Discrete gauge symmetries from supercritical strings

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StringPheno
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Discrete gauge symmetries from (closed string) tachyon condensation, M. Berasaluce-González, M. Montero, A. Retolaza, A. Uranga. hep-th/1305.6788

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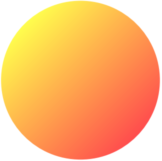

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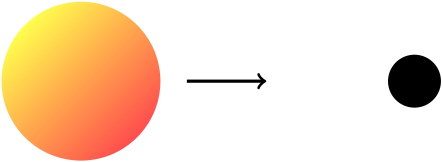

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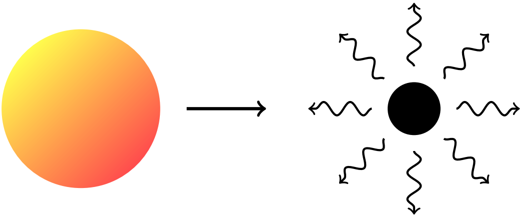

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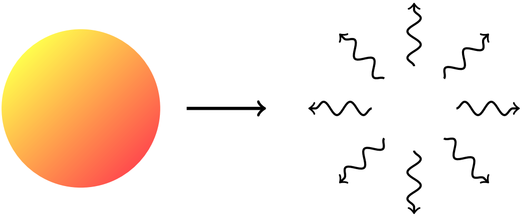

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Discrete gauge symmetries can arise from discrete isometries after dimensional reduction e.g. M. Berasaluce-González *et al.* '12.
Consider pure gravity on $\mathbf{M}^4 \times \mathbf{S}^1$ and 5-d metric

$$g_{MN} = \phi^{-1/3} \begin{pmatrix} g_{\mu\nu} + \phi A_\mu A_\nu & \phi A_\mu \\ \phi A_\nu & \phi \end{pmatrix}$$

- Fourier modes ϕ_n have KK momentum $n \rightarrow$ charge n under A_μ.
- A vev for $\langle \phi_{kp} \rangle,\ k \in \mathbb{N}$ breaks $U(1)$ to $\mathbb{Z}_p$.
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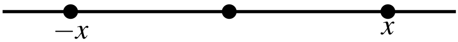

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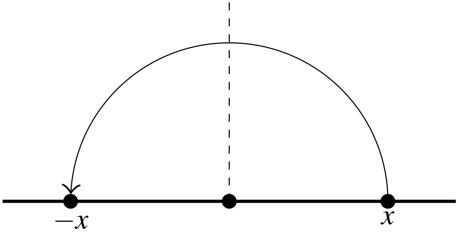

Supercritical strings: How?

Chamseddine '92

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- The price: **closed string tachyons**
- Bosonic string: Usual tachyon.
- Heterotic supercritical strings: A new set of tachyons in the adjoint.
- Type 0: A single tachyon from the ground state of NS-NS sector.

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- The tachyon signals an instability

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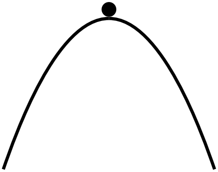

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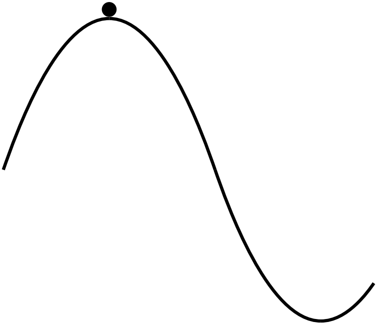

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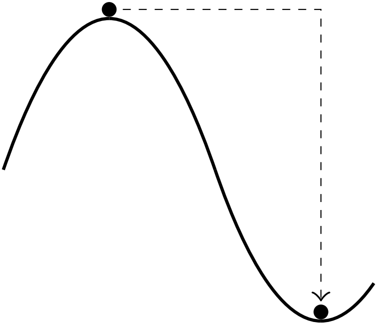

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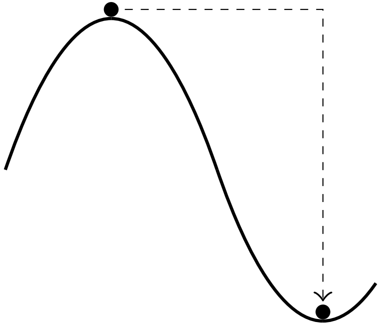


- Under some circumstances it is possible to figure out the endpoint of the condensation!

