Interface Tensions in SU(N) Gauge Theories

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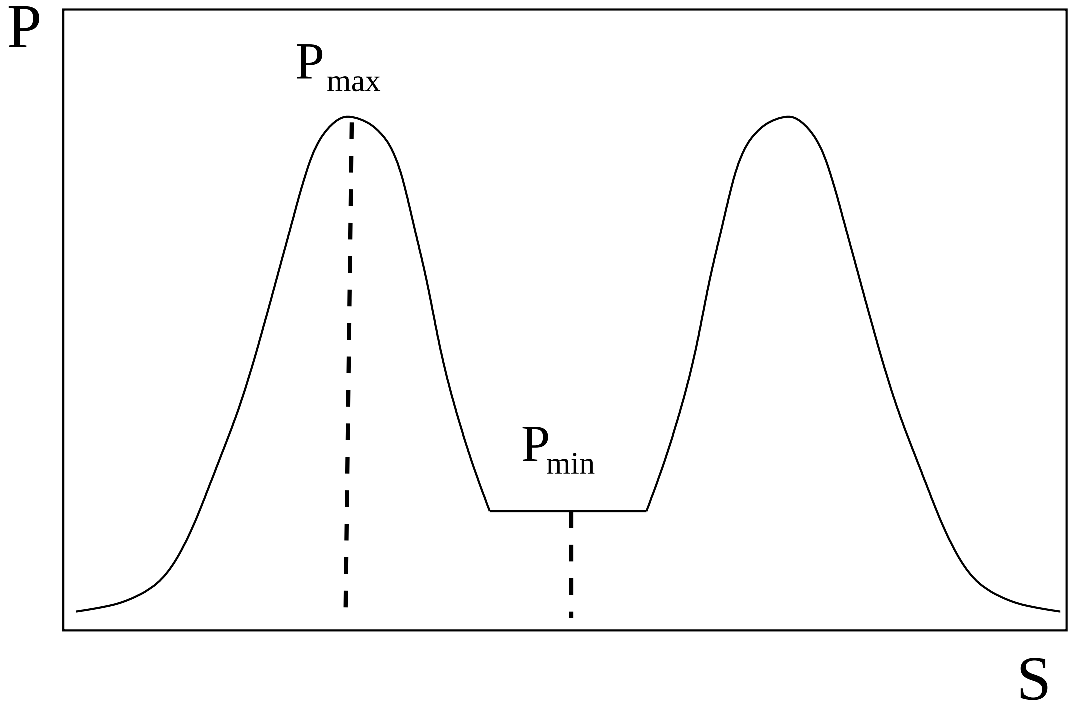
Overview

- First order phase transitions
- The histogram method
- ’t Hooft loop and the order-order tension
- Perfect wetting
- The new method
- Comparison of numerical results
- Conclusions and outlook

