

Introduction to Gauge/Gravity Duality

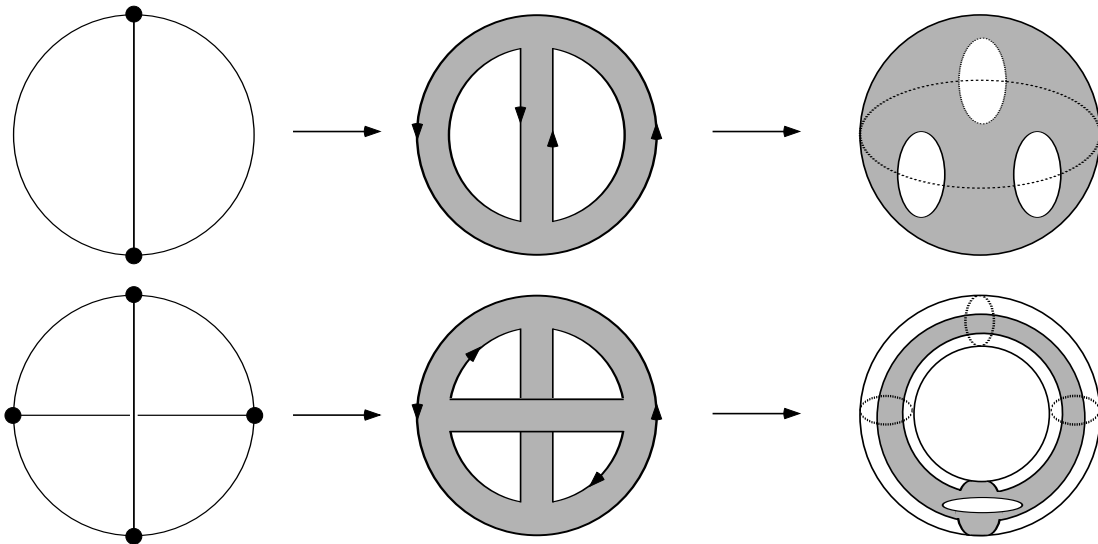
Examples I

To hand in Friday 17th October in the examples class

I. Large N expansion in gauge theories

Evaluate the order in N associated with the two diagrams given and explain the meaning of the three diagrams on each line.

(3 points)



II. Conformal Symmetry

a) Show that a special conformal transformation may be written as a combination of an inversion, a translation and another inversion.

(2 points)

b) Consider a curved space with a metric of Euclidean signature. An infinitesimal *Weyl transformation* of the metric is given by

$$\delta g^{\mu\nu}(x) = 2\sigma(x)g^{\mu\nu}(x), \quad (1)$$

with a scalar function $\sigma(x)$. Show that the conformal Killing equation may be obtained by combining an infinitesimal diffeomorphism with an infinitesimal Weyl transformation, and subsequently reducing to flat space.

(5 points)

c) Show that the scalar two-point function on flat Euclidean d -dimensional space,

$$\langle \phi(x)\phi(y) \rangle = \frac{C}{(x-y)^{2\Delta}} \quad (2)$$

is covariant under conformal transformations.

(3 points)

Special question:

d) Graphical representation of special conformal transformations. Write a computer programme which for a given vector $b_\mu \in \mathbb{R}^2$ generates a graphical representation of the special conformal transformation

$$x'_\mu = \frac{x_\mu + b_\mu x^2}{\Omega^b(x)}, \quad \Omega^b(x) = 1 + 2(b \cdot x) + b^2 x^2, \quad (3)$$

of a square lattice.

(3 additional points)