

クォーク は 量子重力

# Fundamental Physics Prize (三億円)



<http://www.princeton.edu/main/news>

# CLAY 数学研究所 ミレニアム問題（一億円）

The screenshot shows the Clay Mathematics Institute website. At the top is a blue navigation bar with the CMI logo and links for ABOUT, PROGRAMS, MILLENNIUM PROBLEMS (highlighted), PEOPLE, PUBLICATIONS, EUCLID, and EVENTS. The main heading is "Yang-Mills and Mass Gap". Below it is a large image of a particle detector track pattern. Two red-bordered boxes are overlaid on the page, containing Japanese text: "ヤン・ミルズ・内山の理論にゼロ質量状態が無いことを示せ" and "クォークの閉じ込めを示せ". To the right, there are sections for "Related Documents:" and "Related Links:". At the bottom left, it says "This problem is: Unsolved".

ABOUT PROGRAMS **MILLENNIUM PROBLEMS** PEOPLE PUBLICATIONS EUCLID EVENTS

## Yang-Mills and Mass Gap

The laws of quantum physics stand to the world of elementary particles in the way that Newton's laws of classical physics stand to the world of everyday objects. The laws of quantum physics have been tested at many experimental laboratories, but their mathematical foundation is still unclear. The Yang-Mills theory and a mass gap are central to the understanding of the strong force, but they have not been proven to exist. The problem is to prove the existence of the Yang-Mills theory and a mass gap.

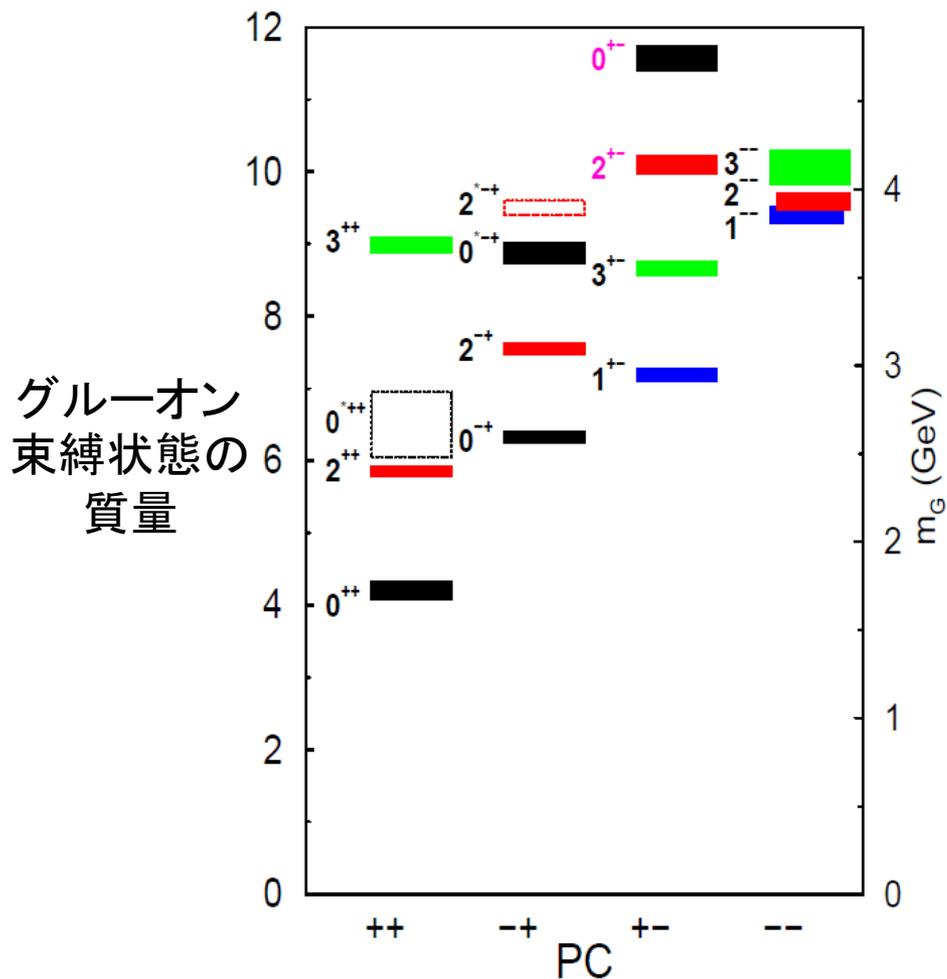
subtle quantum mechanical property of the strong force, even though the classical waves travel at the speed of light. This property has been discovered by physicists from experiment and confirmed by computer simulations, but it still has not been understood from a theoretical point of view. Progress in establishing the existence of the Yang-Mills theory and a mass gap and will require the introduction of fundamental new ideas both in physics and in mathematics.

