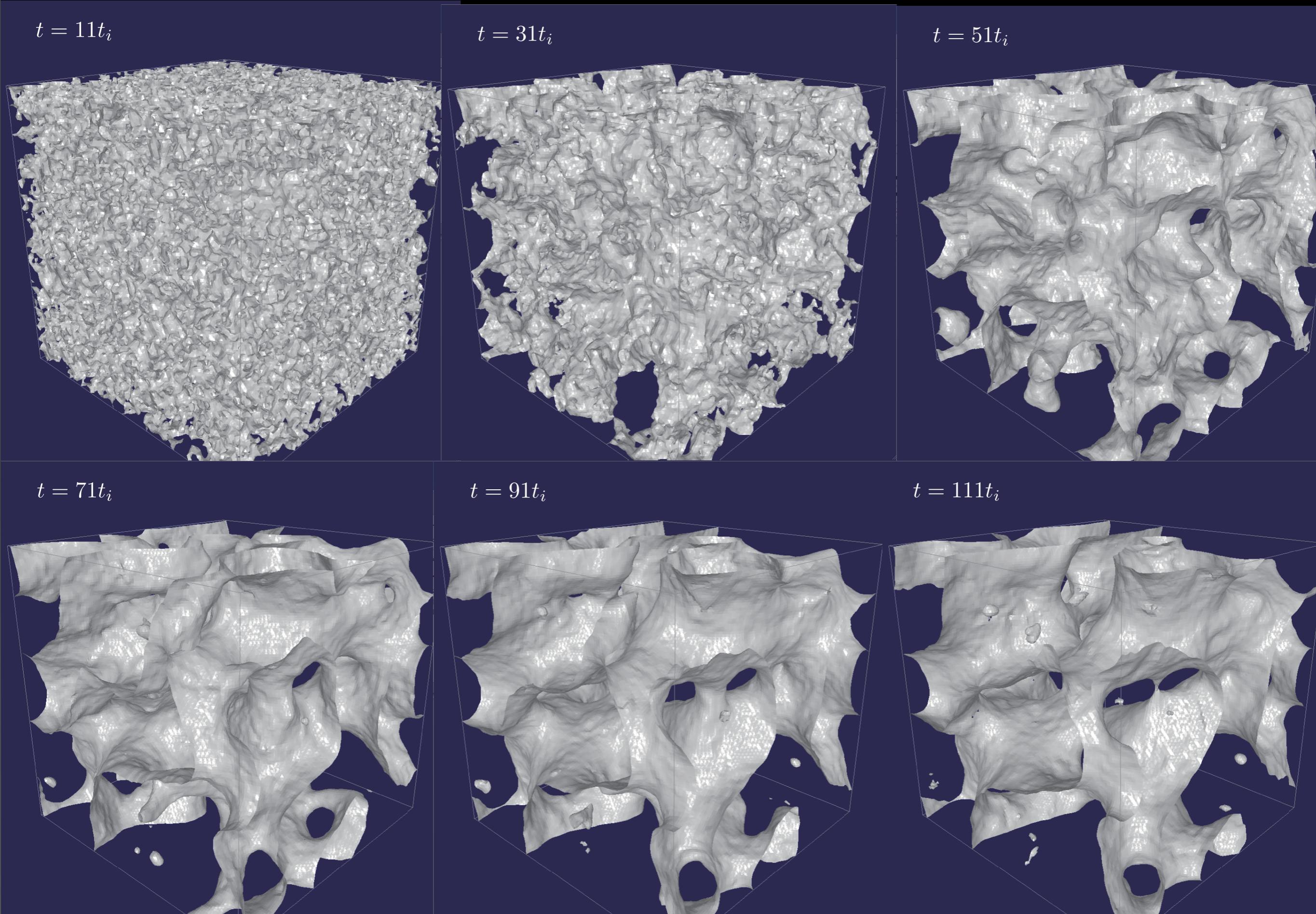
$t = 31t_i$

$t = 51t_i$

$t = 71t_i$

$t = 91t_i$

$t = 111t_i$



