

## Introduction to Gauge/Gravity Duality

### Examples IX

To hand in Thursday 14th January in the examples class

#### I. Two ways to determine the Hawking temperature

Consider the following metric of an asymptotically AdS black hole

$$ds^2 = \frac{L^2}{r^2} \left( f(r) d\tau^2 + \frac{dr^2}{f(r)} + dx^i dx_i \right),$$

with  $f(r) = 1 - \left(\frac{r}{r_H}\right)^d$ .

a) Consider the line element  $ds^2$  near  $r = r_H$ . Show that we must periodically identify  $\tau$  with periodicity

$$\tau \sim \tau + \frac{4\pi}{|f'(r_H)|} = r + \frac{4\pi r_H}{d}$$

in order to avoid a conical singularity in the  $(r, \tau)$  plane.

Identify the temperature  $T_{BH}$  of the black hole.

(5 points)

b) Compute the surface gravity  $\kappa$  and the temperature  $T_{BH} = \frac{\kappa}{2\pi}$  of the black hole.

Hint: The surface gravity  $\kappa$  can be computed by

$$\kappa = \sqrt{\nabla_\mu V \nabla^\mu V}$$

where  $V = \sqrt{K_\mu K^\mu}$  and  $K^\mu$  is the normalized Killing vector.

(5 points)