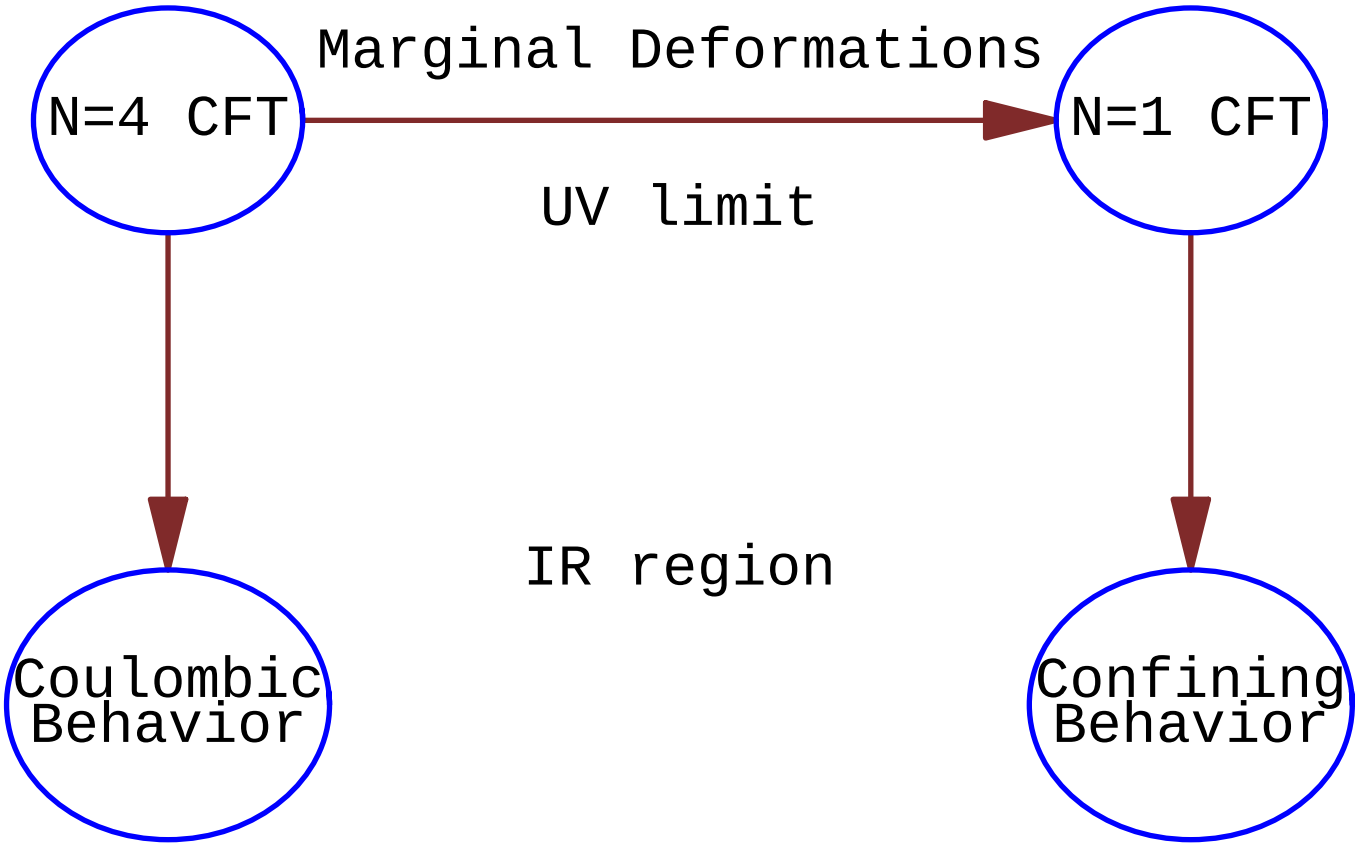
From Marginal Deformations to Confinement

Justin Vázquez-Poritz
University of Cincinnati
University of Kentucky

Based on work done with Changhyun Ahn
(hep-th/0508075, 0603142)