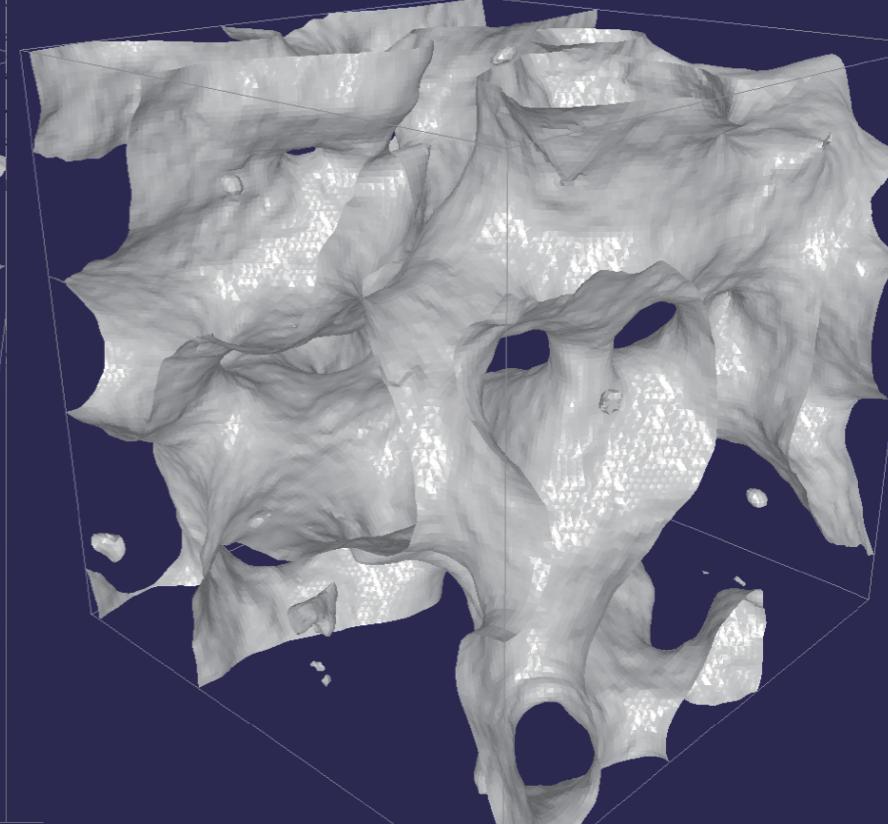
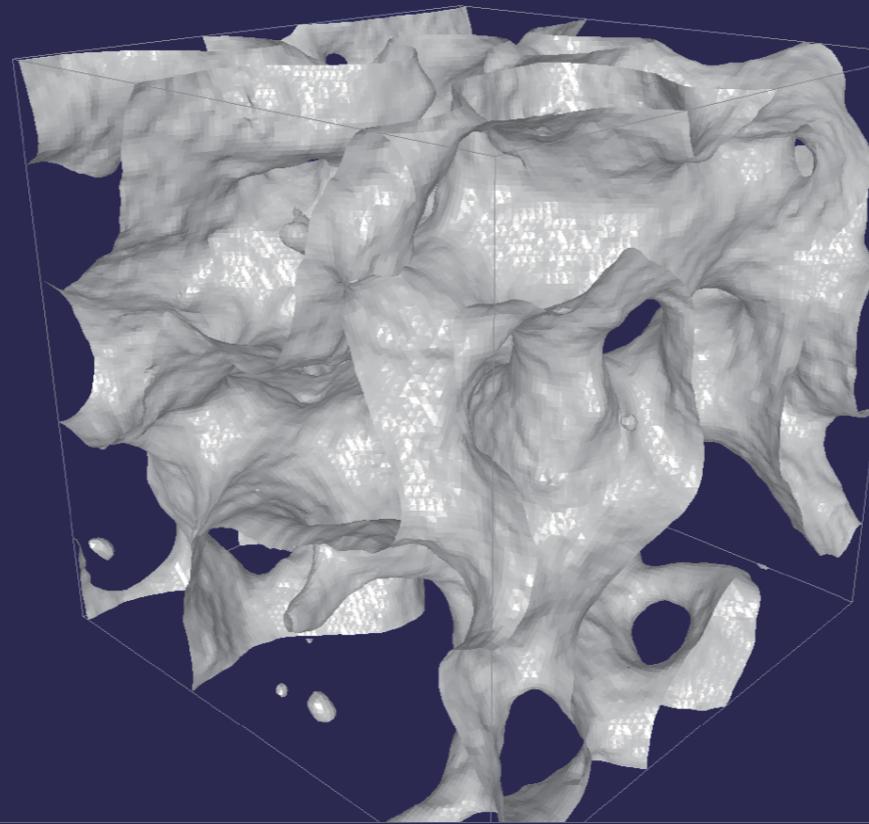
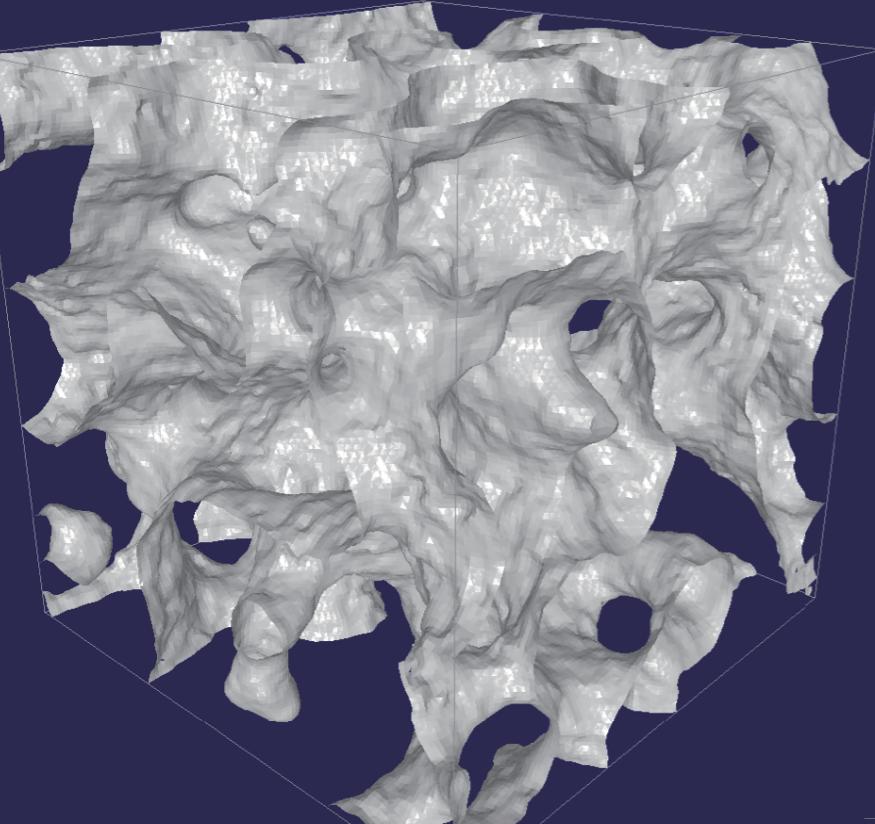
# Domain Wall Evolution

