Title: Quantum Information and holography

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Collection: Quantum Information and holography (2021/2022)

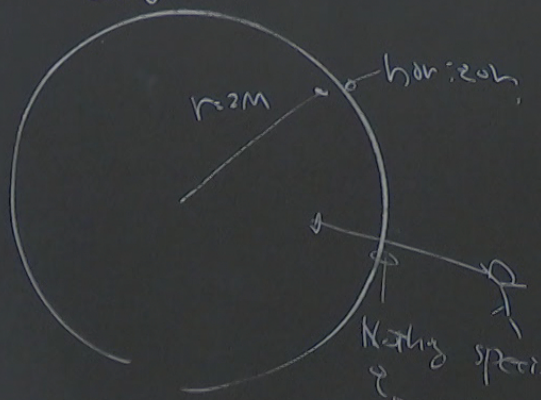
Date: April 22, 2022 - 9:00 AM

URL: https://pirsa.org/22040052

Abstract: Topics will include (but are not limited to):
- Quantum error correction in quantum gravity and condensed matter
- Quantum information scrambling and black hole information
- Physics of random tensor networks and random unitary circuits

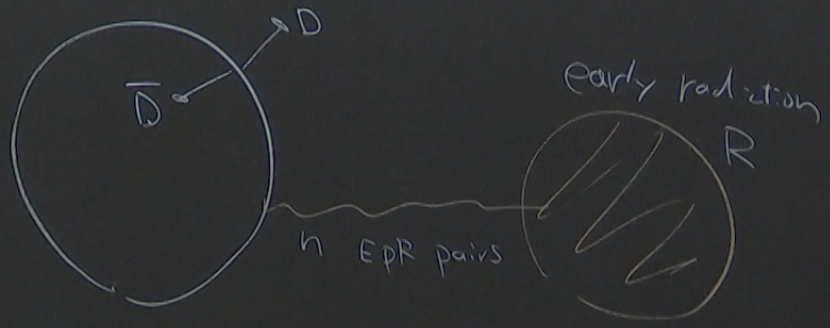
Firewall puzzle (BH information puzzle)

- Large BH



- Mathur 2009

old BH (after Page time)



- Outgoing D infalling $\bar{D}$ ($\simeq$ 1 EPR pair) Hawking radiations.

$$I(D, \bar{D}) \simeq \text{large}.$$

- Old BH

$$I(D, R) \simeq \text{large},$$

Monogamy of entanglement

- D cannot be entangled with two things simultaneously.

$$I(D,\bar{D}) + I(D,R) \leq 2S_D$$

- proof

Use strong subadditivity

$$S_{AB} + S_{BC} \geq S_A + S_C.$$

$\Leftrightarrow S_D + S_{\bar{D}} - S_{D\bar{D}} + S_D + S_R - S_{DR} \leq 2S_D$

$S_{\bar{D}} + S_R \leq S_{D\bar{D}} + S_{DR}$ — (S.A).

$A \to \bar{D}$

$B \to D$

$C \to R$

$\leq 2S_D$

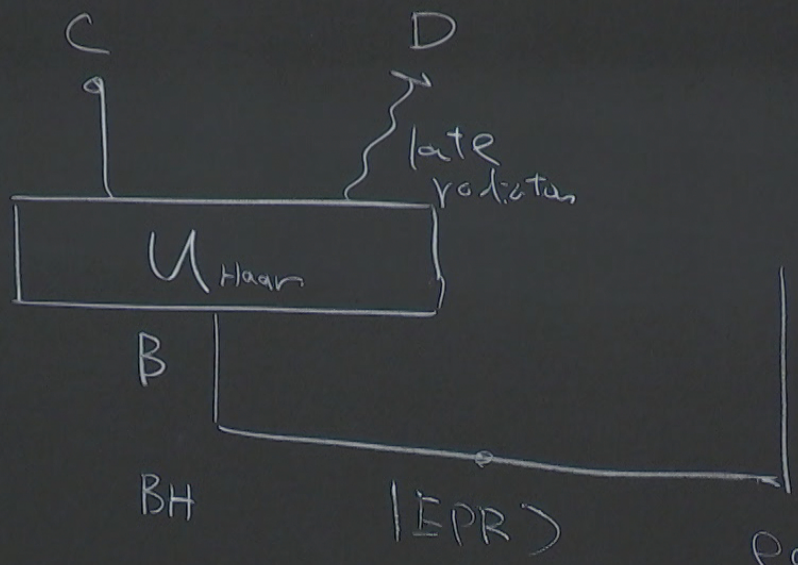
1.

