

2次元 $\mathcal{N} = 2$ 超対称 $O(N)$ 非線形シグマ模型の
Large N による解析

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木村 哲士, 都築 誠, 東島 清 (阪大理),
新田 宗土 (東工大理工).

Quadric Surface

$$Q^{N-2}(\mathbb{C}) = \frac{SO(N)}{SO(N-2) \times U(1)}$$

$$\mathcal{L} = \int d^4\theta K(\varphi_i, \varphi_i^\dagger)$$

$$K(\varphi_i, \varphi_i^\dagger) = c \log \left\{ 1 + \varphi_i^\dagger \varphi_i + \frac{1}{4} (\varphi_i^\dagger)^2 (\varphi_i)^2 \right\}$$

φ_i : Dynamical chiral superfields

$$\begin{aligned} \mathcal{L} = & \int d^4\theta \{ \Phi_i^\dagger \Phi_i e^{2V} - cV \} \\ & + \left(\int d^2\theta \Phi_0 \Phi_i^2 + \text{h.c.} \right) \end{aligned}$$

Φ_i : Dynamical chiral superfields

V : Auxiliary vector superfield

Φ_0 : Auxiliary chiral superfield

Symmetry

local (gauged) $U(1)$ symmetry

$$\Phi_i \rightarrow e^{i\alpha(x)} \Phi_i ,$$

$$\Phi_0 \rightarrow e^{-2i\alpha(x)} \Phi_0 .$$

global $U(1)$ symmetry

$$\Phi_i(\theta) \rightarrow \Phi_i(e^{i\alpha}\theta) ,$$

$$\Phi_0(\theta) \rightarrow e^{2i\alpha} \Phi_0(e^{i\alpha}\theta) ,$$

$$\lambda \rightarrow e^{i\alpha} \lambda .$$

global chiral $U(1)$ symmetry

$$\psi_i \rightarrow e^{i\gamma_3\alpha} \psi_i ,$$

$$(M - i\gamma_3 N) \rightarrow e^{-2i\gamma_3\alpha} (M - i\gamma_3 N) .$$

Effective Potential

- $SO(N)$ fields Φ_i を全て Integrate Out
⇒ 補助場 Φ_0 , V の有効理論を構成
- Large N Leading Term を Pick Up
⇒ $N \rightarrow \infty$ で生き残る理論

Vacua

Keywords

- $\mathcal{N} = 2$ Supersymmetric
- **IR-Divergence Free** ⇒ Mass Gap
- $SO(N)$ Symmetric ⇒ $\langle \Phi_i \rangle = 0$
- Stable

Schwinger Phase

$SO(N)$ vector fields Φ_i

(perturbative) (non-perturbative)

massless \Rightarrow massive : m

Auxiliary fields Φ_0, V

(perturbative) (non-perturbative)

massless \Rightarrow massive : $2m$

- $\langle V \rangle = m$: 質量の起源
- Φ_0 と V はそれぞれ独立に質量を獲得
- **Schwinger mechanism**

\Rightarrow massive gauge boson

Asymptotic Free !

Higgs Phase

$SO(N)$ vector fields Φ_i

(perturbative) (non-perturbative)

massless \Rightarrow massive : m

Auxiliary fields Φ_0, V

(perturbative) (non-perturbative)

massless \Rightarrow massive : $2m$

- $\langle \Phi_0 \rangle = m$: 質量の起源
- Φ_0 と V の mixing で質量獲得
- **Higgs mechanism**
 \Rightarrow massive gauge boson

Asymptotic Free !

Summary

超対称非線形模型の **線形起源** を考察

Quadric surface

2 種類の安定な真空の発見

- **Schwinger phase, Higgs phase**
- 補助場は全て質量を獲得
- 漸近的自由

Future

- **Grassmannian model** 等への応用。
- Conformal 理論への拡張
- 他の時空次元への拡張