$$\epsilon = 0$$

$t = 51t_i$

$t = 71t_i$

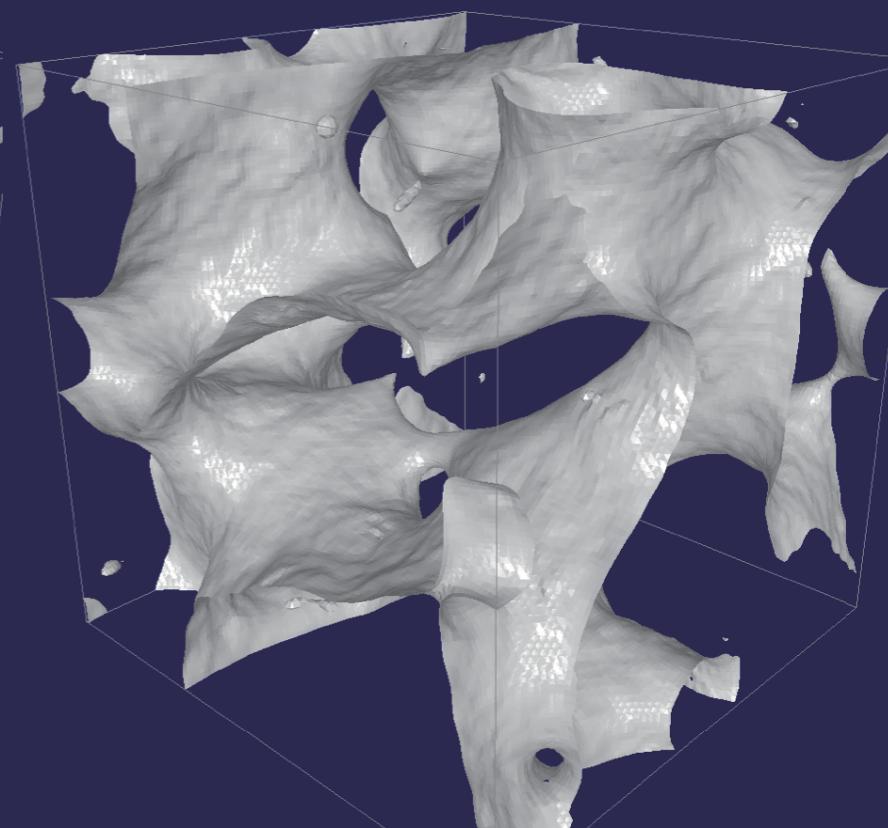
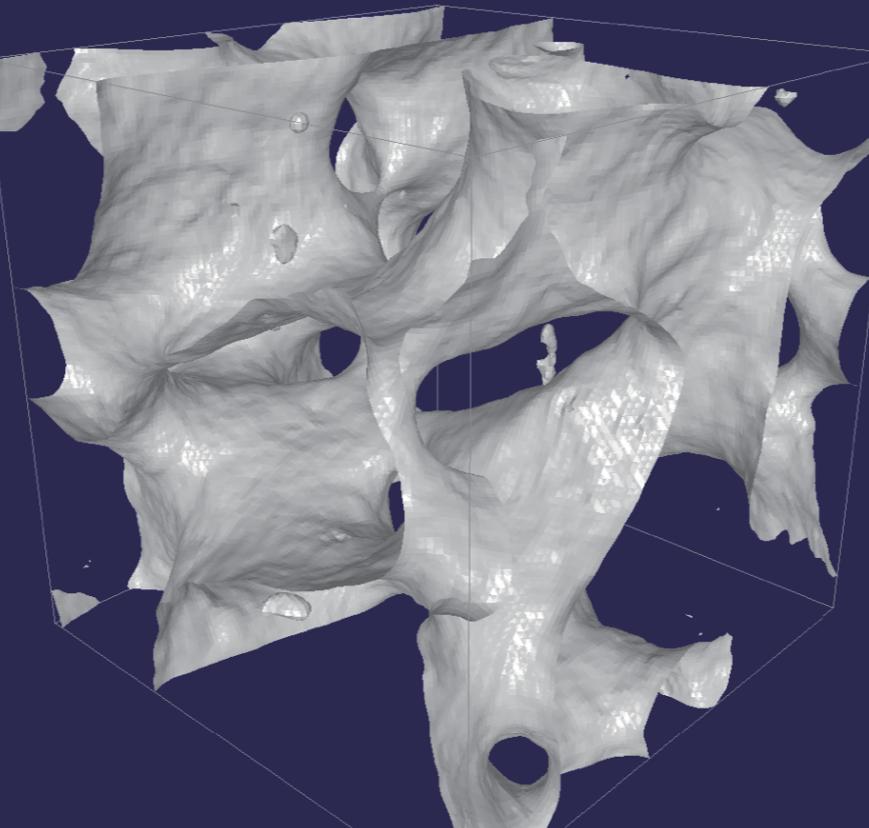
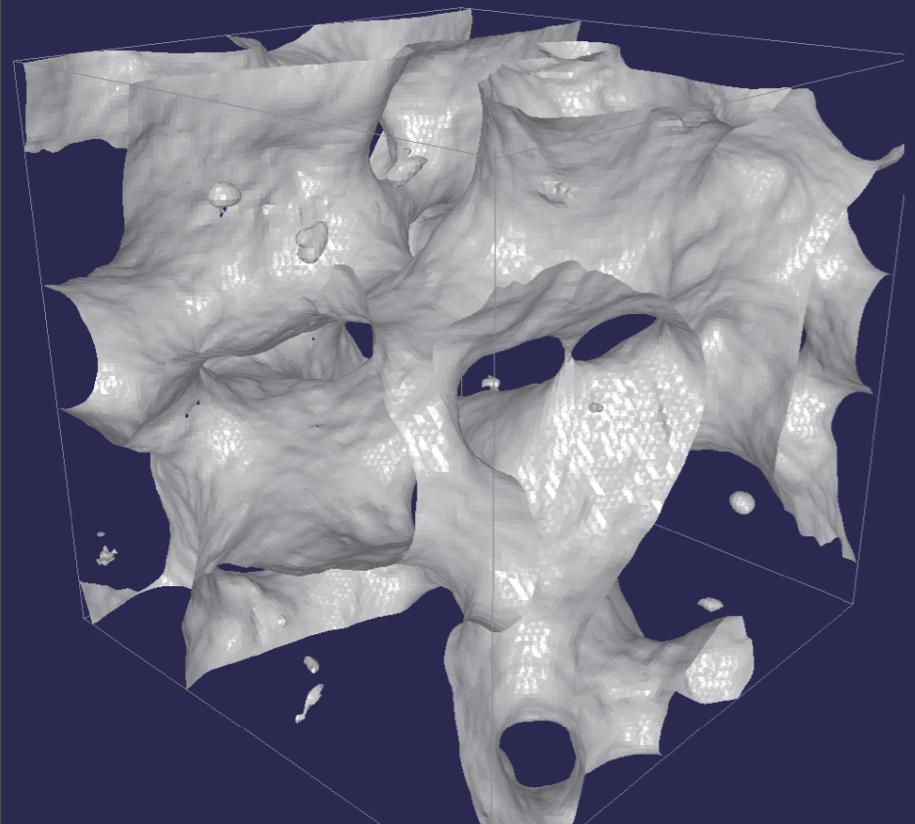
$t = 91t_i$



