A New Mechanism of Spontaneous SUSY Breaking

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hep-th/9912229

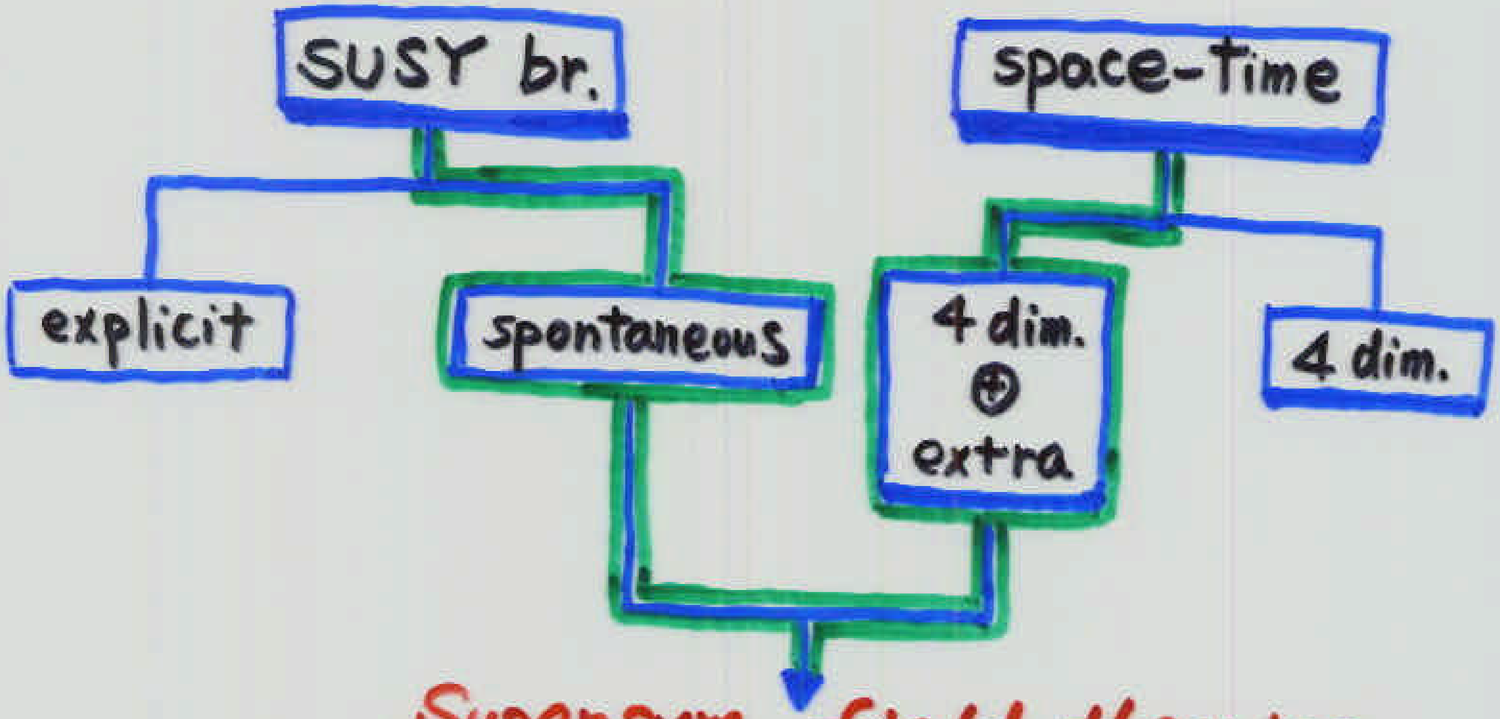
Why ~~SUSY~~ & Why Extra Dimensions?

If Superstring is realized in Nature, we have to solve the problems of

- SUSY breaking
- compactification (10 d. → 4 d.)

⋮

How to describe the physics at energies $M_W < E < \Lambda$?