This problem is: Unsolved

Related Documents:  
The Yang-Mills Problem  
Statement of the Problem  
by Michael Douglas

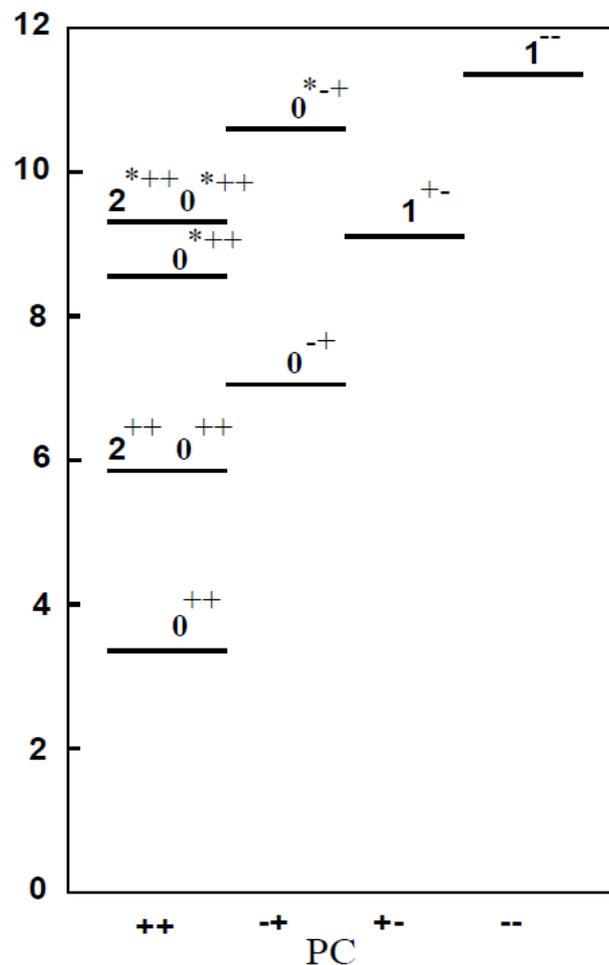
Related Links:  
Lecture by Lorenzo Sadun

# グルーオン 数値計算



[Morningstar, Peardon (99)]

# 量子重力



[Brower, Mathur, Tan (03)]