$t = 111t_i$

$t = 131t_i$

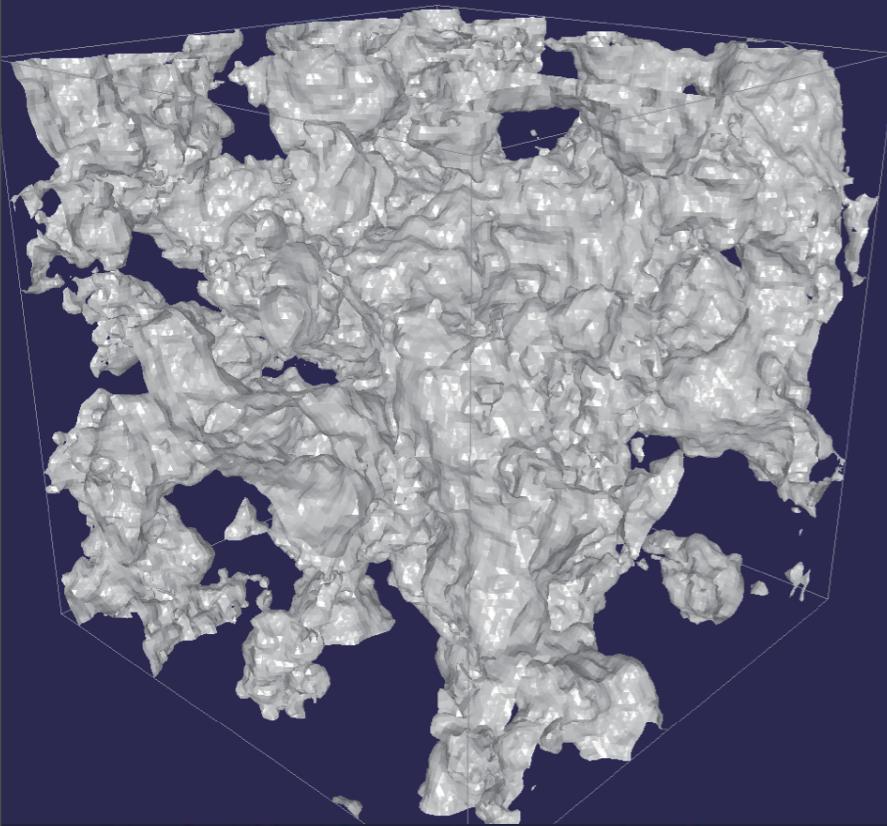
$t = 151t_i$



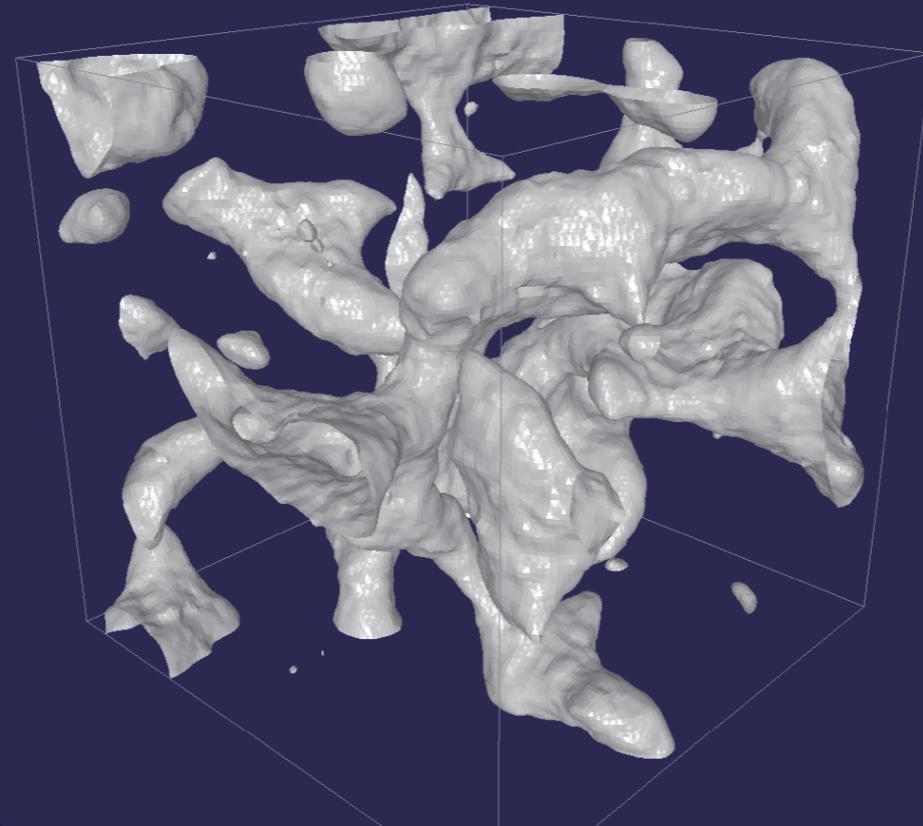