Various holographic flows

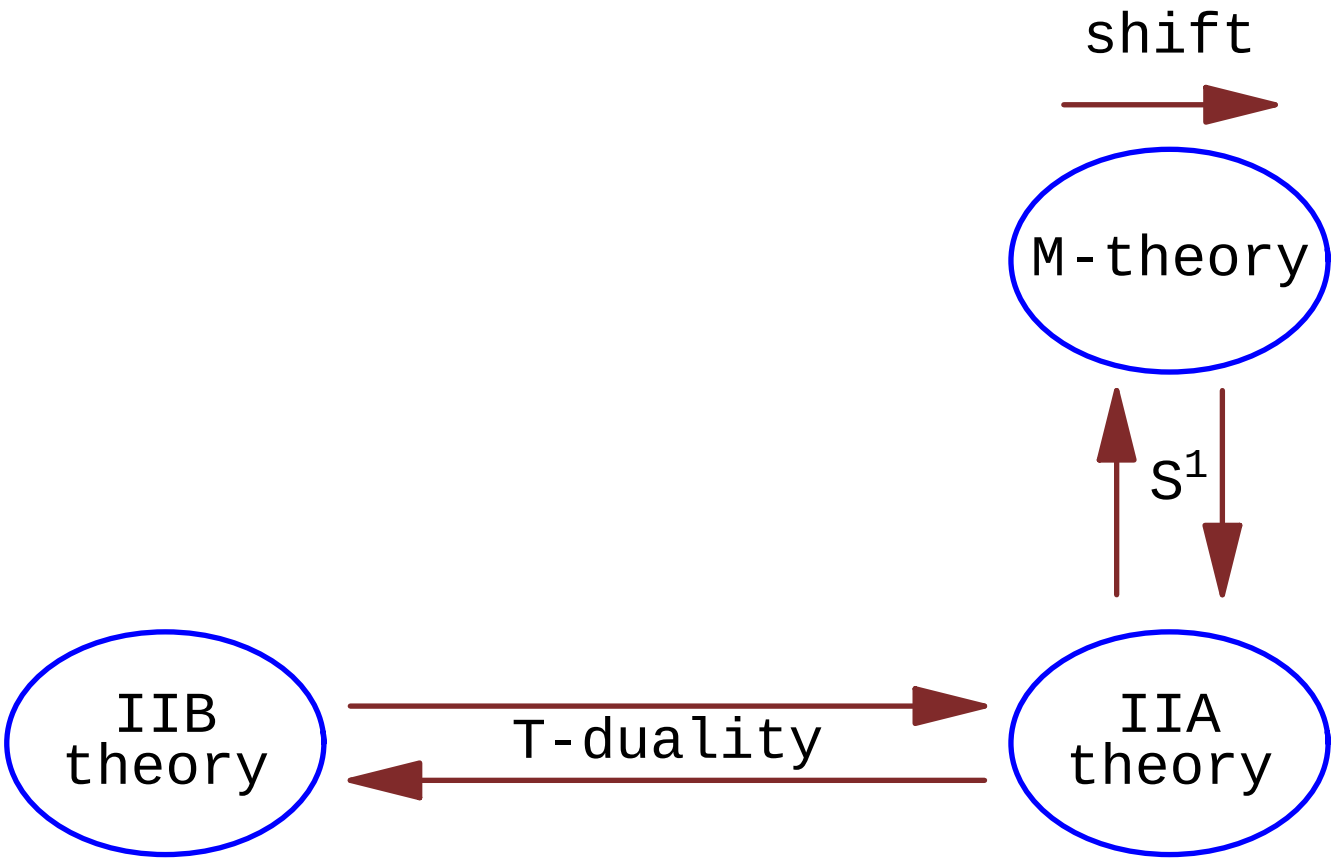


Marginal deformations of Coulomb branch of $\mathcal{N} = 4$ super Yang-Mills theory

(Dorey 2003)

We will see this from the gravity description

Marginal deformations via U-duality



Marginal deformations of $\mathcal{N} = 4$ super Yang-Mills

$SL(3, R)$ shift: γ, σ

$AdS_5 \times S^5 \rightarrow$ warped $AdS_5 \times X^5$

$\mathcal{N} = 4 \rightarrow \mathcal{N} = 1$ conformal field theory

(Lunin and Maldacena 2005)