## 問題

1

電磁場で閉じ込めを壊せるか

## 原因

2

理論計算不可、実験は可能

## 我々の理論解

3

仮想量子重力によるクォークの記述



臨界電場、シュウィンガー効果、絶縁破壊、熱化、非閉じ込め

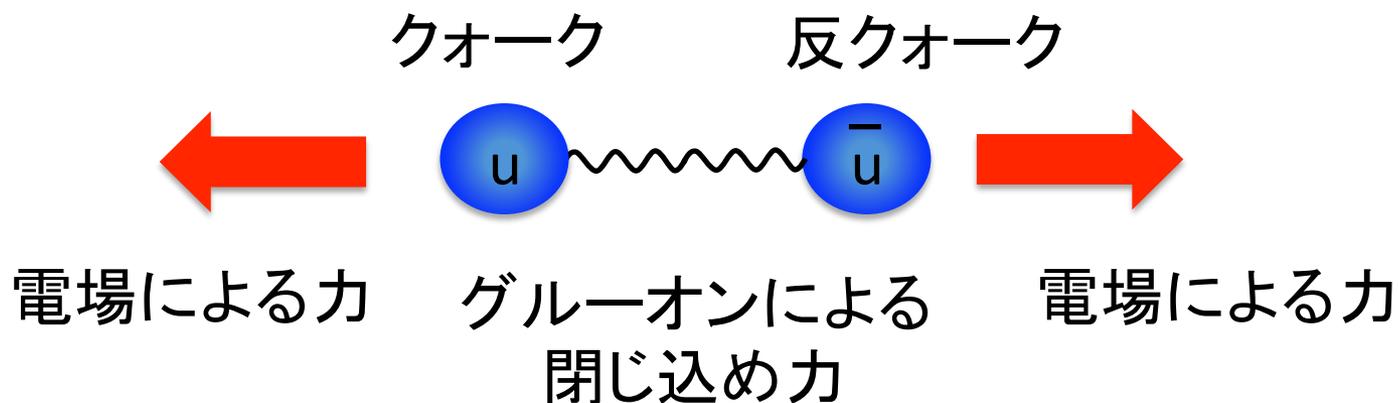
[橋本・岡(東大工)・園田, arXiv:1403.6336]

[橋本・岡(東大工), arXiv:1307.7423]

## 1

## 電磁場で閉じ込めを壊せるか？

物理的描像：クォークをつなぐ「閉じ込め力」 < 電場



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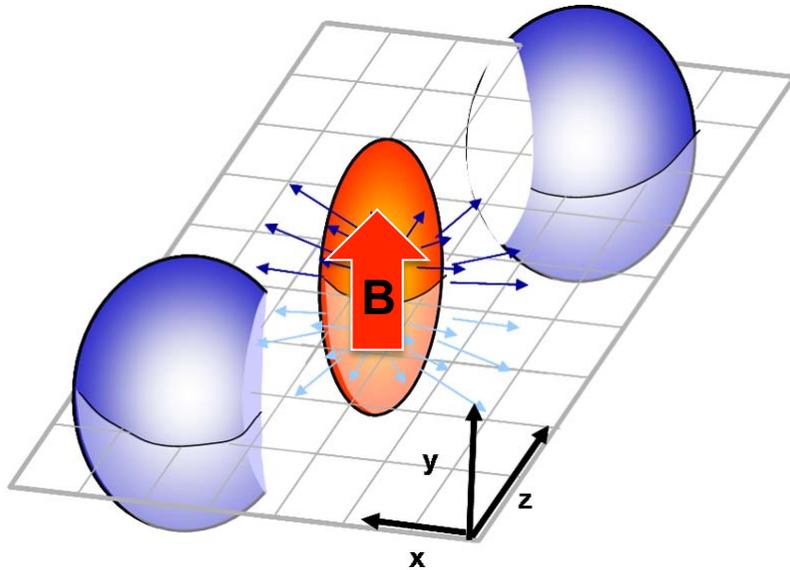
仮想量子重力によるクォークの記述



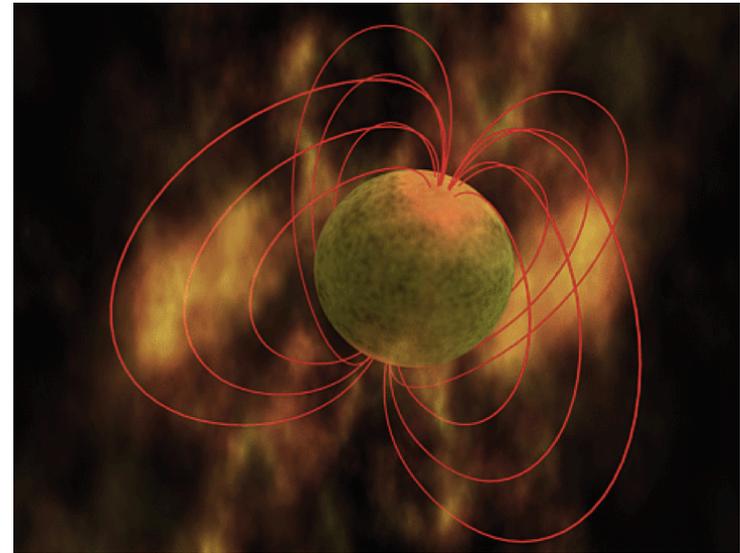
臨界電場、シュウィンガー効果、絶縁破壊、熱化、非閉じ込め

[橋本・岡(東大工)・園田, arXiv:1403.6336]