# Domain Wall Evolution

$\epsilon = 0.02$

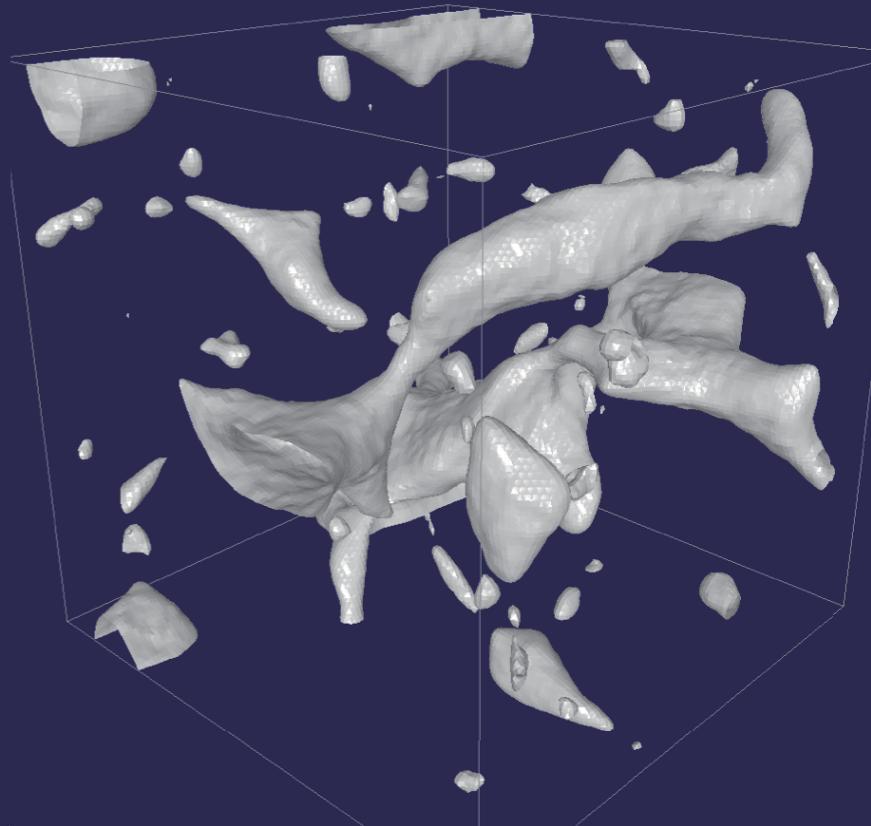
$t = 31t_i$



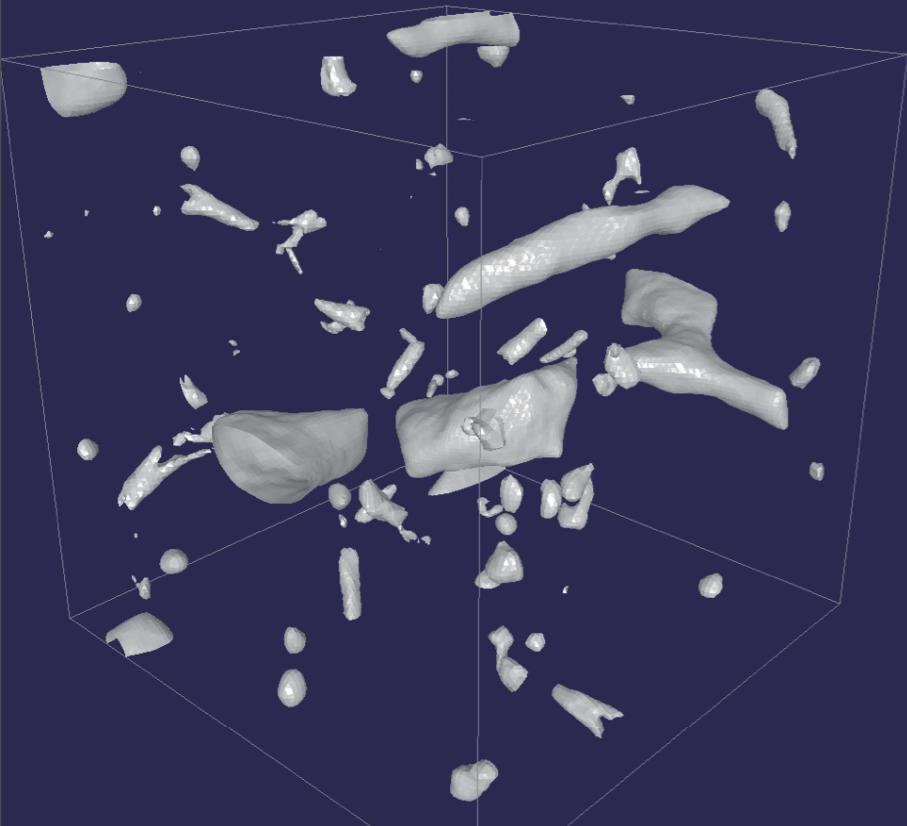
$t = 51t_i$



