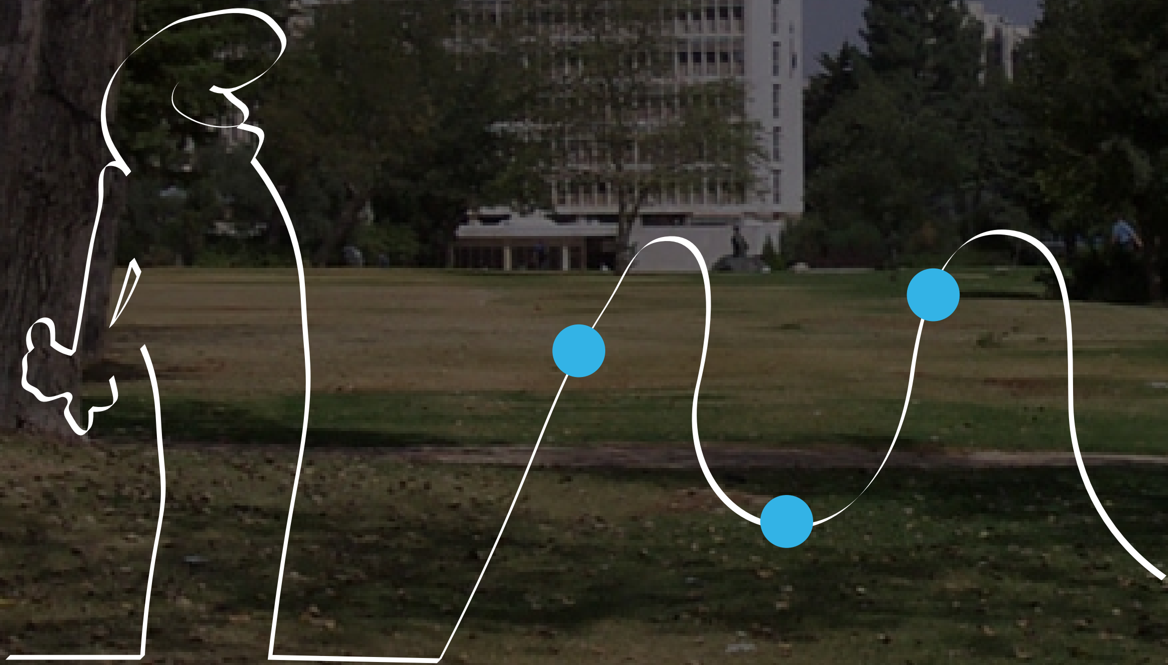
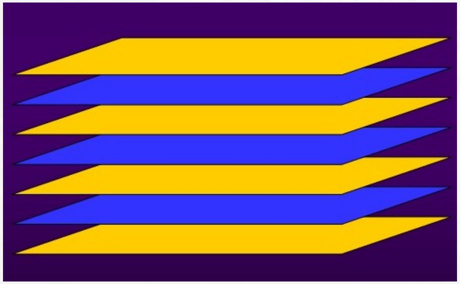
Effects of disorder in fluctuating one-dimensional interacting systems