$$W = Tr(e^{i\pi\beta}\Phi_1\Phi_2\Phi_3 - e^{-i\pi\beta}\Phi_1\Phi_3\Phi_2)$$

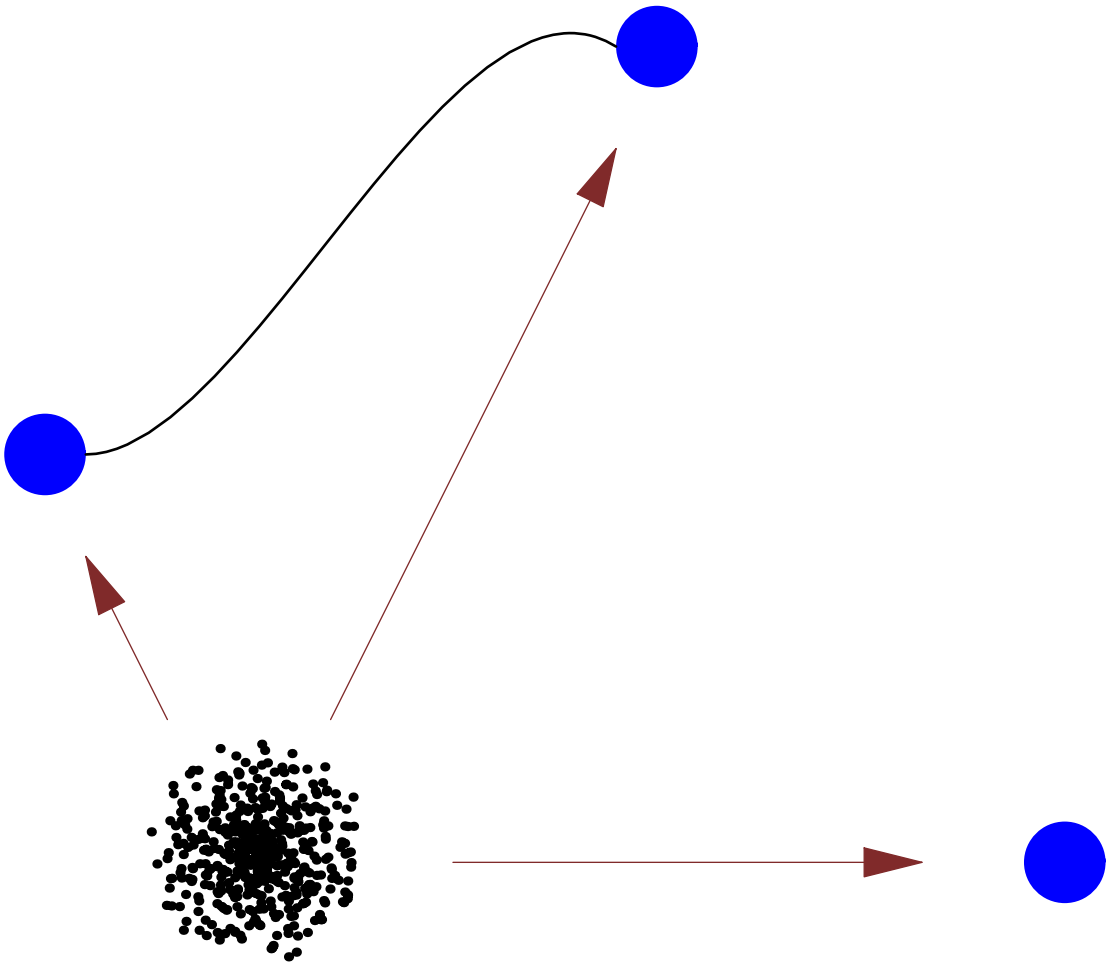
$$\beta = \gamma - \tau_s\sigma$$

(Leigh and Strassler 1995; many earlier papers)

Now go with the Coulomb branch flow

(Ahn and J.F.V.P. 2005)