Suppose.

$I(D,R) \approx 2S_D \Rightarrow I(D,\bar{D}) \approx 0$

excited state near horizon "Firewall"!

Toy model



$I(O, R) \simeq \max.$

Proposal I

Infalling mode $\bar{O}$ is actually "embedded" on R.

$I(O, R) \simeq \max.$

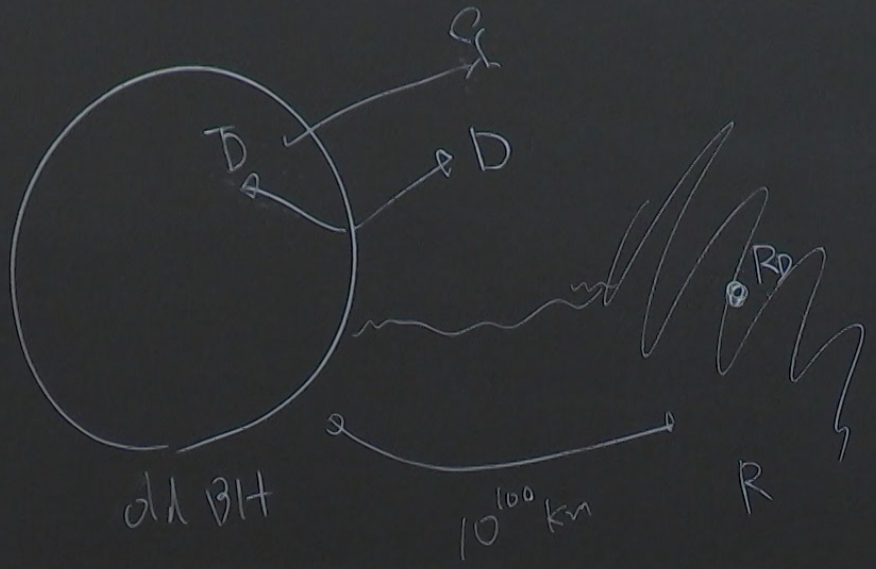
Proposal I