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重イオン衝突での  
強電磁場

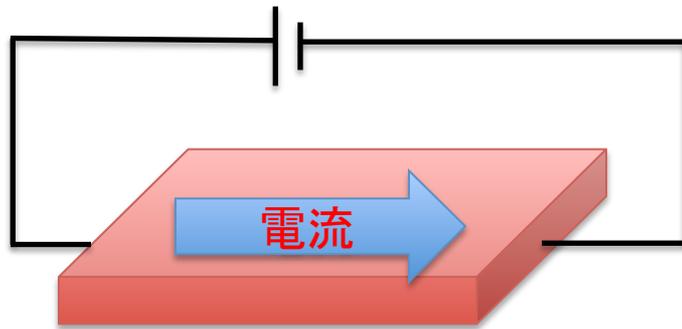
[Kharzeev, McLerran, Warringa, 0711.0950]  
[Voronyuk et.al 1103.4239]  
e.g. [板倉数紀, 原子核研究(2012/09)]

中性子星での  
強電磁場

e.g. [T.Enoto, 天文月報 105(2012)431]

物性系で：「絶縁破壊」

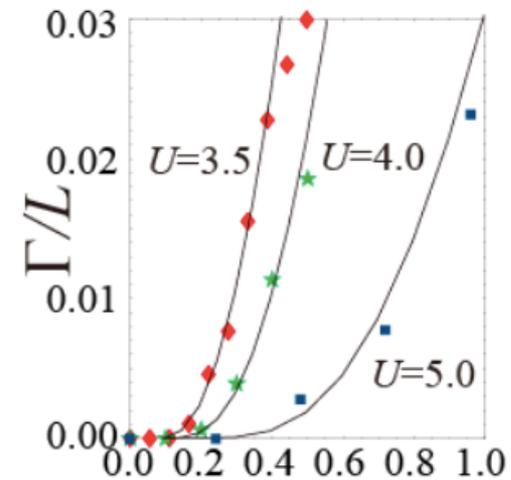
実験



強相関物質の絶縁破壊

理論計算

1次元モット絶縁体での崩壊確率



電場

[Oka, Aoki, PRL 95 (2005) 137601]