The Coulomb branch

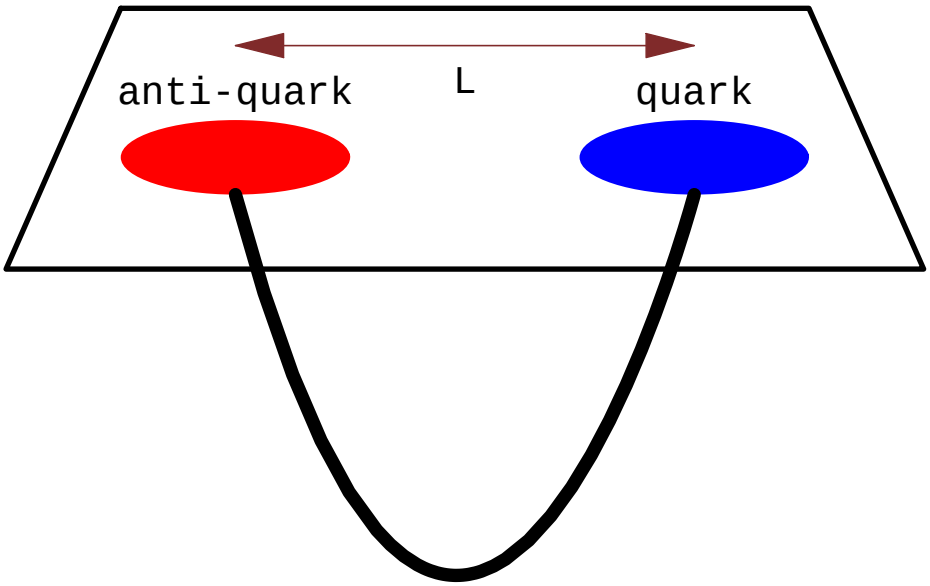


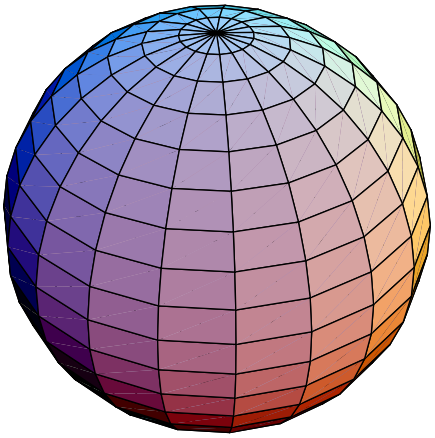
Certain scalar fields get expectation values

Conformal symmetry broken
$\mathcal{N} = 4$ SUSY preserved

(Kraus, Larsen and Trivedi 1998)

Probing the theory





uniform distribution of
D3-branes on S^3 shell

(Rey and Yee; Maldacena 1998)
(Brandhuber and Sfetsos 1999)

Regime of validity

For supergravity background:

$$R \gg 1\,, \qquad \gamma,\, \sigma \ll R$$

$R^4 = 4\pi g_{YM}^2 N$ in string units

For string probe:

$$r_{min} \gg \frac{\ell_i}{R^2}$$

r_{min} is minimum distance
from D3-brane distribution

Wilson loop calculations

Static string configuration with action:

$$S = \frac{1}{2\pi\alpha'} \int d\tau \, d\sigma \, \sqrt{\det G_{MN} \partial_\alpha X^M \partial_\beta X^N}$$

σ effect due to conformal factor:

$$1 + \sigma^2 f(r, \theta_i)$$

Radial solution for $SO(4) \times SO(2)$ symmetry

D3-branes uniformly distributed on 3-sphere

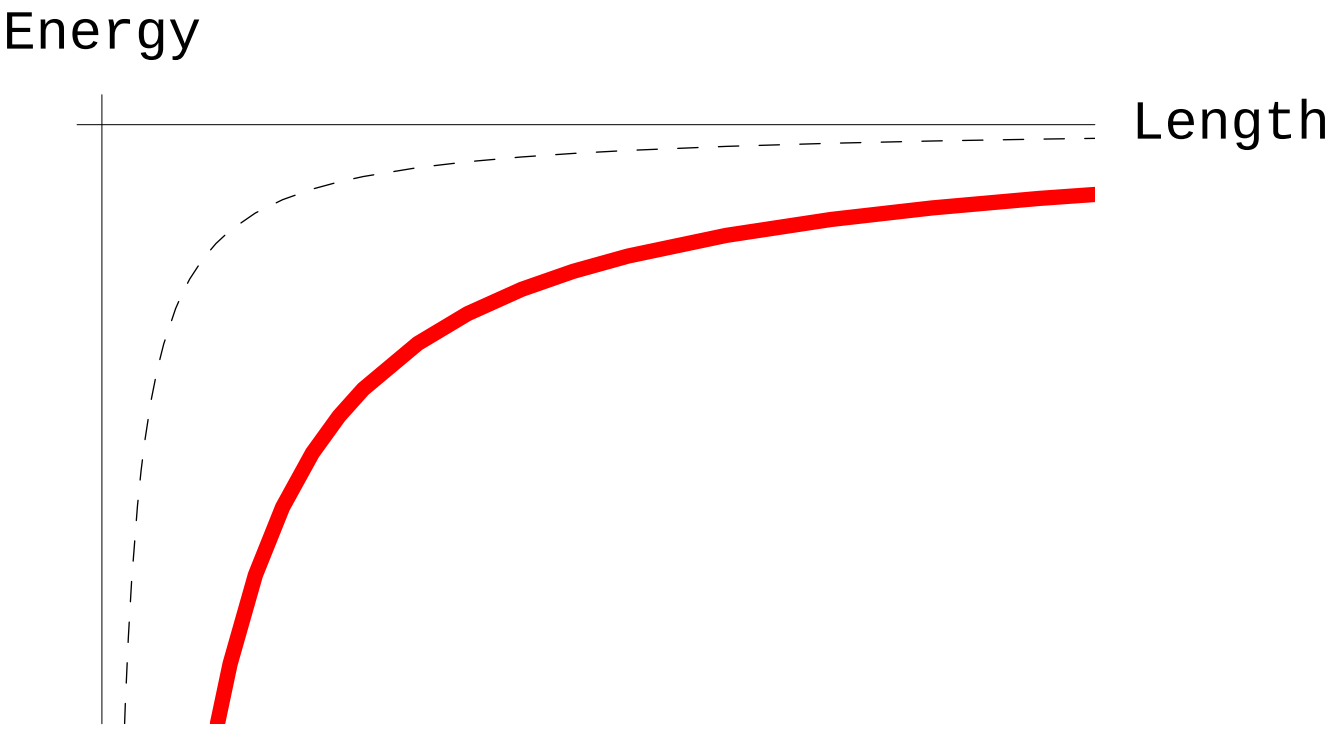
Find L from solution; $E = \frac{S}{\int d\tau}$