Supersym. field theories with extra dimensions

Basic Idea

A supersym. model

Φ_j : chiral superfields

$W(\Phi)$: superpotential

Scalar Potential

$$V(A_i) = \sum_j |F_j|^2 \equiv \sum_j \left| \frac{\partial W(A)}{\partial A_j} \right|^2$$

$V(A_i)$ ↑ lowest

F_j ↑ highest

SUSY

$$-F_j^* = \left. \frac{\partial W(A)}{\partial A_j} \right|_{A=\bar{A}_k} = 0 \quad \forall j$$

$\longrightarrow$ $V(\bar{A}) = 0$!

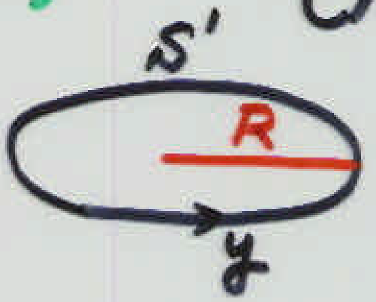
Q Mechanism to be $\langle A_j \rangle \neq \bar{A}_j$?

$\Rightarrow$ { Extra compactified dimensions
nontrivial boundary conditions

Ex.) ★ spacetime $M^{D-1} \otimes S^1$
$(x^\mu, \; y)$

■

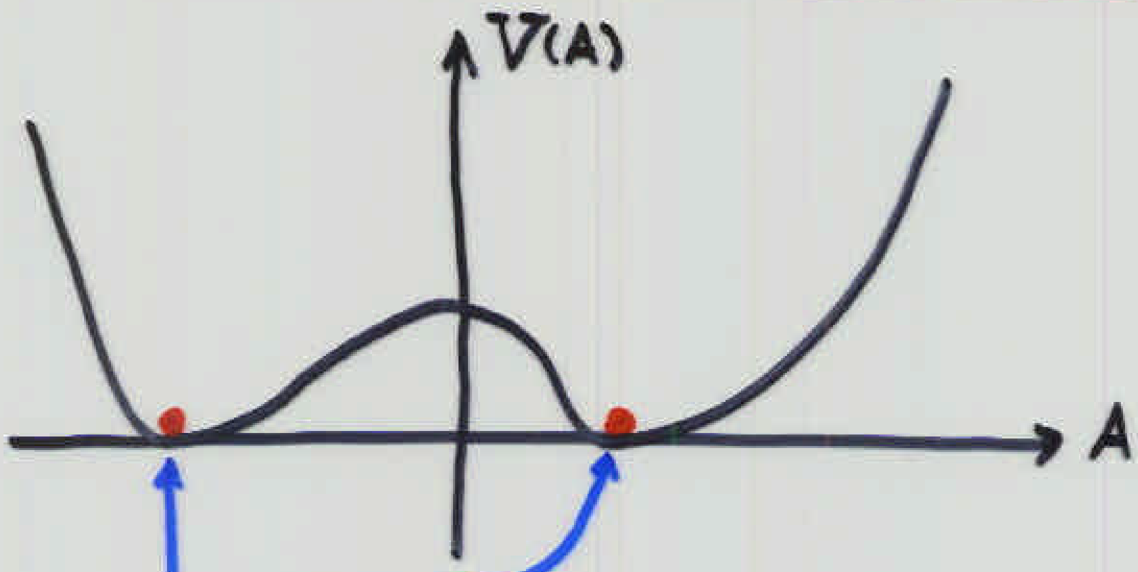
$$\Phi(x^\mu, y + 2\pi R) = e^{i\theta}\, \Phi(x^\mu, y)$$



nontrivial bdry cond.

chiral S.F.

➡ $\langle \Phi(x^\mu, y) \rangle \neq$ nonzero const !



These are (would-be) supersymmetric vacua but $A(x,y)$ cannot sit on them !

★ Novel feature — phase structure —

$$\langle A(x,y) \rangle = \begin{cases} 0 & R \le R^* \\ f(y) & R > R^* \end{cases}$$

R^*: critical radius

Breaking of Translational Inv.