by Uri London

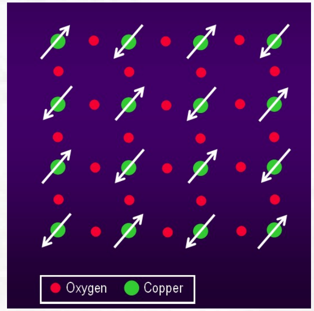
supervisor: Dr. Dror Orgad



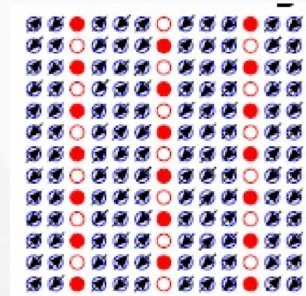
Motivation - Stripes



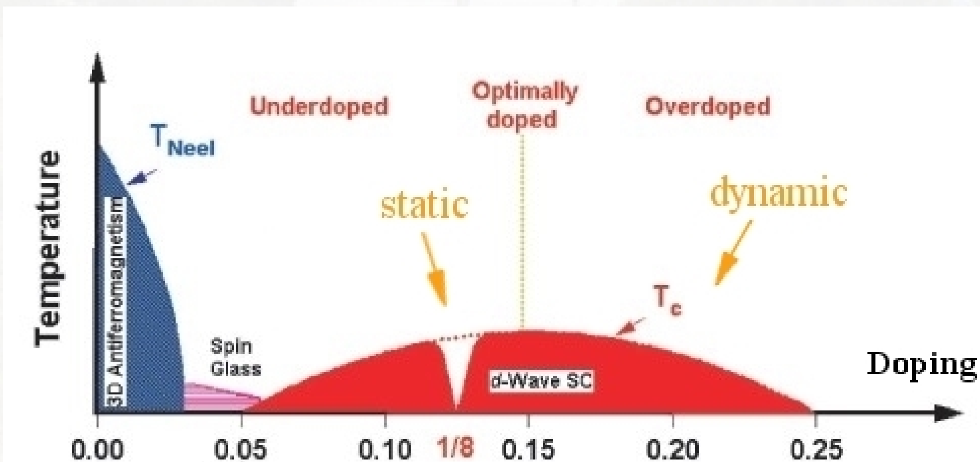
Cuprates has qusi-2d structure



AF Planes



Doped holes segregates to 1d channels - stripes



Tc drops where stripes are static

Metal-Insulator Transition

Metal	Insulator
$\sigma(T=0) > 0$	$\sigma(T=0) = 0$

- **Anderson transition** - localization induced by disordered.
- Mott transition - localization induced by interactions.

1D non-interacting systems:

- exact solution.
- always insulating.
- localization length $\sim$ mean free path.

2D non-interacting systems:

- scaling theory.
- always insulating.
- long localization length .

3D non-interacting systems:

- scaling theory.
- Metal-Insulator transiotion depends on disorder strength
- long localization length .

One-Dimensional Interacting Systems

- **Luttinger Model**: low energy physics

$$H = H_0 + H_{e-e,f} + H_{e-e,b} + H_{dis}$$

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- weak random potential $\xi(x)$ uncorrelated in space

$$\overline{\xi^*(x)\xi(x')} = D\delta(x - x')$$

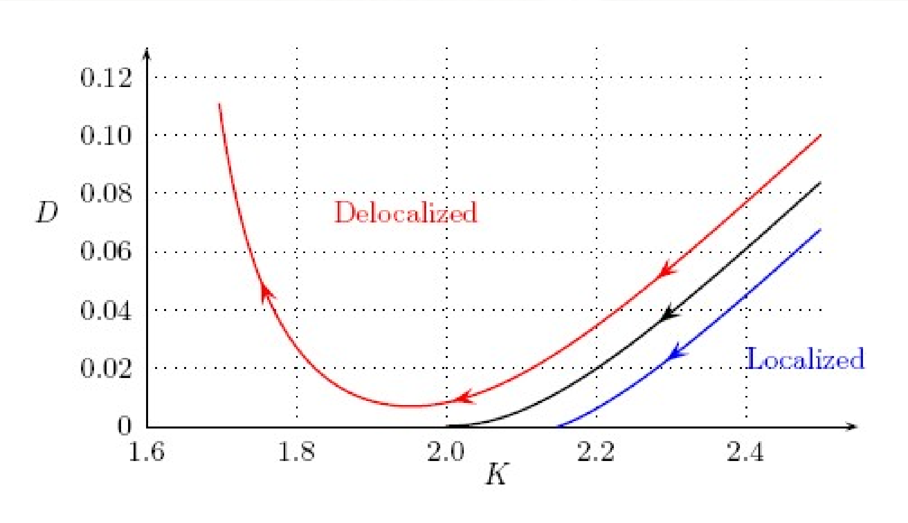
Renormalization

perturbation in g (e-e backward spin-flip scattering) and D (backward disorder)

real-space renormalization group

electron interactions:

