Getting information out of nothing

Borun D Chowdhury

Biography

Completed my PhD from Ohio State University 2008

Pointed out a conceptual mistake in the (still) famous Parik-Wilczek tunneling

Found “Hawking Radiation” from Fuzzballs

Proposed Fractional brane cosmology as alternate to stringy cosmology

Postdoc at TIFR, India 2008-2009

Studied evolution-fractionation of simple excitations in the D1-D5 close to orbifold point

Postdoc at UvA, The Netherlands 2009-2013

Penrose process like emission of supertubes from stringy black holes

CFT interpretation of enigma

Quantum Information and Horizons

Firewalls in AdS/CFT

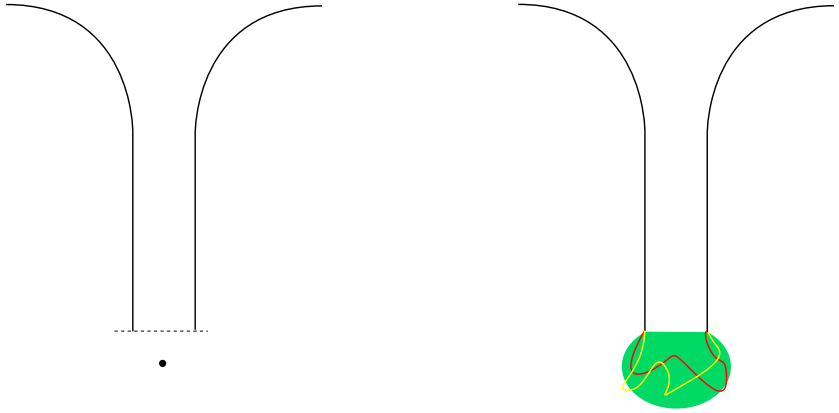
Postdoc at ASU, USA 2013-2015

Hole in spacetime

Subtleties of AdS/CFT

Used Fermi-LAT data to investigate intergalactic helical magnetic fields

1. Fuzzballs



Main Idea

e^S states compete with action to make saddle point approximation incorrect

Collapsing shell becomes a superposition of fuzzball states

My Work

Construction of non-extremal classical states

Radiation from such states highly coherent, manifests as classical instability

We showed that such radiation is Bose-enhanced Hawking radiation (LASER)

The incoherent version (light bulb) corresponds to usual Hawking radiation

2. Firewalls

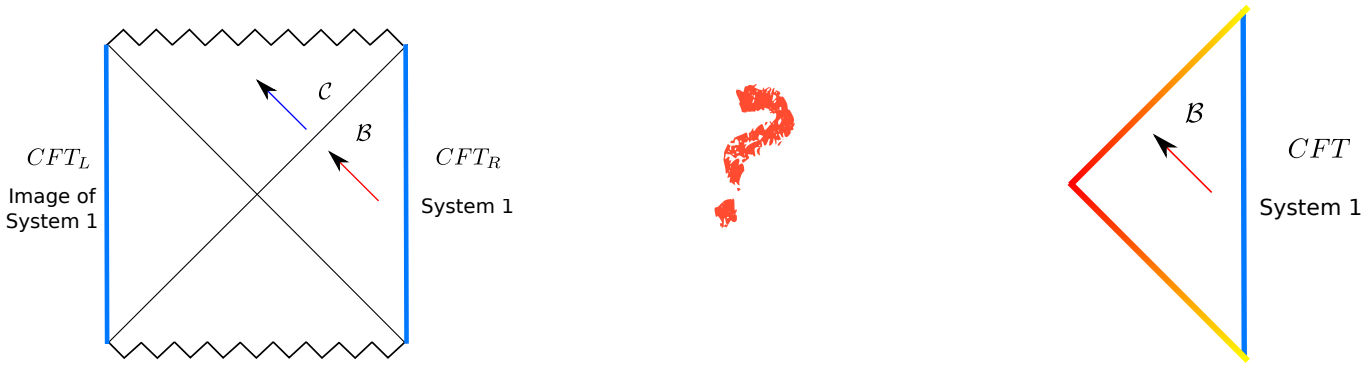
Most fuzzballers were silent on infaller's experience

AMPS claimed free infall in maximally entangled black holes not possible - firewalls

My Work

Quantum information theoretic studies to show oldness of black hole a red herring

Pointed out implications for AdS/CFT

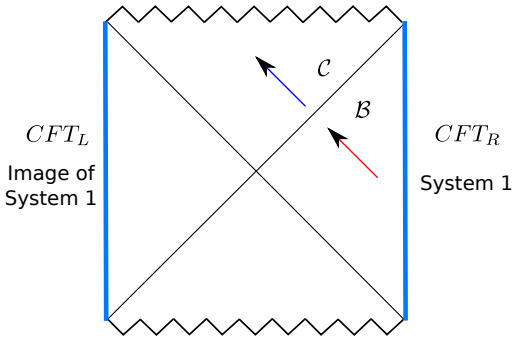


Maldacena's picture in conflict with AMPS

each CFT is maximally mixed (old)

2. Firewalls

My Work



Two CFTs are decoupled but the bulk has an interaction between the left and right

Do the CFTs together know about this interaction?

