On $AdS_3/ICFT_2$ with a dynamical scalar field located on the brane

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Joint Work with Yan Liu and Hong-Da Lyu

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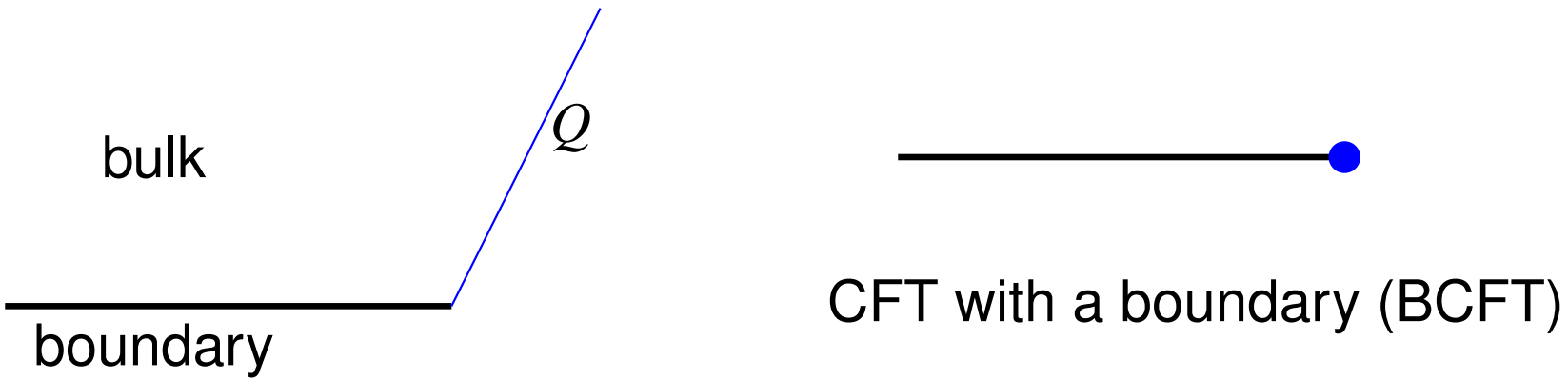
Introduction: holographic dual of BCFT



- Conformal boundary $\Rightarrow$ brane is a pure AdS.
- Non-conformal boundary $\Rightarrow$ brane can be a flow geometry.

[T. Takayanagi, 2011]
[H. Kandaa, M. Satoa, Yu-ki Suzukia, T. Takayanagi, et, al. , 2023]

Introduction: thin-wall model of ICFT

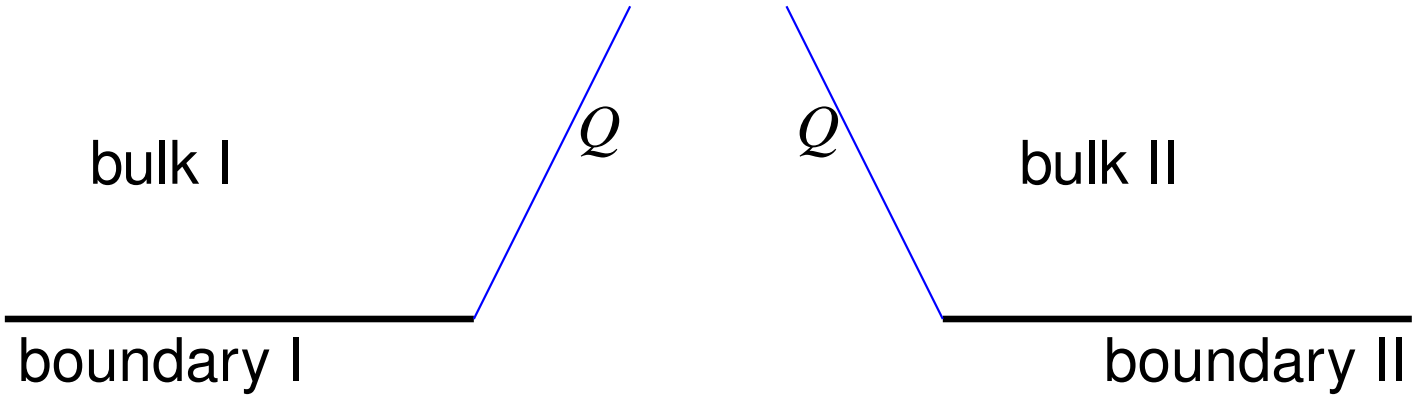


Figure: With a tension T on the brane.

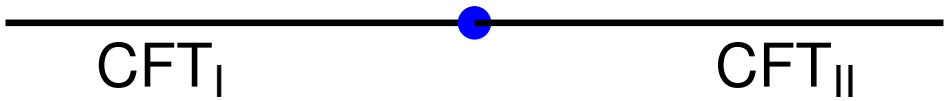
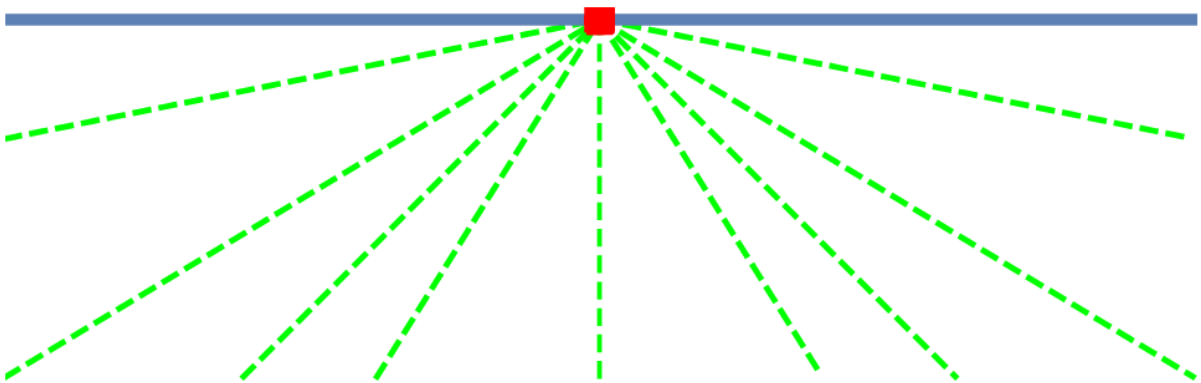


