Potential Analysis in Holographic Schwinger Effect

Yoshiki Sato (Kyoto Univ.)

In collaboration with Kentaroh Yoshida (Kyoto Univ.)

Abstract: We consider the Schwinger effect from the viewpoint of quark-anti quark potential. The potential analysis gives a strong support for Semenoff-Zarembo’s proposal from another perspective.

**What is the Schwinger effect?**

- Pair creations of electron and positron in an external field.
- Pair creations of particle and anti-particles in an external field are said ubiquitously.
- Non-perturbative phenomenon
- The Schwinger effect is a tunneling process with the potential barrier
- Critical electric field
- The potential barrier decreases gradually as \(E\) becomes large. When \(E = E_c\), the potential barrier vanishes.
- \(E_c\) is a critical electric field. However, this is not confirmed in QED.

**Pair creation in N=4 SYM and Potential Analysis**

- To argue the Schwinger effect, a U(1) gauge field should be introduced. It is necessary to spontaneously break SU(N+1) to SU(N) \(\times\) U(1).
- Quark: SU(N) fundamental rep., U(1) charge: 0

The potential barrier vanishes when \(E \geq 0.70\frac{2\pi m^2}{\sqrt{\lambda}}\).

\[
\alpha_i = 4\pi\sqrt{\lambda/1(1)}^i
\]

The critical electric field is not the same as the one of DBI result.

We revisit this issue.

The probe is put near the horizon! cf. [Semenoff-Zarembo, PRL 107 (2011) 171601]

**Potential Analysis in confining background**

The metric of AdS-Soliton:

\[
d\bar{s}^2 = \frac{r^2}{L^2} \left( r_{out}^2 dx^2 + \frac{d\phi^2}{\sin^2 \phi} + \frac{L^2}{r^2} dr^2 + L^2 d\Omega_5^2 \right)
\]

The potential barrier becomes flat around \(r = \alpha \cdot r_c\).

The electric field is balanced with the confining string tension \(T_F \left( \frac{r_c}{L} \right)^2 \phi\).

**Two critical electric fields.**

1. The orange line (\(\alpha = 1.0\)): The potential barrier vanishes. This behaviour is the same as the previous case.

2. The red line (\(\alpha = \beta^2\)): The potential barrier becomes flat around \(x \to \infty\).

The electric field is balanced with the confining string tension \(T_F \left( \frac{r_c}{L} \right)^2 \phi\).