Holographic Linear Dilaton Gravity and the Emergence of Black Holes

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- Scattering theory: Entropy goes to infinity at infinite r. Must be monotonic. Define $r = 0$ to be minimum entropy point.
- Finite Causal Diamonds Depend on Choice of Time-like Trajectory. For the models we'll study, we choose the trajectory at rest at minimum entropy point.

- 't Hooft: Near Horizon Coordinates Satisfy $[h,u]=u,\ [h,v]=-v,\ [u,v]=-i$. $HST_{1+1}:\psi_u(u)=F.T.\psi_v(v)$. $H=\int\ \psi^\dagger L_P^{-1}(uv+vu)\psi$. ψ canonical fermion. $v=\frac{p+\lambda}{\sqrt{2}}$. $u=\frac{p-\lambda}{\sqrt{2}}$. Upside down oscillator potential.

- Minkowski coordinate given asymptotically by $r = t(\lambda)$ Time of flight $t(\lambda) = L_P \int \frac{dx}{\sqrt{-v(x)}} \sim L_P \ln \lambda$. Fermion entropy $\int dp dx \theta(p^2 - x^2) = \lambda^2 = e^{\frac{2r}{L_P}}$: Linear dilaton!

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- CGHS: Black Hole Formed by Shock wave. 2D Analog of 't Hooft Dray Calculation. Near horizon limit of many different dilaton black holes in string theory. Different numbers of massless matter fields.

Alexandrov Kazakov Kostov S-matrix

- One body operator $uv + vu$ is first order. Eigenfunctions singular at u or $v = 0$, leads to doubling ψ_i. Transformation to $\ln u$ or $\ln(-v)$ (analogous to transformation between conformal and $\partial_t \phi = 0$ gauges in LEFT): $uv + vu \to \pm \frac{\partial}{\partial_r}$.

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- $S = S_{in} S_{hor} S_{out}$ *cf.* 't Hooft . $S_{in/out}$ are just transformation between near horizon and asymptotic coordinates.

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- Deformations of model in Planck regime, where interactions take place.

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- If we have $N \gg 1$ fermions, as in CGHS, we get meta-stable states, with lifetimes and entropy of order N, but emission rates and infall times Planck scale.
- These are the properties of classical linear dilaton black holes.

Black Hole Interiors as Image of Scrambling on Horizon

- TB and Fischler resolution of AMPS paradox. Drop mass $M_P < m \ll M$ onto black hole $\rightarrow$ entropy increase $\sim mM/M_P^2$ by the time the black hole equilibrates (4D). Sign of constrained DOF that have to be "turned on" in order to equilibrate mass with black hole. Off diagonal terms in HST matrix models.

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- Linear Dilaton Black Holes consistent with this picture. No area, means scrambling on the horizon takes place on Planck scale.

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- Ignored leg poles. Mostly weak coupling string theory stuff, but Polchinski argued leading order gravity interaction between two pulses was also in leg poles.