

“超対称小生理論とブラックホール”

プラン

0. overview

1. SUSY

2. SCFT

3. SUSY index

4. superconformal index

5. computation of 4d SC I

6. SC I in 4d $N=4$ SYM

7. SUSY Cardy formula

8. BH entropy from SC I

0. Overview

BH : thermodynamic

macroscopic entropy :

[Bekenstein - Hawking]

$$S_{BH} = \frac{A}{4G}$$

統計力学的解釈?

量子重力の試金石

弦理論?

Seminal work by Strominger - Vafa '96

For an asymptotically flat SUSY BH,

$$S_{BH} = \log [\# \text{ of BPS states}]$$

漸近 AdS の場合?

AdS / CFT 対応

(2)

$$\text{Gravity on AdS}_{d+1} (\times M) \overset{\text{dual}}{\longleftrightarrow} \text{CFT}_d$$

Q. 5次元 AdS BH の entropy は
CFT 側から微視的に説明できるか?

$$S_{\text{CFT}} = \log \left(\begin{array}{l} \# \text{ of states} \\ \text{w/ BH's quantum numbers} \end{array} \right)$$

この意義

$$\text{Type IIB on AdS}_5 \times S^5 \longleftrightarrow 4d \text{ SU(N) N=4 SYM}$$

に focus

重力俱り

(3)

≡ SUSY BH

- 2 supercharges
- 2 angular momentum (J_1, J_2)
($AdS_5 \rightarrow SO(5,1), SO(4,2)$ 3cartn)
- 3 electric charges (Q_1, Q_2, Q_3)
($S^5 \rightarrow SO(6)$)

$$S_{BH} = \sqrt{Q_1 Q_2 + Q_1 Q_3 + Q_2 Q_3 - \underbrace{\frac{\pi}{4G_N g_4^3} (J_1 + J_2)}_{\frac{N^2}{2} \Big|_{N \gg 1}}}$$

↑
これを $N=4$ SYM から出した

(4)

大分配関数

$$\begin{aligned}
 Z &= \text{Tr} \left[\prod_i e^{m_i Q_i} \right] \\
 &= \sum_{\{Q_i\}} d(\{Q_i\}) e^{m_i Q_i}
 \end{aligned}$$

$$\text{AdS/CFT} \rightarrow d(\{Q_i\}) \Big|_{\text{strong coupling, } N \gg 1} \sim e^{S_{\text{BH}}}$$

計算難しい！

SUSY index (superconformal index)

$$\begin{aligned}
 I &= \text{Tr} \left[(-1)^F \prod_i e^{m_i Q_i} \right] \\
 &= \sum_{\{Q_i\}} (d_B(\{Q_i\}) - d_F(\{Q_i\})) e^{m_i Q_i}
 \end{aligned}$$

$$d_B - d_F \leq d \quad \text{lower bound}$$

計算しやすい

最近の進展: I から S_{BH} が出了!!