Holographic Schwinger Effect and Chiral condensate in SYM Theory

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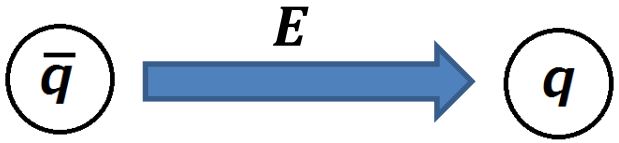
K.Ghoroku and M. I. arXiv: 1604.05025[hep-th]

Holographic Schwinger effect

We consider the Schwinger effect of quarks by Holographic duality (Holography)



Schwinger effect: quark-antiquark pair production under the strong electric field E

Quarks in the 4D Yang-Mills theory

Schwinger pair production rate

Γ

Electric field E

Current quark mass, chiral condensate

Holography

D7-brane in the 10D curved space time

Imaginary part of D7-brane Lagrangian

$\frac{ImL_{D7}}{2\pi^2\tau_7}$ *K.Hashimoto and T. Oka, '13*

U(1) field in D7-brane action

Embedding of D7-brane

D7-brane embedding

Quarks in the 4D YM theory

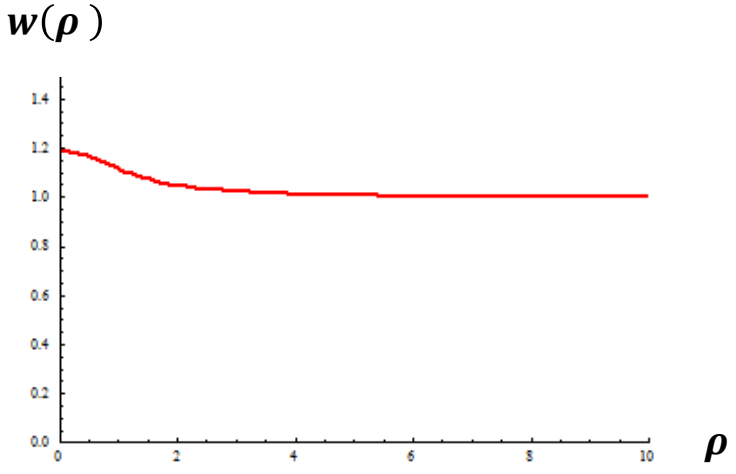
Holography

D7-brane embedding in the curved 10D space-time

A. Karch and E. Katz 2002

D7-brane embedding $w(\rho)$

$$w(\rho) = m_q + \frac{c}{\rho^2} + \cdots$$



Current quark mass: m_q

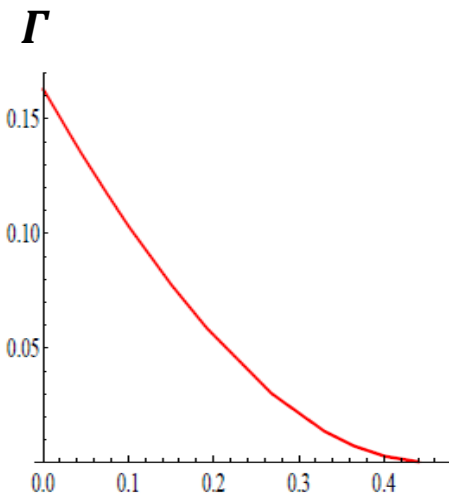
VEV of chiral condensate: $c \equiv -\langle \bar{\psi}\psi \rangle > 0$

Production rate

Electric field $\boldsymbol{E}$ ⟷ (Holography) ⟷ U(1) field in D7-brane action

$$S_{D7} = -\tau_7 \int d^8\xi \sqrt{-det(g_{ab} + F_{ab})} \qquad A_x = -Et$$

The production rate Γ of quark-antiquark pair $\Gamma \equiv \frac{ImL_{D7}}{2\pi^2\tau_7}$

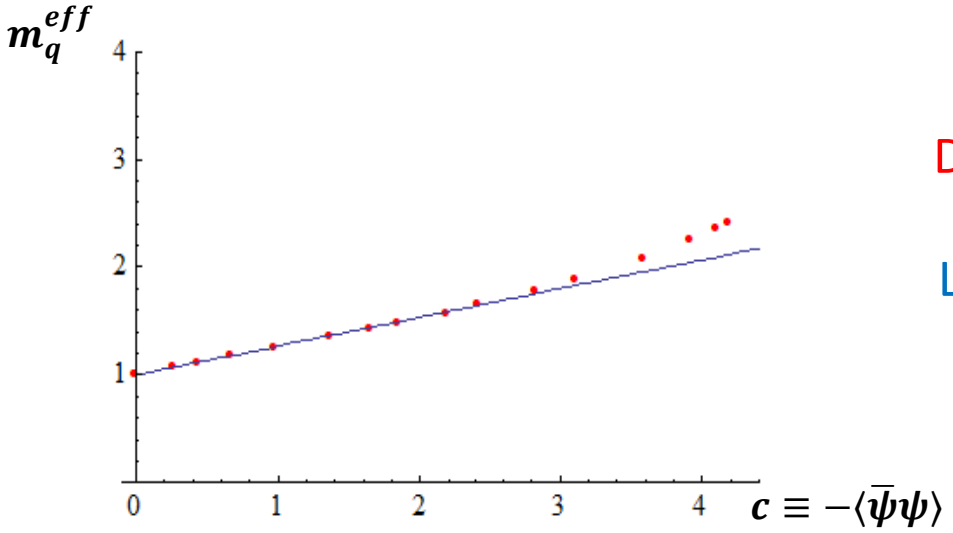


Γ decreases with $c \equiv -\langle\bar{\psi}\psi\rangle$

Effective quark mass increases with c
and it becomes difficult to be pair created.

Effective quark mass and NJL model

We derive the effective quark mass m_q^{eff} from Γ.



Dots: Results from D7-brane

Line: $\mathbf{m_q^{eff}} = m_q - 2g_s\langle\bar{\Psi}\Psi\rangle + \cdots,$

$g_s = 0.74/E$

The effective quark mass agrees with NJL model for small c

$$L_{NJL} = \bar{\Psi}\left(i\gamma^\mu \partial_\mu - m_q\right)\Psi + g_s(\bar{\Psi}\Psi)^2 + \cdots, \qquad g_s = 0.74/E$$