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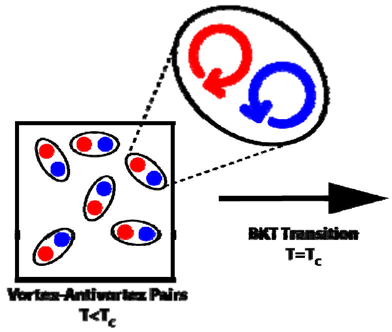
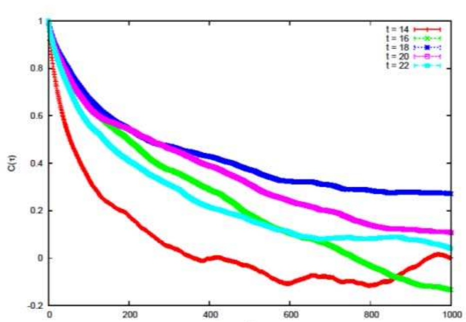
Berezinskii-Kosterlitz-Thouless phase transition from lattice sine-Gordon model

The BKT transition is a transition without long range order. It is driven by topological defects --- vortices. Below the transition temperature, vortex-antivortex pairs are bound. Above the transition temperature, they become unbound, proliferate, and screen.



XY model → 2d Coulomb gas → sine-Gordon model

$$S[\phi] = \frac{1}{t}\int d^2x \,\left\{\frac{1}{2}[\partial_\mu \phi(x)]^2 - g\cos\phi(x)\right\}$$

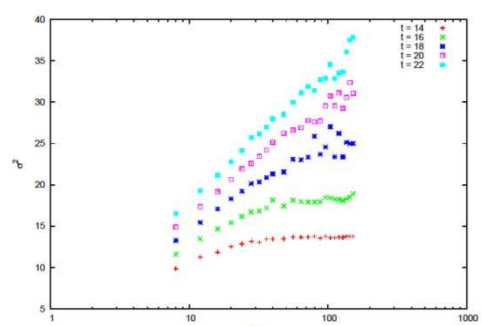


Autocorrelation of thickness with Fourier accelerated hybrid Monte Carlo. Note that, as expected, the autocorrelation is largest at the critical temperature.

Thickness

$$\sigma^2 = \frac{1}{V^2}\sum_{x,y}\langle(\phi(x)-\phi(y))^2\rangle$$

Hasenbusch, Marcu & Pinn 1994



$$\sigma^2 \simeq \begin{cases} \frac{t}{\pi}\ln L + \text{const.}, & t > t_c \\ \text{const.} & t < t_c \end{cases}$$

Hasenbusch, Marcu & Pinn 1994

Figure at right shows precisely this behavior, with $t_c \approx 18$. We note that the *y* → 0 limit (fugacity expansion) predicts $t_c = 8\pi \approx 25$, so there is apparently some renormalization of t arising from *y* = 0.1. If we fit the coefficient c of

$$\sigma^2 \simeq c\ln L + \text{const.}$$

for the *t*=22 data, we obtain $c \approx 6.7 \pm 0.2$, which is to be compared with $t/\pi = 7.0$
We attribute the small discrepancy (1.5σ) to a possible underestimation of errors and a renormalization of *t*.

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