★ Fourier expansion

$$A(x^\mu, y) = \frac{1}{\sqrt{2\pi R}} \sum_{n=-\infty}^{\infty} a^{(n+\alpha)}_{(x)} e^{i\frac{n+\alpha}{R}y}$$

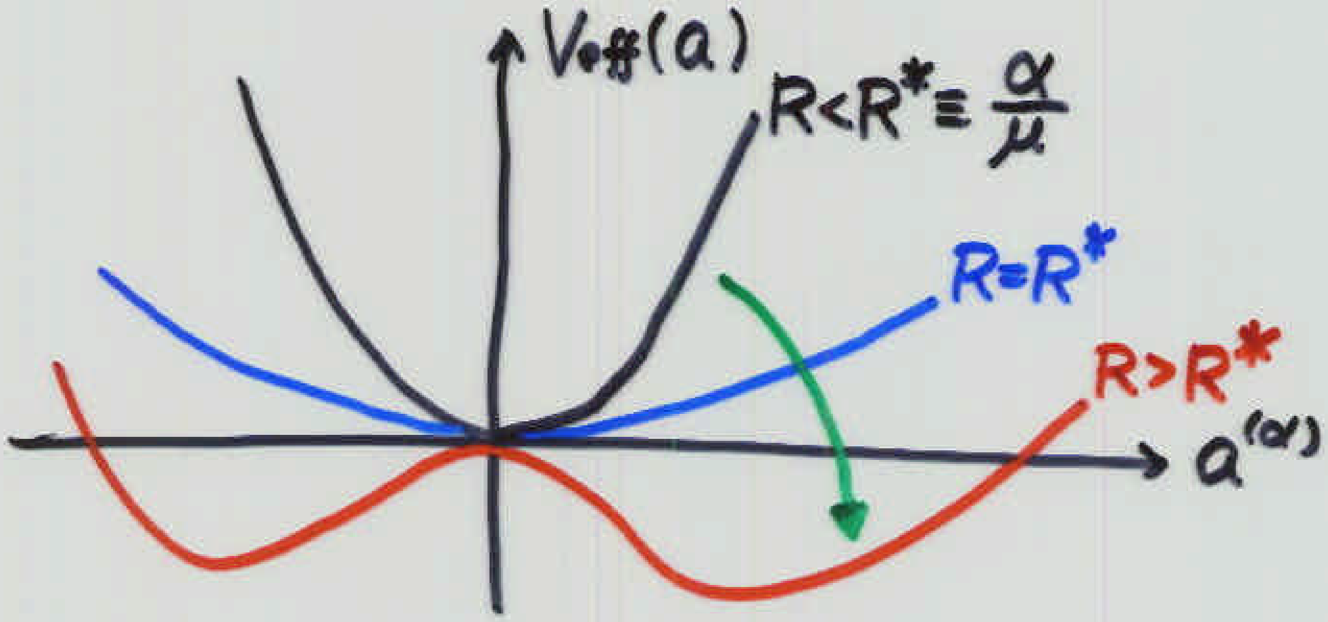
No zero mode!

★ "Effective potential"

$$V_{eff}(a) \equiv \int_0^{2\pi R} dy \left\{ |\partial_y A|^2 + V(a) \right\}$$

$$= \sum_n \left[\left(\frac{n+\alpha}{R}\right)^2 - \mu^2 \right] |a^{(n+\alpha)}|^2 + \cdots$$

$$= \left[\left(\frac{\alpha}{R}\right)^2 - \mu^2 \right] |a^{(\alpha)}|^2 + \cdots$$



Summary & Discussion

★ A New Mechanism of spontaneous ~~SUSY~~

- Extra dimensions
- nontrivial bdry cond.

keywords

- $\mathbb{Z}_2$-model on $M^3 \otimes S^1$ (hep-th/9912229)

- Phase structure (R^*)
- translational inv. breaking
- mass spectra

  Goldstone boson & fermions

  ~~transl~~ ~~SUSY~~

Future works

- Gauge dynamics
- more cpx manifold than S^1

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