Paper

Sven Köppel

koeppel@fias.uni-frankfurt.de

Generation date: Wednesday 16th April, 2014, 12:48

This is Paper1, coming after Calc12.

Title: Holographic screens in ultraviolet self-complete quantum gravity and large extra dimensions

Contents

Abstract

In this paper we study the geometry and the thermodynamics of a *holographic screen* in the framework of the ultraviolet self-complete quantum gravity. Large extra dimensions address the gauge hierarchy problem and allow the effective fundamental scale be not far from 1 TeV. In this paper we show that holographic principles recently presented by Nicolini and Spalucci can be smoothly extended with flat, torodially compactified extra dimensions.

Sven: Reference Guide

Wesentliche Vorlagen hierfür sind:

- Rizzo2006 [Riz06]: NC + LXD
- N+Spallucci [NS14, NS13]: Holographic screens in ultraviolet self-complete quantum gravity stellen jeweils h und h_α vor.
- Isi, Mureika, N [IMN13, IMN14]: GUP, aber als Rahmenvorlage von N definiert
- Bleicher, N 2010: LXD at LHC
- Dickes13: No minimal length neccessary

1 Introduction

Blablabla warum QG toll ist.

1.1 Ultraviolet Protection

Authors of [...] have shown that gravity may be self-complete:

Anfangen mit [IMN13]:

$$r_H = \lambda_C \tag{1}$$

Minimal BH, dann das Holy Grail-Bild (Isi Abb 1)

1.2 The large extra-dimensions scenario

Ähnlich BN2010, Rizzo2006

$$M_\star^{(2+k)} = M_P^2 / R^k \tag{2}$$

Schwarzschild-Tangherlini-Metrik ansprechen

2 Self-regular black hole solutions

We start from the energy density for a point-particle in spherical coordinates as

$$\rho(r) = \frac{M}{\Omega_{n+2}\, r^{n+2}} \delta(r) \tag{3}$$

where $\delta(r)$ is the Dirac delta. The energy distribution implies a black hole for any value of mass M even for subplanckian values where one expects just particles.

We can express the Dirac delta distribution as the derivative of a Heaviside step-function Θ,

$$\delta(r) = \frac{\mathrm{d}\Theta(r)}{\mathrm{d}r} \tag{4}$$

We modify the energy distribution (3) in order to overcome the ambiguities of the Schwarzschild-Metrik by considering a "smooth" function $h(r)$ in place of the Heaviside step

$$\Theta(r) \to h(r) \tag{5}$$

The new profile is defined throught $h(r)$ by

$$\rho(r) = \frac{M}{\Omega_{n+2}\, r^{n+2}} \frac{\mathrm{d}h(r)}{\mathrm{d}r} \equiv T_0^0 \tag{6}$$

By means of the conservation equation $\nabla_\mu T^{\mu\nu} = 0$ one can determine the remaining components of the stress tensor [Riz06]

hier ausführlich machen (7)

One eneds up with the metric

$$\mathrm{d}s^2 = -\left(1 - V(r)\right)\, \mathrm{d}t^2 + \left(1 - V(r)\right)^{-1}\, \mathrm{d}r^2 + r^{2+n}\, \mathrm{d}\Omega_{2+n} \ldots \tag{8}$$

with

$$V(r) = \frac{2}{n+2} \frac{M}{M_\star^{n+2}} \frac{1}{\Omega_{n+2}} \frac{h(r)}{r^{n+1}} \tag{9}$$

Carfeully making back the transition $h \to \Theta$, actually $h \to 1$ in the $r > 0$ regime, one ends up with Schwarzschild-Thangerlini.

If we set the mass aribitriarly

$$M = \frac{n+2}{2}\, \Omega_{n+2}\, \frac{1}{h(r_H)} \left(\frac{r_H}{L_\star}\right)^{n+1} M_\star \tag{10}$$

M has the physical meaning of a mass for a spherical *holographic screen* with radius r_H.

Eigenschaften angeben: $M = ...$, Ereignishorizonte $r_h = ...$

3 Thermodynamics, area quantization and mass spectrum

Temp-Plot. T_H, C und ganz wichtig Logarithmische Entropie-Korrektur S.

Area Quantization: Nachfragen ob ich das auch machen soll. Ist vermutlich schnell gemacht.

4 Conclusions

Kurzum: Nichts neues passiert.

We showed that the idea of holography is compatible with the concept of extra dimensions in space-time.

Oder

We showed that the holographic principle is invariant under extension of spacial dimensions.

5 Self-regular

References

[IMN13] M. Isi, J. Mureika and P. Nicolini, *Self-Completeness and the Generalized Uncertainty Principle*, JHEP **1311**, 139 (2013), 1310.8153.

[IMN14] M. Isi, J. Mureika and P. Nicolini, *Self-Completeness in Alternative Theories of Gravity*, (2014), 1402.3342.

[NS13] P. Nicolini and E. Spallucci, Holographic screens in ultraviolet self-complete quantum gravity, 2013.

[NS14] P. Nicolini and E. Spallucci, *Holographic screens in ultraviolet self-complete quantum gravity*, Adv.High Energy Phys. **2014**, 805684 (2014), 1210.0015.

[Riz06] T. G. Rizzo, *Noncommutative Inspired Black Holes in Extra Dimensions*, JHEP **0609**, 021 (2006), hep-ph/0606051.