Given in terms of complete elliptic integrals

UV conformal fixed-point

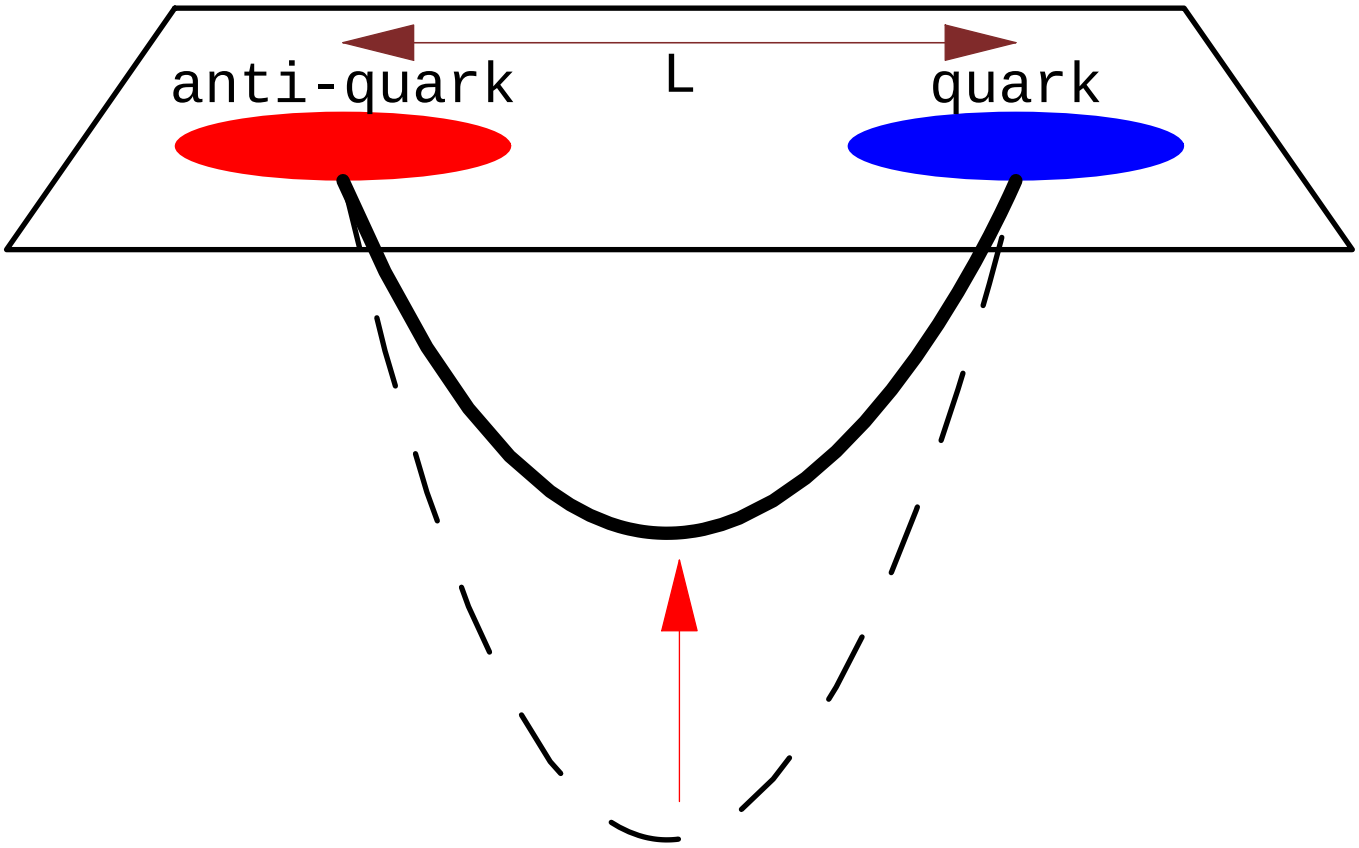
Enhanced Coulombic force

$$E = -\frac{4\pi^2\sqrt{2g^2_{YM}N(1+\sigma^2)}}{\Gamma(1/4)^4\,L}$$