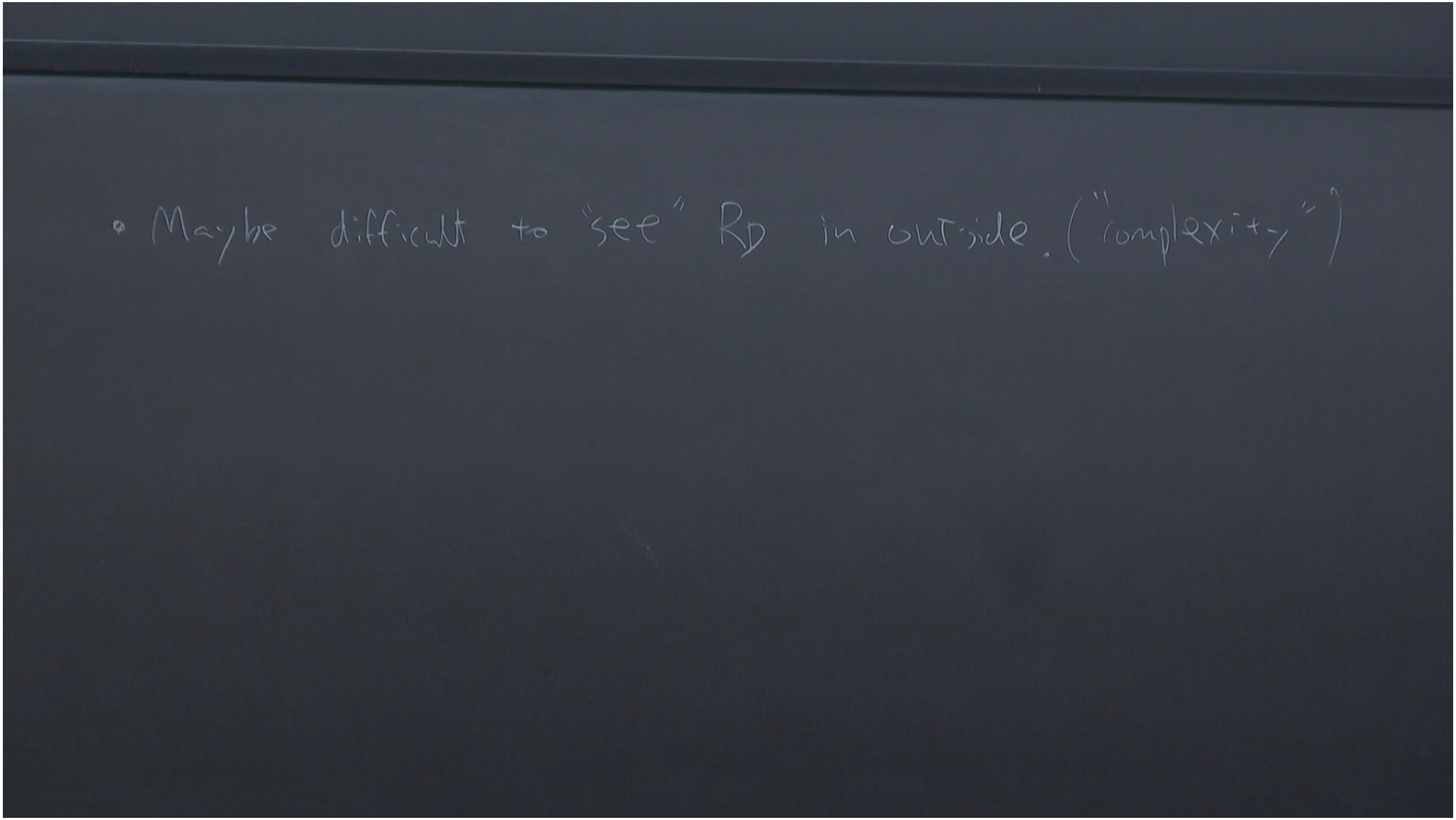
Infalling mode $\bar{O}$ is actually "embedded" on R.

$\exists$ qubit R_O on R s.t.

$\bar{O} = R_O$

Non-locality problem



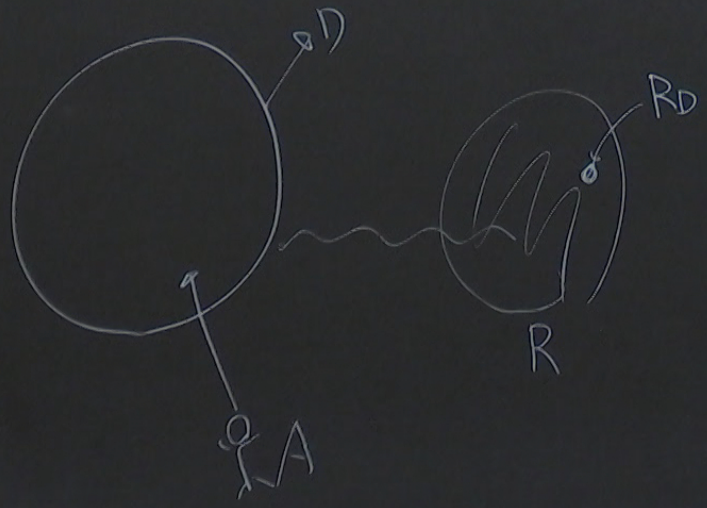

• Maybe difficult to "see" R_D in outside. ("complexity")

BH complementarity ?