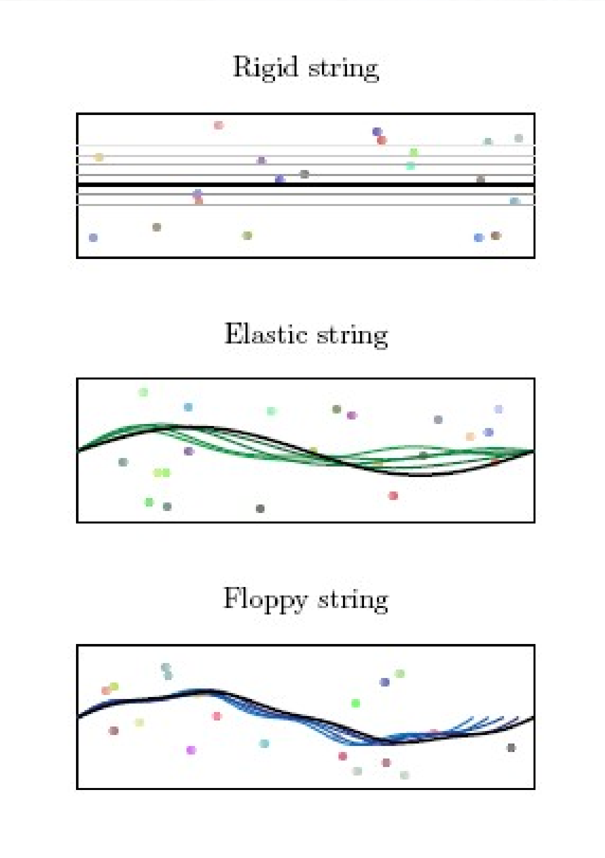
attractive	non-interactive	repulsive
$K > 1$	$K = 1$	$K < 1$



T. Giamarchi, H. J. Schulz, PRB 37:325, 1988

Fluctuations

Three models of string fluctuations



$$L_u = \frac{M}{2}\left(\partial_\tau u\right)^2 + \frac{M\omega_0^2}{2}u^2$$

$$\langle u^2 \rangle = \lambda^2$$

$$\lambda = \frac{1}{\sqrt{2M\omega_0}}$$

$$L_u = \int_0^{L_x} dx \left[\frac{\rho}{2}\left(\partial_\tau u\right)^2 + \frac{\sigma}{2}\left(\partial_x u\right)^2\right]$$

$$\left\langle \left(\frac{\partial u}{\partial x}\right)^2 \right\rangle = \frac{\lambda}{2\pi\alpha}$$

$$\lambda = \frac{1}{(\sigma\rho)^{\frac{1}{4}}}$$

$$L_u = \int_0^{L} ds \left[\frac{\rho}{2}\left(\partial_\tau u\right)^2 + \frac{\gamma}{2}\left(\partial_s^2 u\right)^2\right]$$

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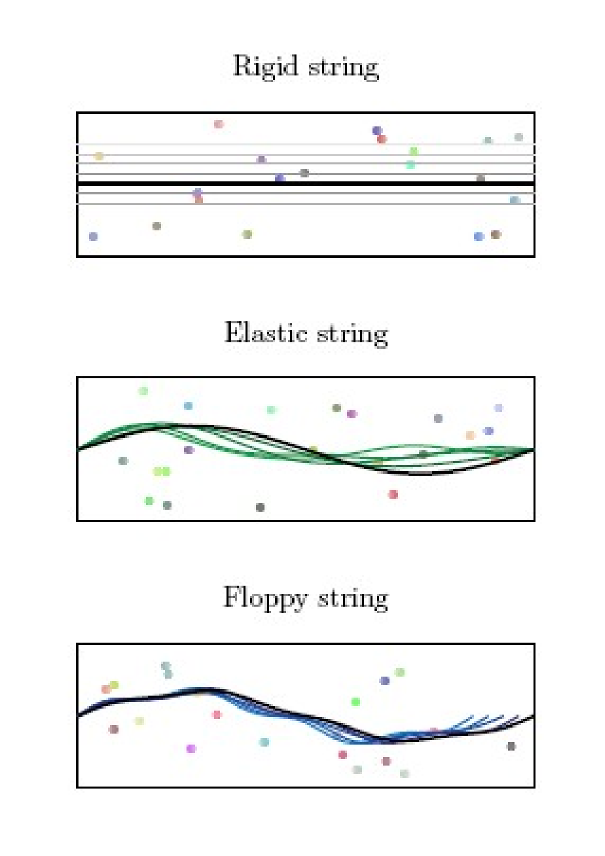