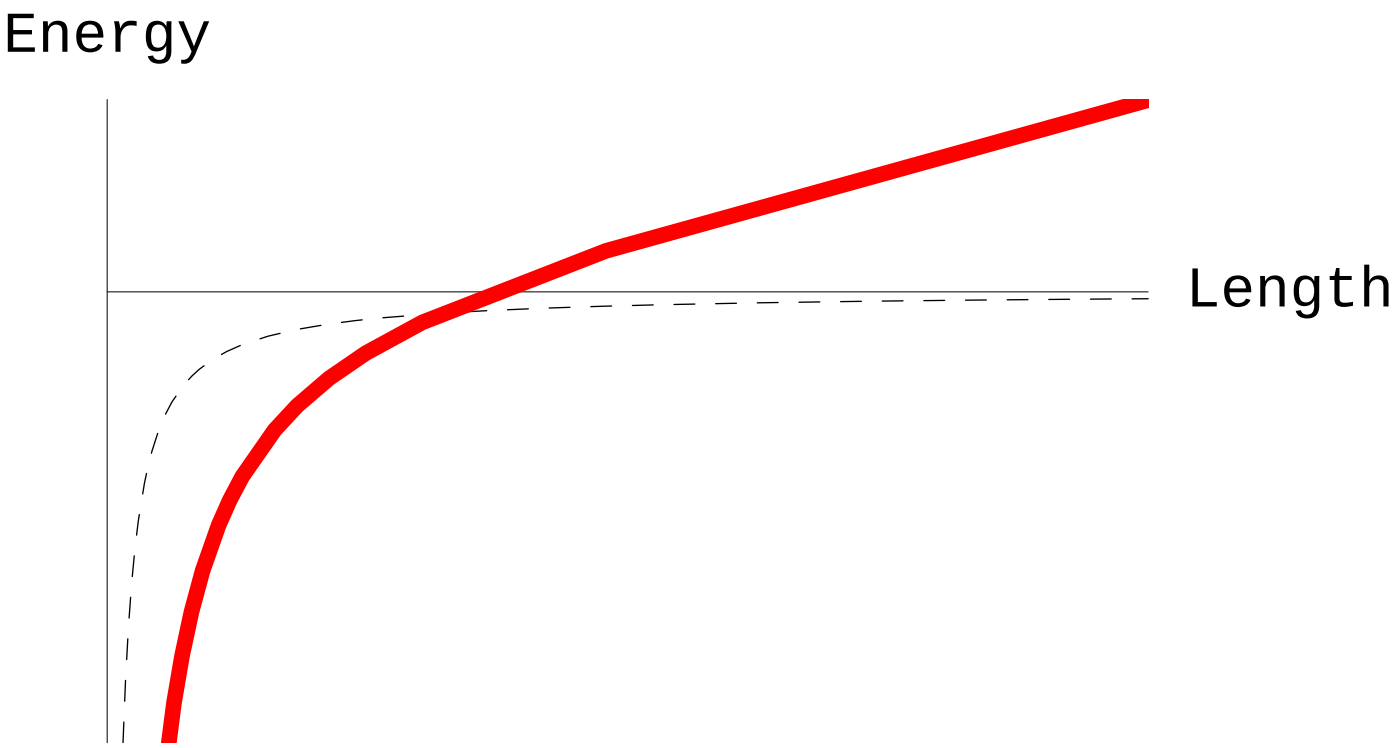


(Ahn and J.F.V.P. 2006)

Effect of σ in IR region



Transition to confinement



$E \sim L$ for large L

String tension increases with σ

(Ahn and J.F.V.P. 2006)