- AMPS thought experiment

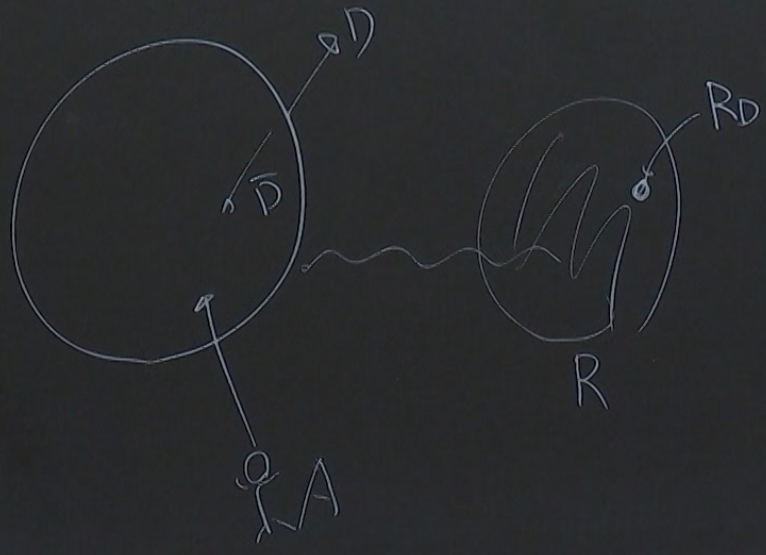
i) Distill R_D

ii) Give R_D to infaly observer.



BH complementarity ?

- AMPS thought experiment



i) Distil

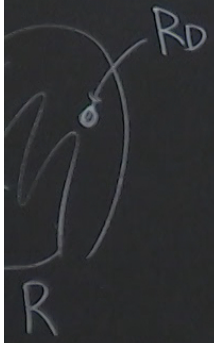
ii) Give

iii) Alice

i) Distill R_D

ii) Give R_D to infaly observer and jump into B+1.

iii) Alice crosses the horizon



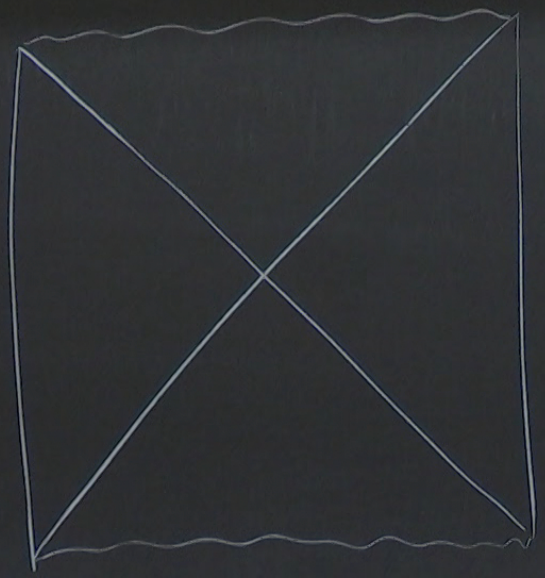
i). Distill R_D (= pre-computation)

ii) Give R_D to infaly observer and jump into B.H.