First order phase transitions

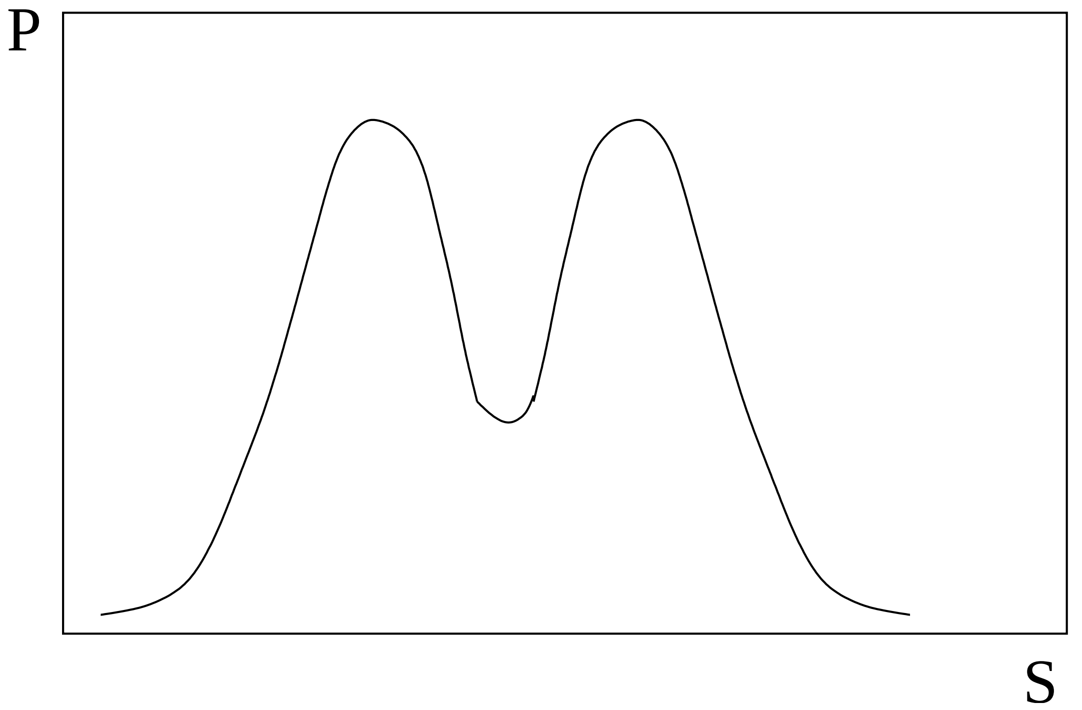


- Latent heat

$$L_h = S_2 - S_1$$

- Interface free energy

The histogram method



$$\hat{\Sigma} = \frac{1}{2L^2}\log\frac{P_{max}}{P_{min}} + \frac{1}{2L^2}\left(\log\frac{cL_z^{3/2}}{L} + \log G\right)$$

't Hooft loop

- in 3D SU(N)

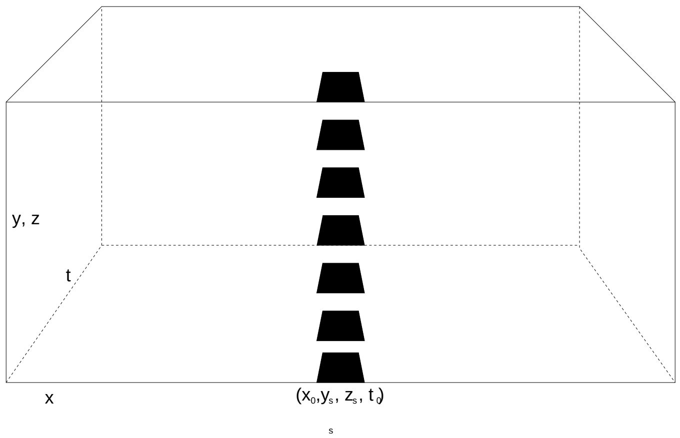
$$\phi^\dagger A_\mu \phi = \Omega(A_\mu) + 2\pi k/N \;, \qquad k \in \mathbb{Z}$$