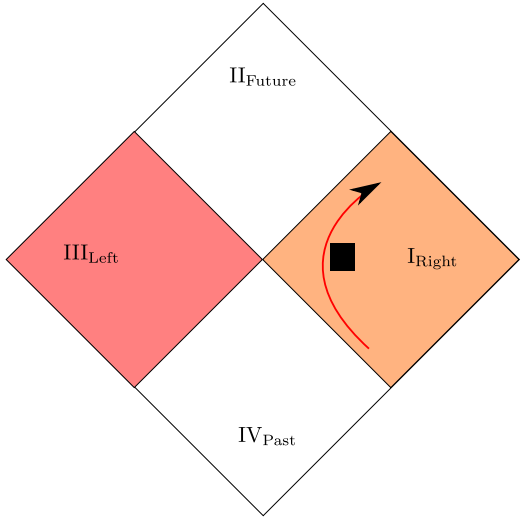
Is this interaction unique?

Does AdS/CFT duality holds in presence of horizons

An infalling observer does a joint measurement (Bell measurement) on modes on two sides of horizon

$$|\varphi_1\rangle := \frac{1}{\sqrt{2}}(|\hat{0}\rangle|0\rangle + |\hat{1}\rangle|1\rangle)$$
$$|\varphi_2\rangle := \frac{1}{\sqrt{2}}(|\hat{0}\rangle|0\rangle - |\hat{1}\rangle|1\rangle)$$
$$|\varphi_3\rangle := \frac{1}{\sqrt{2}}(|\hat{0}\rangle|1\rangle + |\hat{1}\rangle|0\rangle)$$
$$|\varphi_4\rangle := \frac{1}{\sqrt{2}}(|\hat{0}\rangle|1\rangle - |\hat{1}\rangle|0\rangle)$$

state	$\hat{\sigma}_x \otimes \sigma_x$	$\hat{\sigma}_y \otimes \sigma_y$	$\hat{\sigma}_z \otimes \sigma_z$
$\|\varphi_1\rangle$	+1	-1	+1
$\|\varphi_2\rangle$	-1	+1	+1
$\|\varphi_3\rangle$	+1	+1	-1
$\|\varphi_4\rangle$	-1	-1	-1

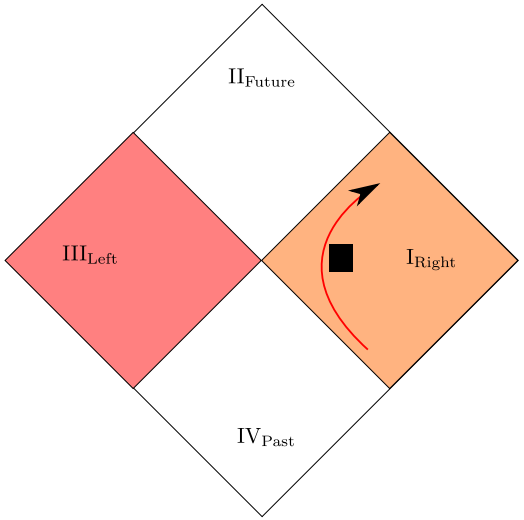


Creating such an observer by acting on only one CFT looks like a violation of subregion duality i.e. physics close to a boundary patch is captured only by that patch