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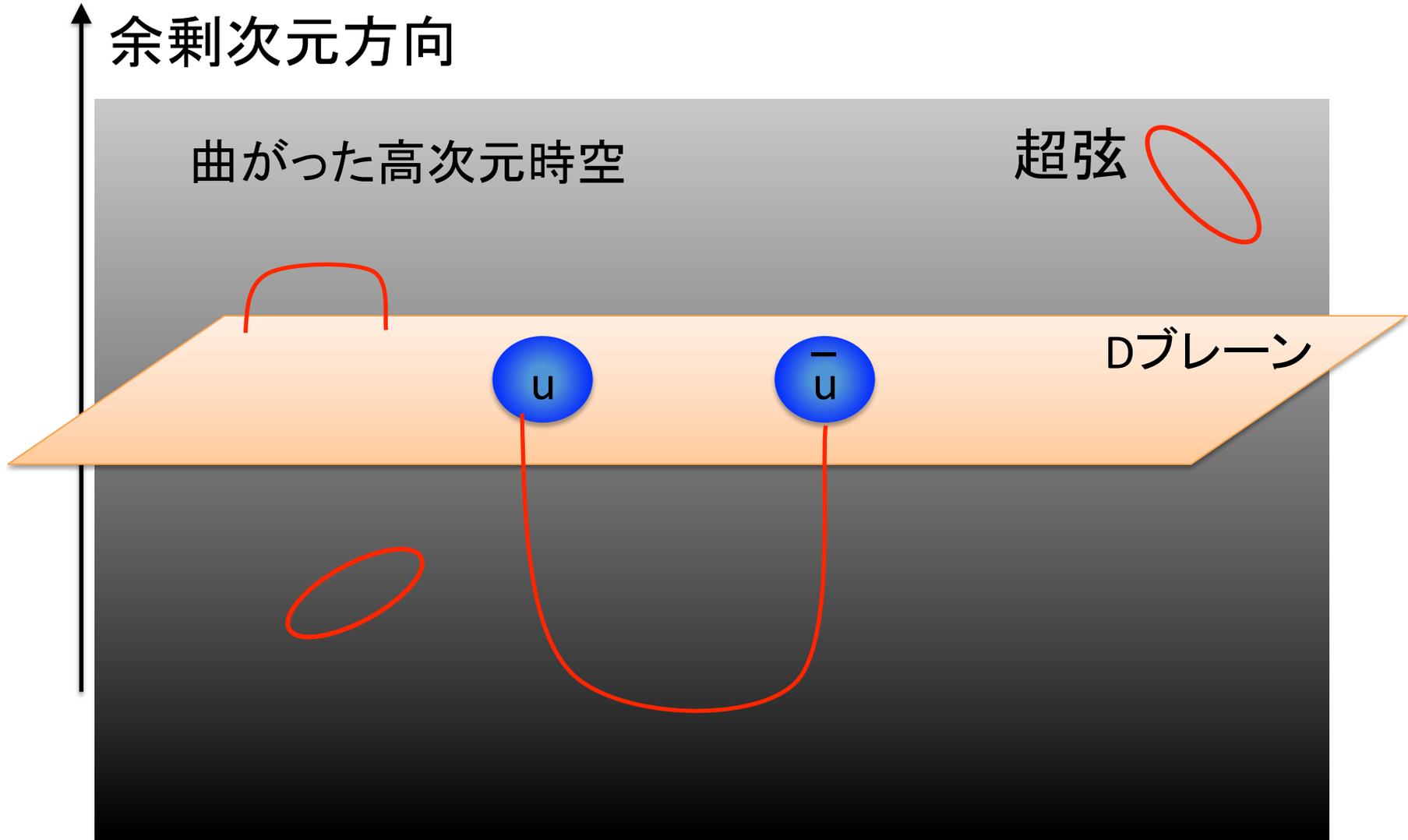
クォーク                  反クォーク



グルーオンによる  
閉じ込め力

3-1

# 仮想重力によるクォークの記述



AdS/CFT 対応 [Maldacena]:

N=4超対称ヤンミルズ理論  
 ラージ N 展開、強結合展開

||

AdS<sub>5</sub> x S<sup>5</sup> 上の量子重力(超弦)

我々の手法:

AdS中のプローブD7ブレーンに  
 外場の電磁場をAdS境界で導入、  
 Dブレーンの低エネルギー作用  
 (Dirac-Norn-Infeld作用)を評価



Welcome to INSPIRE, the  
 questions, comments or

HEP :: HEPNAMES :: INSTITUTIONS :: CONFERENCES :: JO

topcite 7000+

Brief format

find j "Phys.Rev.Lett.,105" :: さらに

並べ替え:

結果の表示

新しいものから

desc.