- in 4D

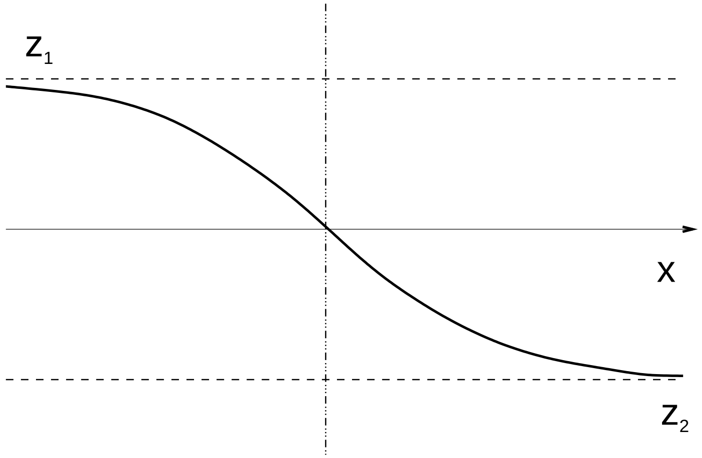
$$AB = e^{2\pi i k/N} BA$$

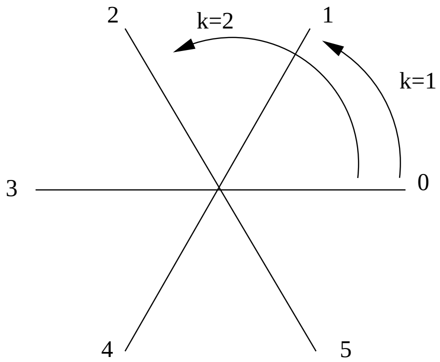
- on the lattice

$$i \in \mathcal{S} = \{x = x_0,\; t = t_0\}$$
$$\Downarrow$$
$$U_{xt}(i) \to e^{2\pi i k/N} U_{xt}(i)$$