3. Ordinary causal holes

Rindler horizons have infinite entropy from UV and IR

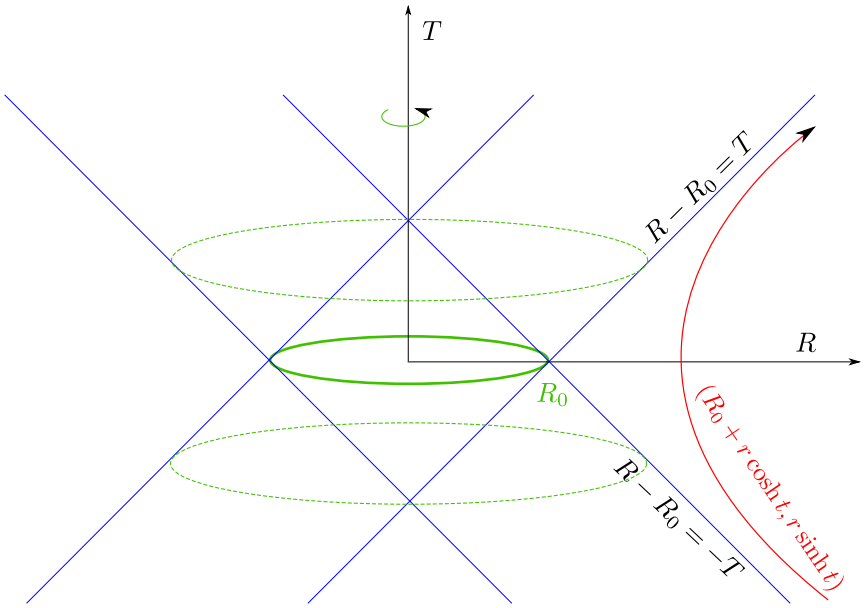
Gravity gives UV cutoff A/G



My Work

We can “sphericalize” Rindler spacetime to give IR cutoff

$$ds^2 = -r^2 dt^2 + dr^2 + (R_0 + r\cosh t)^2 d\Omega_{d-1}^2$$



$$S = \mathcal{A}/4G_N$$

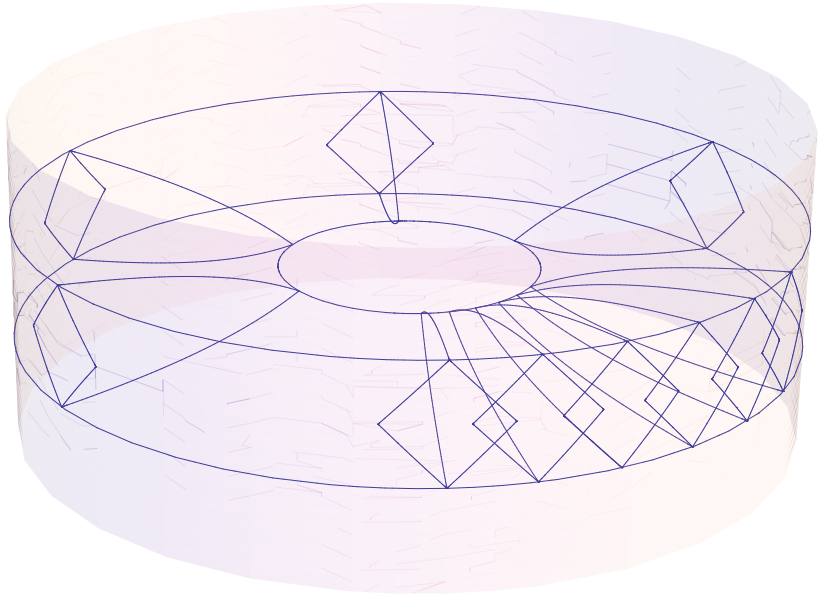
3. Ordinary causal holes

My Work

Embedded the construction in AdS and gave a CFT explanation of entropy for AdS_3

$$ds^2 = L^2\left(-\sinh^2 r\, dt^2 + dr^2\right) + \left(R_0 \cosh r + \sqrt{R_0^2 + L^2}\, \sinh r \cosh t\right)^2 d\Omega_{d-1}^2.$$

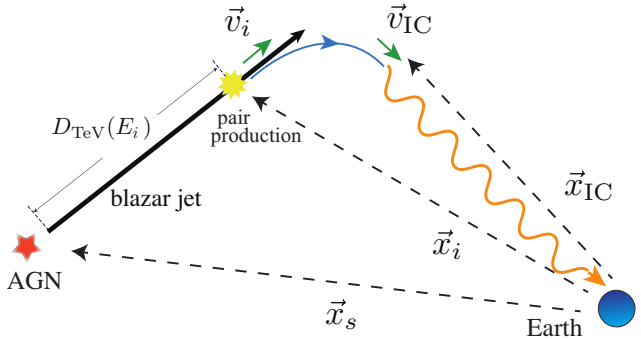
Residual Entropy comes from limitedness of measurements (in time/space)