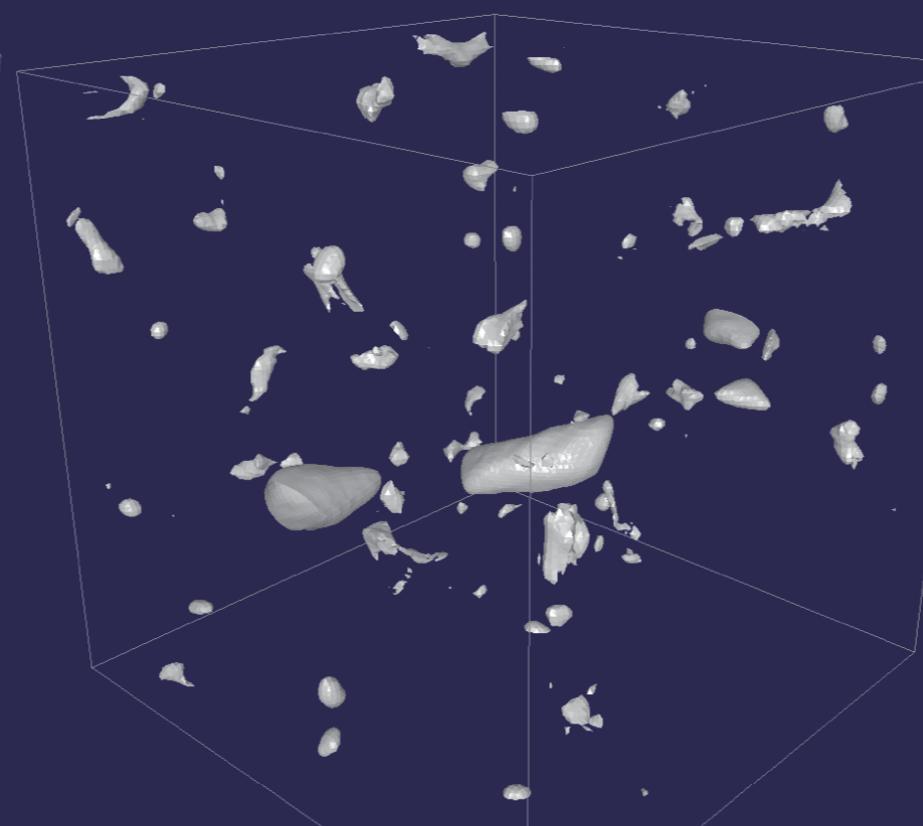
$t = 71t_i$



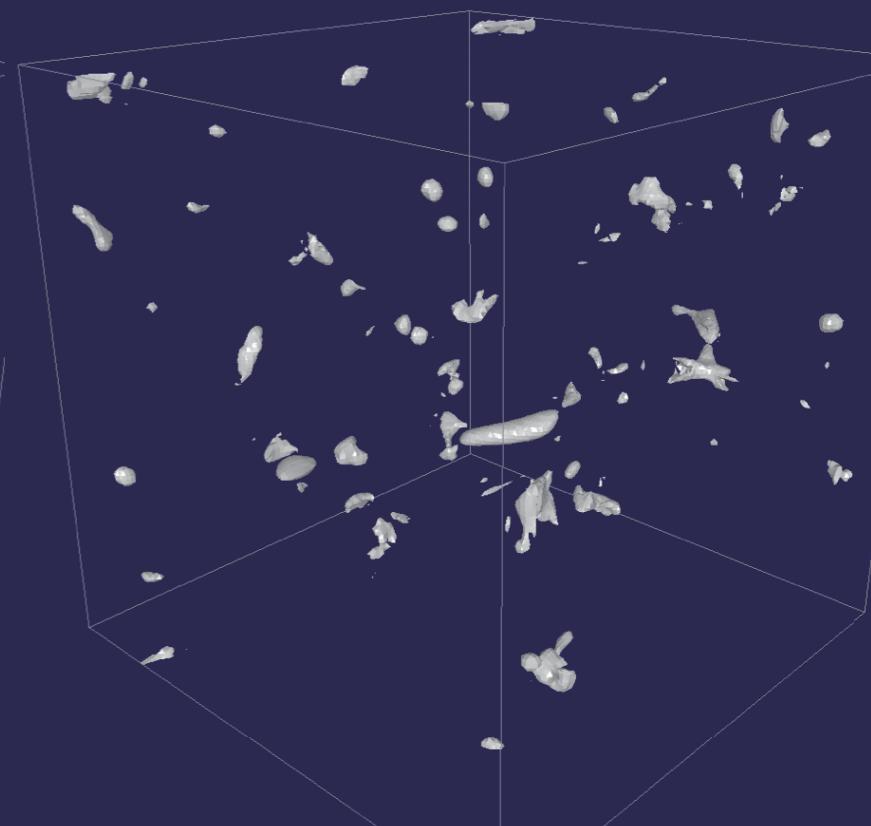
$t = 91t_i$



$t = 111t_i$

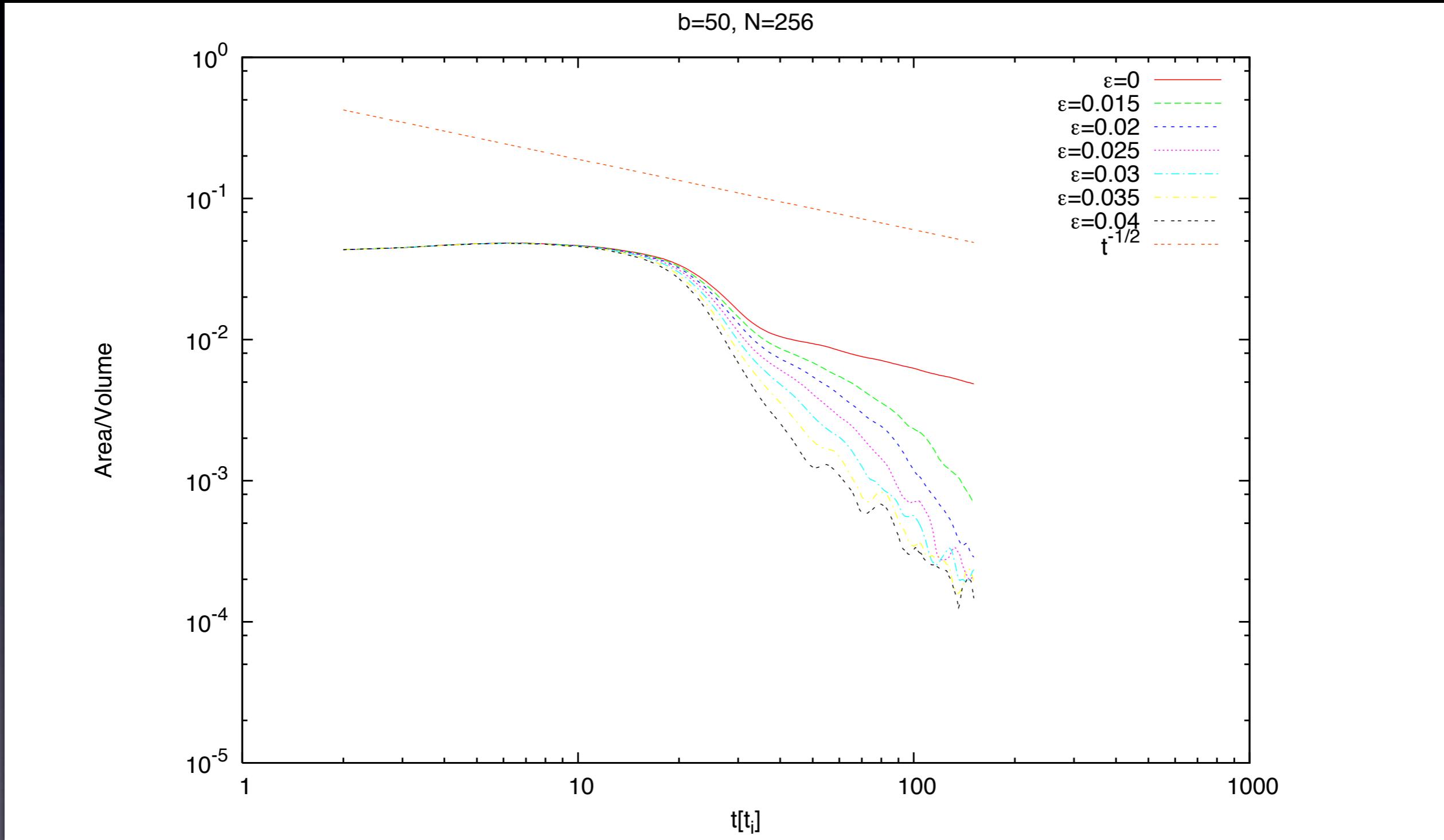