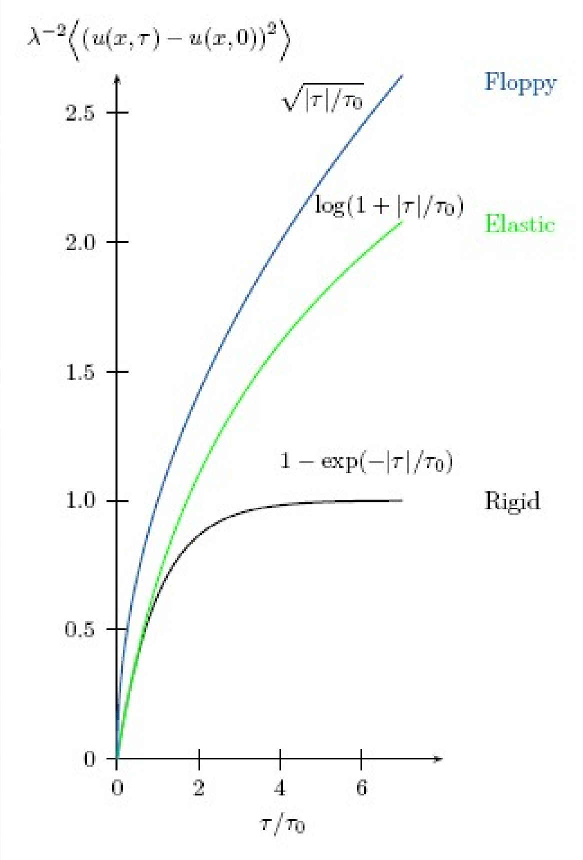

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- The bare disorder is decreased by fluctuations $D \to \frac{D}{\lambda}$.

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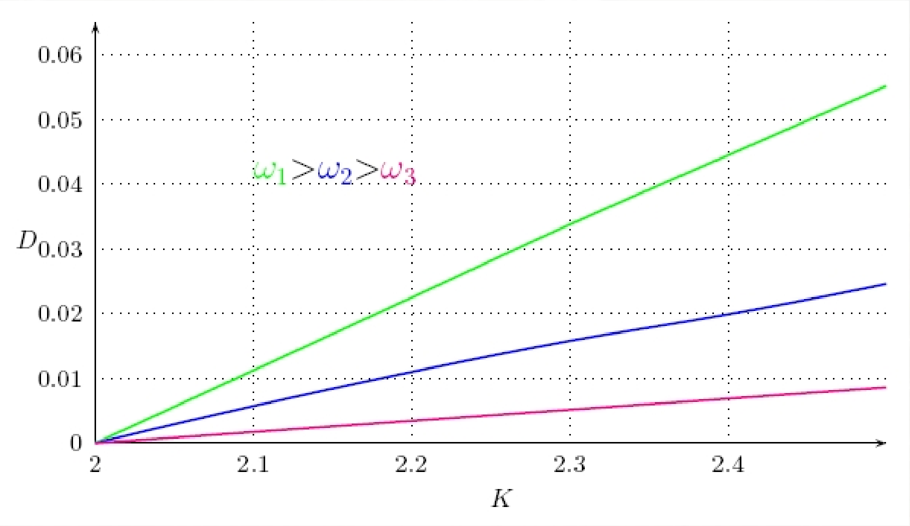

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  for white noise disorder average.

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- Extension of the floppy model: Elastic Energy $= \int ds \gamma \partial_s^n u$, results in shift of

  the critical point to $K^* = 3/2$ when $n \to \infty$.

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- Further investigation - coupled fluctuating strings (imitating better quasi-one dimensionality)

FIN