Order-order interfaces





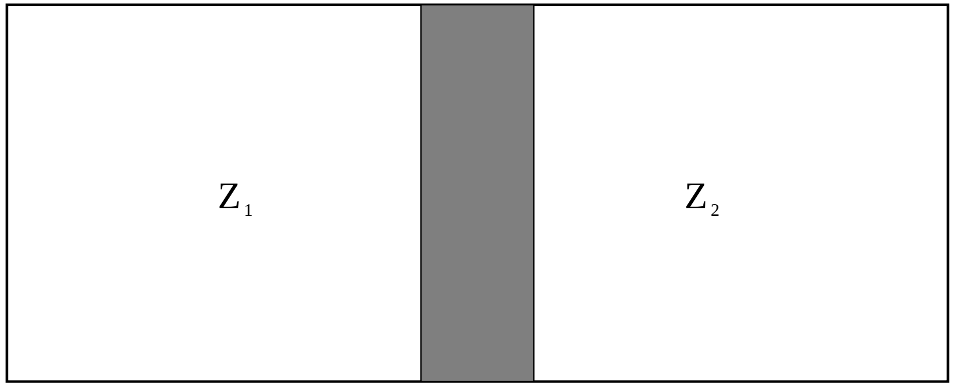
At high temperature for $N \geq 4$

$$\frac{\Sigma_k}{\Sigma_1} = \frac{k(N-k)}{N-1}$$

Numerical result for SU(4) at $T/T_c = 1.2$

$$\frac{\Sigma_2}{\Sigma_1} = 1.285 \pm 0.020$$

Perfect wetting

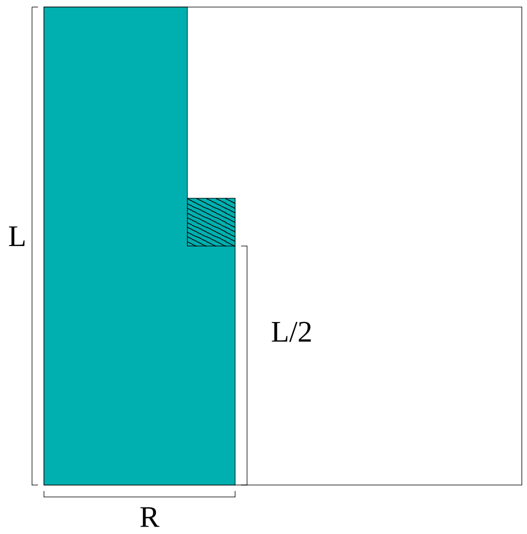


$$\Sigma_1 = w\Sigma_{od}$$

In general $w \leq 2$

Perfect wetting if $w = 2$

The new method



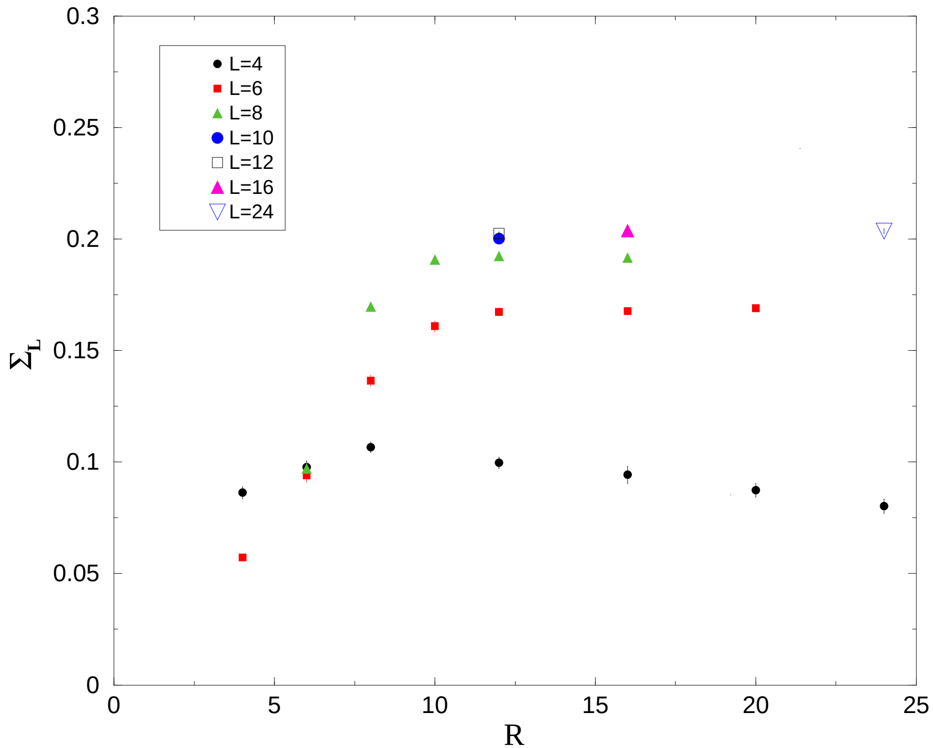
$$k = L \times (R - 0.5)$$

$$\frac{Z_k}{Z_{k+1}} = e^{F_\Sigma(k+1) - F_\Sigma(k)}$$

$$F_\Sigma(k+1) - F_\Sigma(k) = \hat{\Sigma} + \frac{\pi}{12(R-0.5)^2}$$

Finite size effects - I

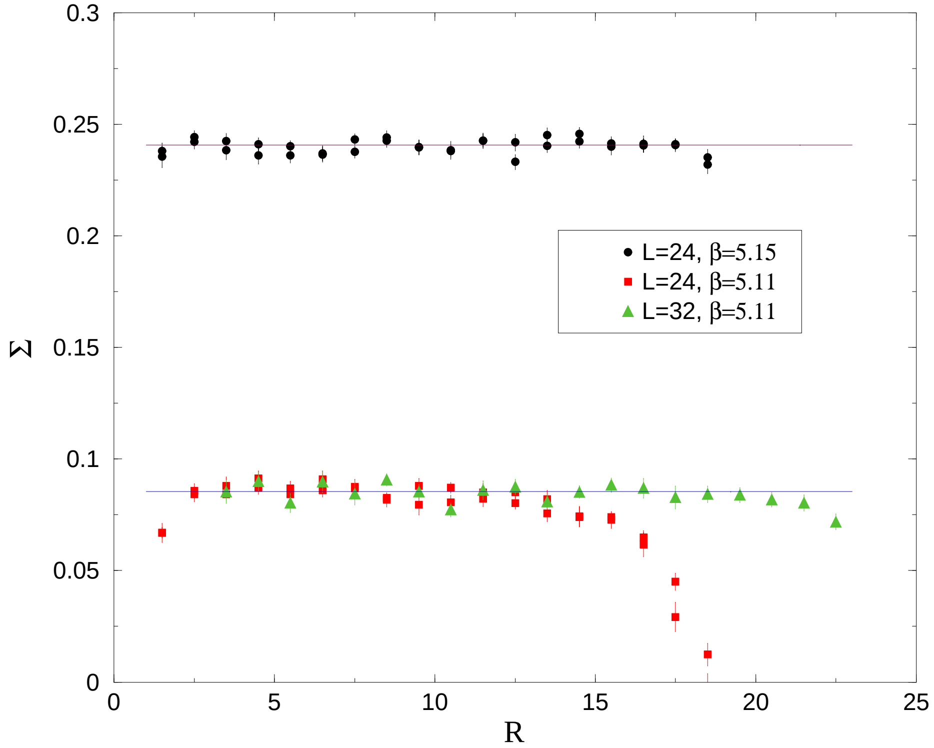
On a lattice $L^2 \times 2R \times 2$