iii) Alice crosses the horizon

R_D

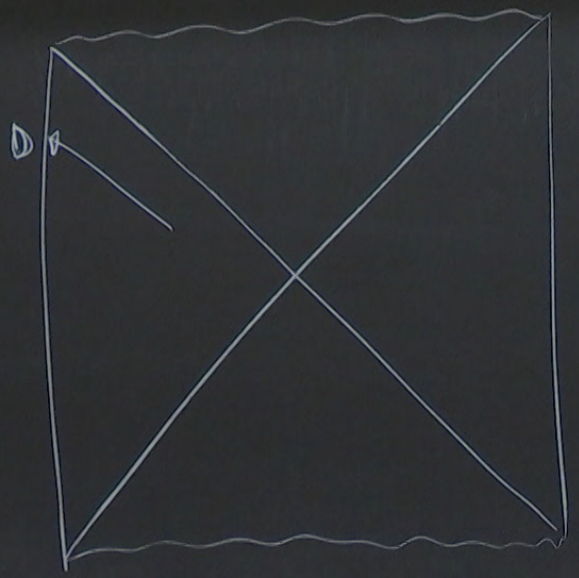
AdS BH



Left ≈ BH

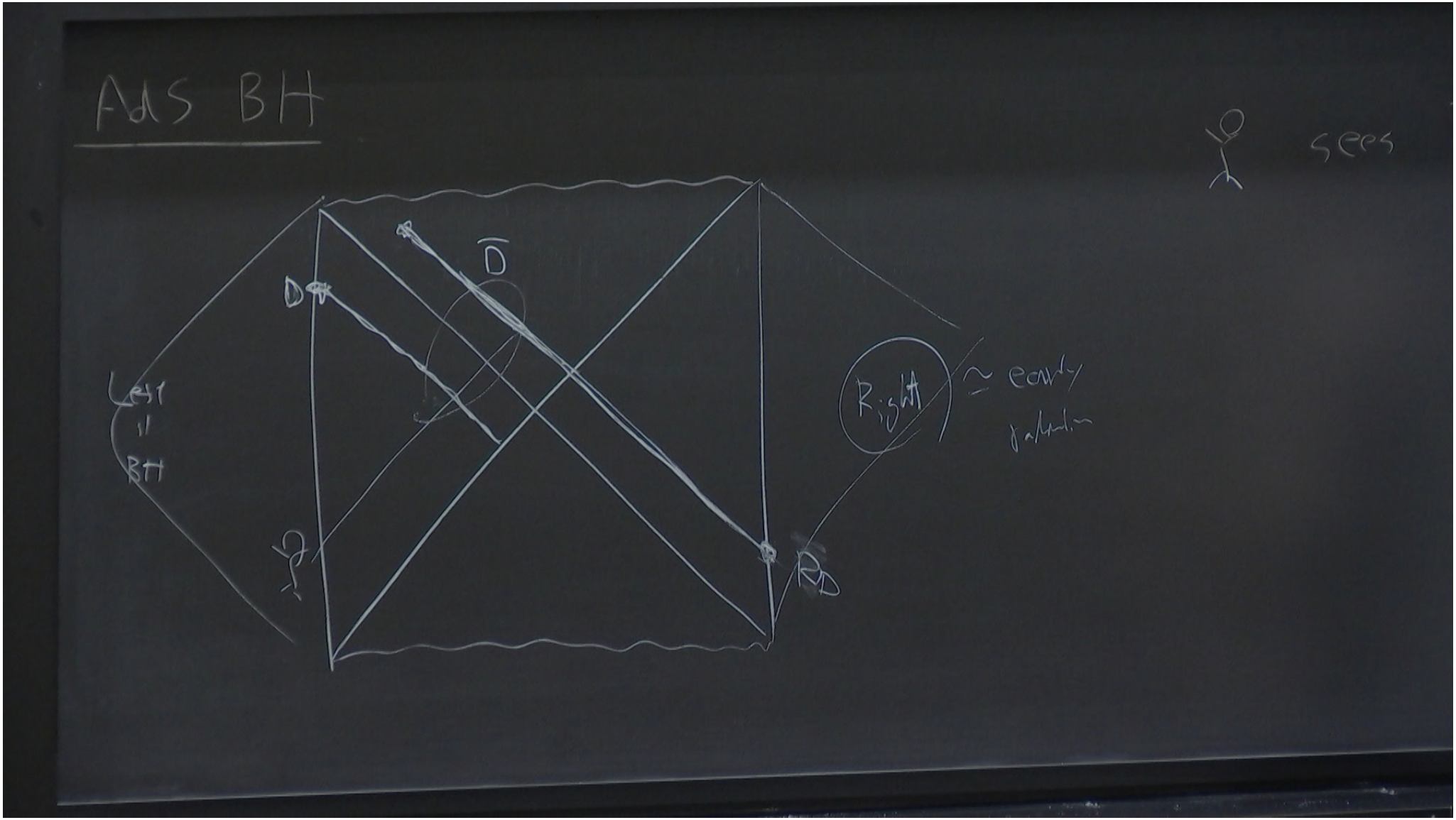
Right ≈ early radiation

AdS BH



Left
=
BH

Right ≃ early


AdS BH
sees
D
Left
of
BH
Right
≃ early
R_D