Black Holes *No. 2*

in Effective String Theory

I. **Introduction**

II. **Model** *(action, basic equations, boundary conditions)*
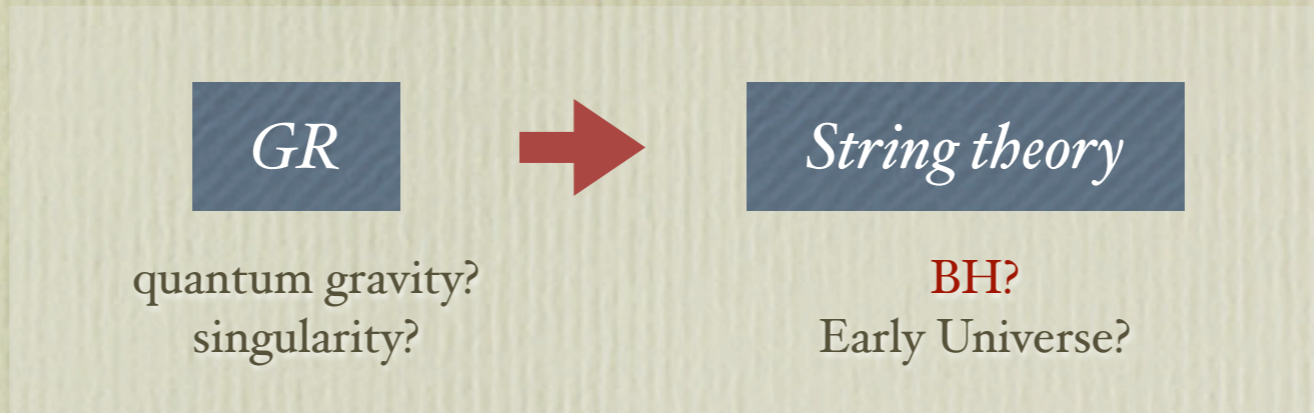
III. **Black Holes** *(horizon radius, fat singularity)*

V. **Summary**

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Introduction

GR ➡ String theory

quantum gravity?
singularity?

BH?
Early Universe?

➤ *Effective theory of superstring theory* **(heterotic string, Metsaev & Tseytlin 87)**

gauge field $\gamma = 1/2$ $\mu = 0,\ 1$

$$S = \frac{1}{2\kappa_D^2} \int d^D x \sqrt{-g} \left[R - \frac{1}{2}(\partial\phi)^2 - \frac{1}{4}e^{-\gamma\phi}F^2 + \alpha_2 e^{-\gamma\phi}\left\{ R_{\text{GB}}^2 - 16\mu(\partial\phi)^4 \right\} \right]$$

$\alpha_2 = \alpha'/8\ (>0)$

Regge slope parameter

$R_{\text{GB}}^2 = R_{\mu\nu\rho\sigma}R^{\mu\nu\rho\sigma} - 4R_{\mu\nu}R^{\mu\nu} + R^2$

GB term

- *Superstring theory is the "fundamental theory". How are the black holes and the early universe described in such theory?*

- *Can the unsolved problem such as the singularity and dark energy are resolved in such theory?*

- *Will the string theory be verified by the observation and/or experiments?*

Introduction

➤ **We will study ...**

- **the black hole solution in the effective string theory with**

    ■ **Gauss-Bonnet term ＋ dilaton（higher order term）**

- **and compare them with the previously known solutions such as**

    ■ **Boulware-Deser solution（$\phi \equiv 0$）**

    ■ **the solution with the model without higher order term of the dilaton (Guo, Ohta & Torii, 2008)**

➤ **We find that ...**

- **The dilaton field affects the structure of the black hole solutions much.**

- **There is the lower limit for the mass (and the horizon radius) of the BH solution in $D = 4, 5$.**

- **The fat singularity appears at non-zero radius in $D = 4, 5$.**

- **The higher order term of the dilaton field does not affect the solutions so much except for the 5-dim case.**

- **For the charged solution, there is no extreme solution when the dilaton field is included.**