4. Intergalactic helical magnetic fields

Important for formation of stars and galaxies

At 10^{-9} to 10^{-16} Gauss

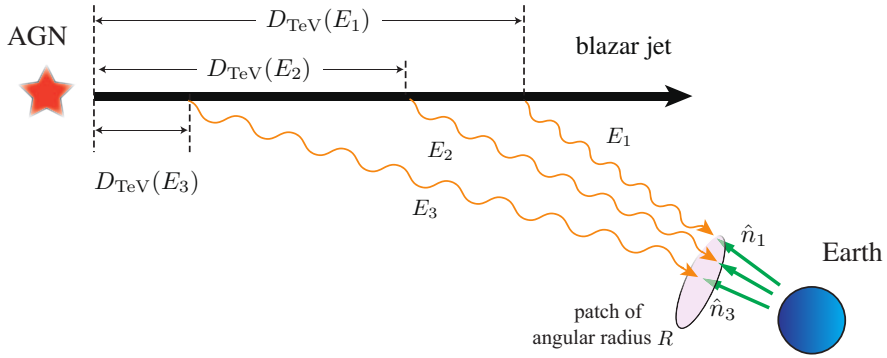


TeV photons from Blazars not aligned with Earth

Extra galactic background light causes pair production

Bending of leptons and subsequent inverse scattering

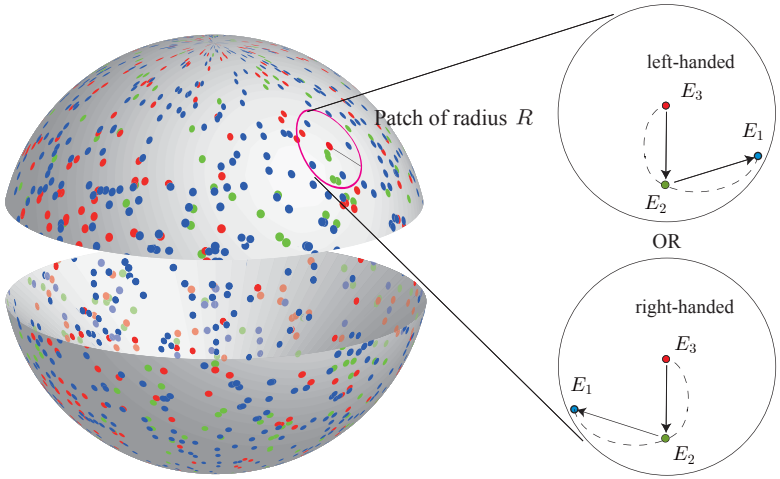
GeV photons reach Earth



Different energies photons scatter differently
CP violating signal

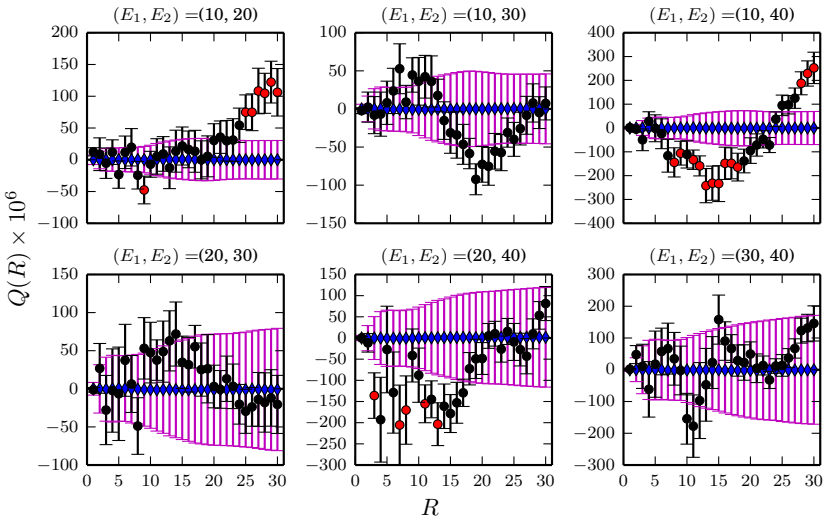
4. Intergalactic helical magnetic fields

$$Q(R) = \langle \boldsymbol{n}(E_1) \times \boldsymbol{n}(E_2) \cdot \boldsymbol{n}(E_3) \rangle_R$$



Triple product of 3 different energies captures this CP violating signal

Screened out photons from milky way direction



Left handed 10^{-14} Gauss

Future directions

Subtleties of AdS/CFT

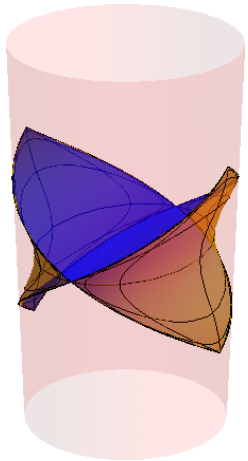
AdS/CFT is supposed to be exact but when talking about introducing an observer we perturb AdC/CFT

Non-normalizable modes correspond to CFT perturbations $r^{\Delta-d}$

Normalizable modes correspond to CFT excitations $r^{-\Delta}$

To introduce an "observer" who falls into black holes requires *perturbing Hamiltonian to change state*… mixing of normalizable and non-normalizable modes… Kosher in strict decoupling limit?

If not then strict decoupling is not possible if we want to introduce new "observers" and cutoff dependent issues like Chowdhury-Parikh become important



Related to this may be the issue of the CFTs clarifying the bulk hamiltonian interaction

BTZ as orbifold of AdS - Oribifolding doesn't commute with approaching the boundary