Tachyon condensation: The idea

Hellerman & Swanson, hep-th/0612051

- Pick a light-like tachyon background

$$\mathcal{T}(X) \sim -\mu_k^2 \cos(kX_2) \exp(\beta_k X^+)$$

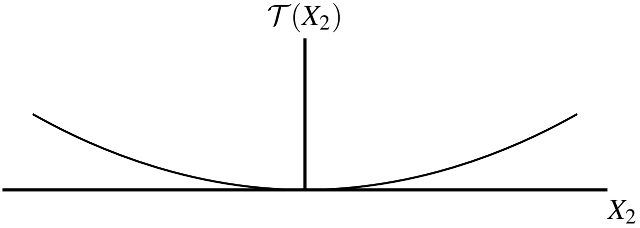
- At early times $\mathcal{T} \approx 0$, at late times $\mathcal{T} \to \infty$ except at $X_2 = 2\pi n$.
- It couples to the worldsheet as a potential,

$$\Delta\mathcal{L} = -\frac{1}{2\pi} : \mathcal{T}(X) :$$

- At late times X_2 acquires a very large effective mass in the worldsheet and can be integrated out.

Tachyon condensation: Dynamics

As we increase X^+…



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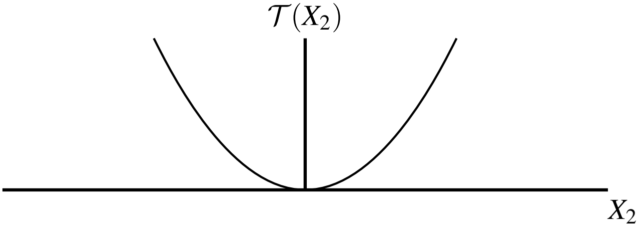

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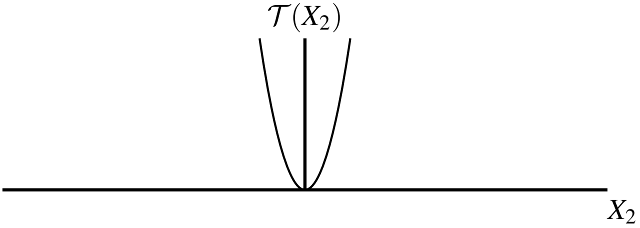

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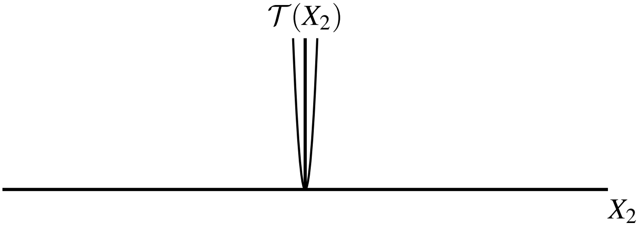

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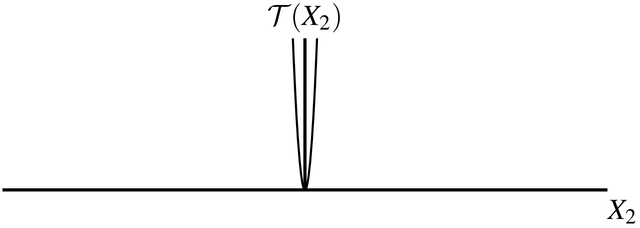

…the theory gets confined to the $X_2 = 0$ slice!

Discrete isometries from quenched rotations

We can embed discrete isometries into continuous ones and then collapse through tachyon condensation.

- Spacetime parity: Add X^{26} and let $\mathcal{T} \sim (Z - \bar{Z})^2 e^{\beta X^+}$ where $Z = X^{26} + iX^{25} = e^{i\theta}$.

$$\mathcal{T} \sim (1 + e^{2i\theta} + e^{-2i\theta}) e^{\beta X^+}, \quad \rightarrow \quad \text{Higgsing!}$$

- $SO(32)$ Heterotic: $\mathbb{Z}_2$ symmetry in which massive spinors are odd, fields in the adjoint even.
  Add two extra dimensions, enhancing the gauge group to $SO(32+2)_{\text{gauge}} \times SO(2)_{\text{rot.}}$.
  There is a tachyon $\mathcal{T}^a$ in the bifundamental, which breaks the gauge group to $SO(32) \times SO(2)_{\text{diag.}} \rightarrow SO(32)$. The tachyon has charge antidiag charge $+2$, and the spinors have charge ± 1, so a discrete remnant of the gauge group is preserved.

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