FSE under control if $L\sqrt{\hat{\Sigma}} \gtrsim 7$

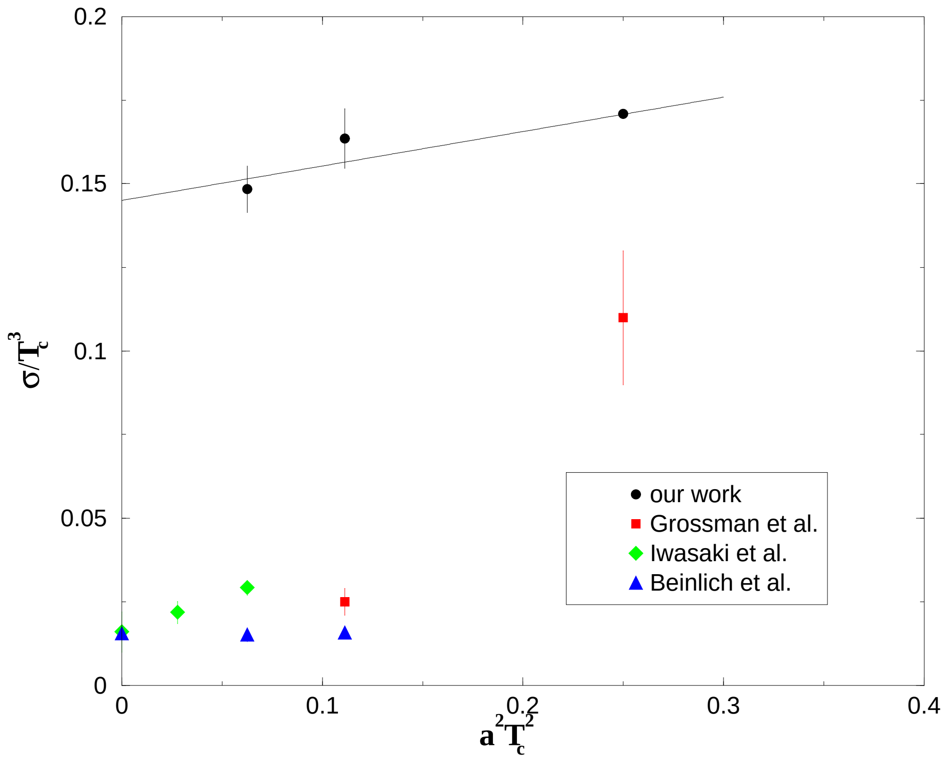
Finite size effects - II

On a lattice $L^3 \times 2$



The Lüscher term describes very well the data from very short distances to at least $L/2$

Continuum limit



A continuum extrapolation gives $\sigma/T_c^3 = 0.145 \pm 0.007$

Compare with $\sigma/T_c^3 = 0.0155 \pm 0.0016$

Conclusions

- Introduction of a new method for the determination of the interface tension in gauge theories
- Application to SU(3) at $T = T_c$
- Disagreement with the histogram method...
- ... But better scaling

Perspectives

- Continuum limit in SU(3)
- Large N limit
- Comparison with perturbation theory for $N \geq 4$