$t = 131t_i$



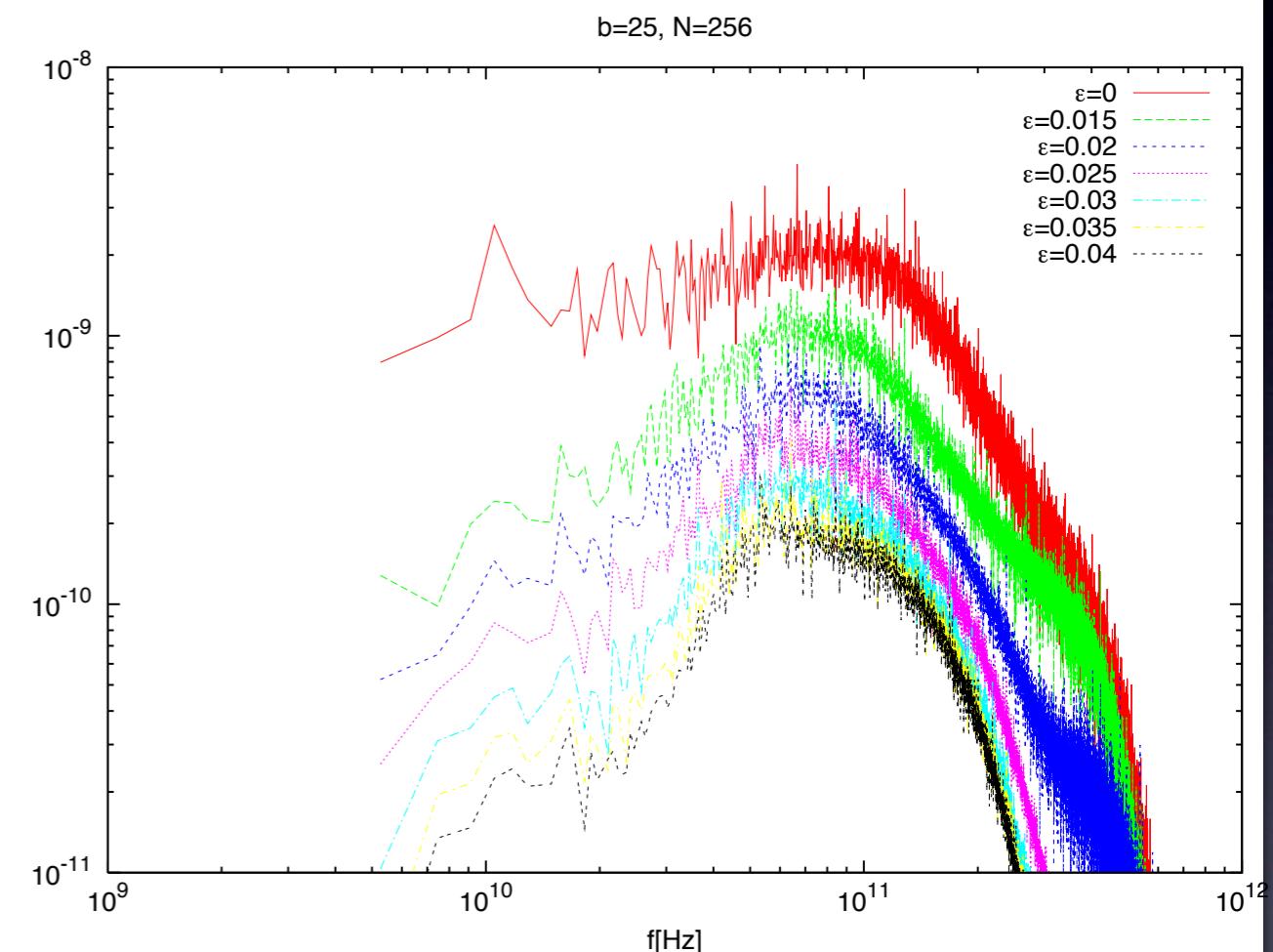
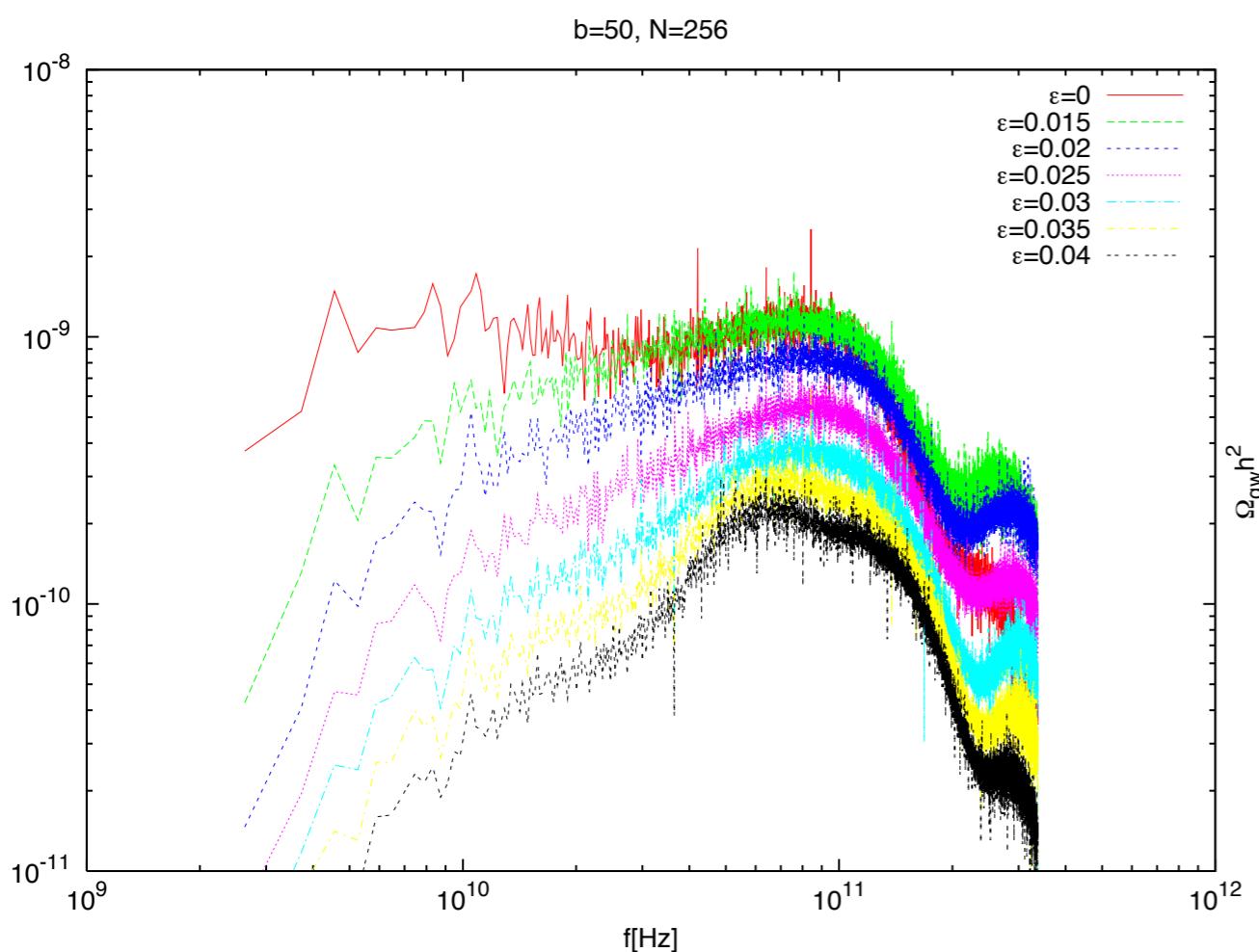
# Domain Wall Evolution