times cited

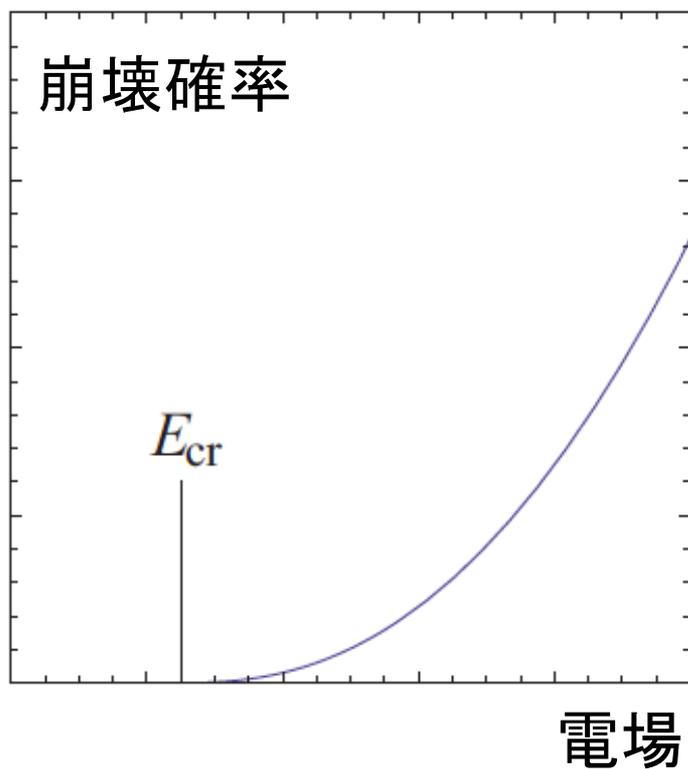
25 結果

単一のリ

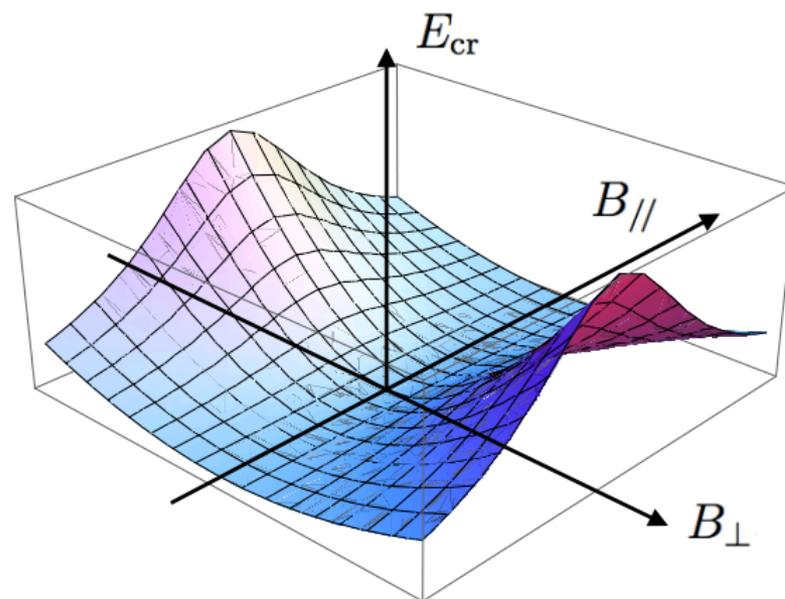
HEP 6 のレコードが見つかりました。

- 1. The Large N limit of superconformal field theories and**  
 (9733) [Juan Martin Maldacena](#) (Harvard U.). Nov 1997. 19 pp.  
 Published in *Adv.Theor.Math.Phys.* **2** (1998) 231-252  
 HUTP-97-A097  
 e-Print: [hep-th/9711200](#) | [PDF](#)  
[References](#) | [BibTeX](#) | [LaTeX\(US\)](#) | [LaTeX\(EU\)](#) | [Harvmac](#) | [EndN](#)  
[ADS Abstract Service](#); [ATMP Server](#)  
[レコードの詳細](#) - Cited by 9733 records 1000+
- 2. A Model of Leptons**  
 (8774) [Steven Weinberg](#) (MIT, LNS). Nov 1967. 3 pp.  
 Published in *Phys.Rev.Lett.* **19** (1967) 1264-1266  
 DOI: [10.1103/PhysRevLett.19.1264](#)  
[References](#) | [BibTeX](#) | [LaTeX\(US\)](#) | [LaTeX\(EU\)](#) | [Harvmac](#) | [EndN](#)  
[ADS Abstract Service](#); [Phys. Rev. Lett. Server](#)  
[レコードの詳細](#) - Cited by 8774 records 1000+
- 3. Measurements of Omega and Lambda from 42 high re**  
 (7641) [Supernova Cosmology Project](#) Collaboration (S. Perlmutter (UC, Ber  
 Published in *Astrophys.J.* **517** (1999) 565-586  
 LBNL-41801, LBL-41801

理論結果： 閉じ込め力に等しい**臨界電場**



臨界電場の磁場依存性



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