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Ongoing research includes:

- Black hole physics: Information paradox, singularity resolution, mass inflation,. . .
- Boundary conformal field theory
- Flux compactifications & generalized complex geometry
- Non-commutative geometry
- Random trees & random surfaces
- Causal dynamical triangulation
- Pattern avoiding permutations
- BRST formulation of integrable models

Thermodynamics of Large AdS Black Holes

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AdS/CFT

large black hole dual to high temperature thermal state

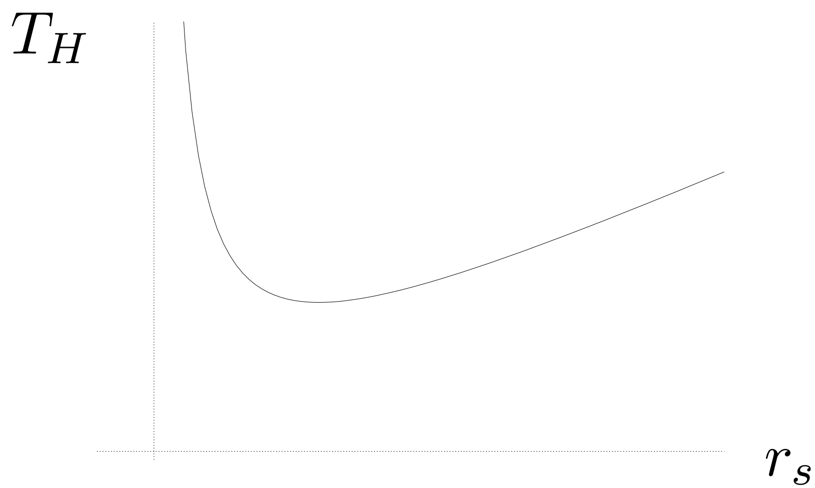
IR regulated string thermodynamics

large black holes dominate at high energy density

AdS-Schwarzschild black hole

$$ds^2 = -f(r)dt^2 + \frac{dr^2}{f(r)} + r^2 d\Omega_{d-1}^2 \quad \text{with} \quad f(r) = \frac{r^2}{\ell^2} + 1 - \frac{\mu}{r^{d-2}}$$

$$\Lambda = -\frac{d(d-1)}{2}\,\ell^2 \qquad\qquad \mu = \frac{16\pi G_N M}{(d-1)a_{d-1}}$$



Black holes emit Hawking radiation

Confining gravitational potential in asymptotic adS background

$\longrightarrow$ Hawking radiation is reflected back

a small black hole evaporates

$\longrightarrow$ final state is an adS 'star'

a large black hole reabsorbs reflected radiation

$\longrightarrow$ black hole + 'atmosphere'

Does high T_H imply a 'hot' atmosphere?

Local temperature is observer dependent

– fiducial observer at fixed r, θ, ϕ $\qquad T_{\text{fid}}(r) = \frac{T_H}{\sqrt{f(r)}}$

$T_{\text{fid}}(r) \longrightarrow 0$ as $r \longrightarrow \infty$

$T_{\text{fid}}(r) \longrightarrow \infty$ as $r \longrightarrow r_s$

– observer in free fall $\quad T_{\text{ff}}(r) = ?$

– relation between $T_{\text{ff}}(r)$ and T_H ?

Temperature measured by observer in free fall

– a large AdS black hole is a cold object even if T_H is high

– estimate order of magnitude of T_{ff} from energy density of Hawking radiation

leading order correction to the total energy

$$\mu = \mu_{\text{cl}} + c\, N G r_s/\ell^2 + \dots \qquad c = O(1) \text{ constant}$$

energy density of radiation within proper distance ℓ of horizon

$$\rho \sim \frac{N}{\ell^3\, r_s} \to 0 \quad \text{as} \quad r_s \to \infty$$

– can also compute $T_{\text{ff}}(r)$ from acceleration in GEMS

E. Brynjolfsson & L.Th., in preparation