- $\varepsilon=0 \rightarrow$  scaling solution
- $\varepsilon \neq 0 \rightarrow$  decay



# GW from Domain Wall (Lattice Simulation)

- Large box vs Small box

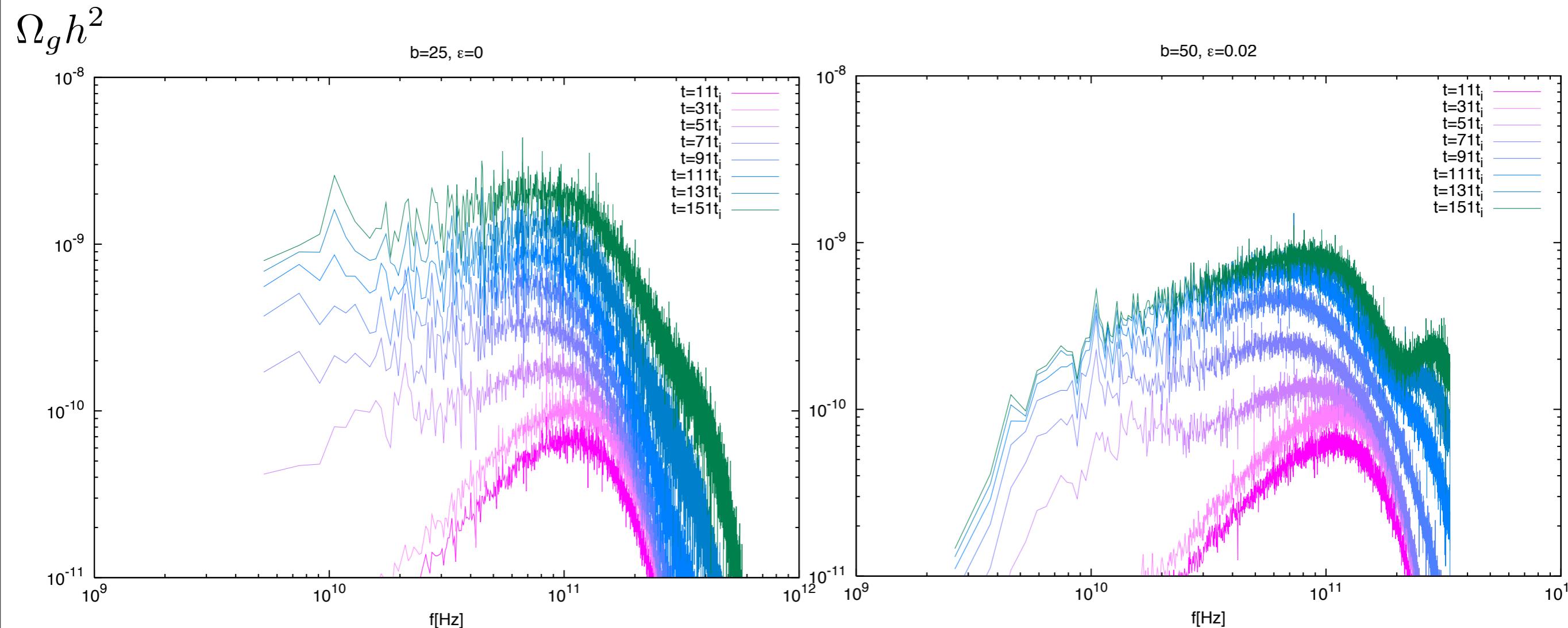


Large box  
Low Resolution

Small box  
High Resolution

# GW from Domain Wall ( Lattice Simulation)

## ● Time Evolution



# Gravitational Waves

- Peak in the spectrum ~ width of wall

$$f_{\text{peak}} \simeq 9 \times 10^9 \epsilon^{1/2} \lambda^{3/4} \left( \frac{\eta}{10^{17} \text{GeV}} \right)^{1/2}$$

- Peak Amplitude

$$(\Omega h^2)_{\text{peak}} \simeq 3 \times 10^{-13} \epsilon^{-2} \lambda^{-2} \left( \frac{\eta}{10^{17} \text{GeV}} \right)^4$$

- Spectral ~ flat

$$(\Omega h^2)_{\text{peak}} \sim f^{21\epsilon+0.24} \quad (f_{\text{edge}} < f < f_{\text{peak}})$$

# Detection by GW experiments