Figure: ICFT.

[C. Bachas, S. Chapman, D. Ge and G. Policastro, 2020], [T. Anous, M. Meineri, P. Pelliconi and J. Sonner, 2022] ...

Introduction: thick-wall model of ICFT



$$ds^2 = e^{2A(r)} \frac{dx^2 - dt^2}{x^2} + dr^2.$$

[A. Karch, Z. X. Luo and H. Y. Sun, 2021] ...

3d Janus: $A(r) = \cosh(r)$. [D. Bak, M. Gutperle, and S. Hirano, 2003]

Introduction: Recover BCFT from ICFT

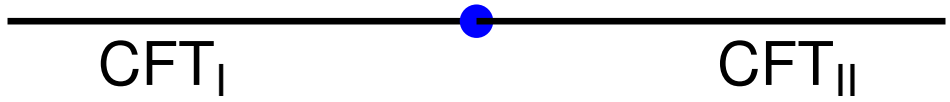


Figure: ICFT.

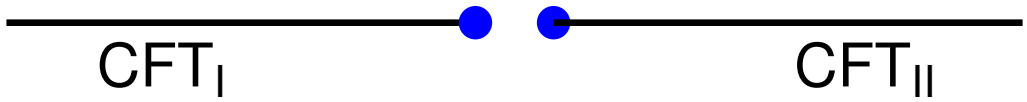


Figure: Decouple.

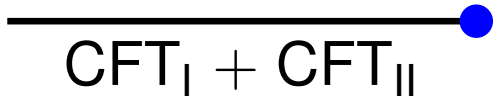


Figure: Folding trick.

Our setup

Our model: Add matter on brane.

$$
\begin{aligned}
S_{\text{holographic ICFT}} = & \int_{N_{\mathrm{I}}} d^3x\sqrt{-g_{\mathrm{I}}}\left[\frac{1}{16\pi G}\left(R_{\mathrm{I}}+\frac{2}{L_{\mathrm{I}}^2}\right)\right] \\
& + \int_{N_{\mathrm{II}}} d^3x\sqrt{-g_{\mathrm{II}}}\left[\frac{1}{16\pi G}\left(R_{\mathrm{II}}+\frac{2}{L_{\mathrm{II}}^2}\right)\right], \\
& + \frac{1}{8\pi G}\int_{Q} d^2y\sqrt{-h}\left[(K_{\mathrm{I}}-K_{\mathrm{II}})-(\partial\phi)^2-V(\phi)\right].
\end{aligned}
$$

- Solve the system with a static brane and static scalar.
- Zero temperature and finite temperature.
- Systems with various potential $V(\phi)$.
- Null energy condition holds for zero/finite temperature.

The possible brane profile

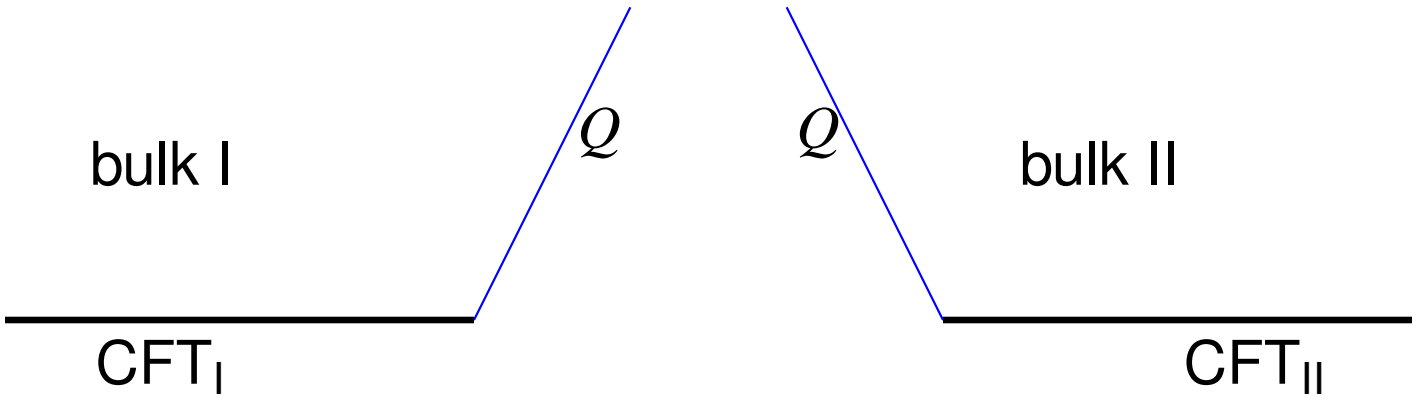
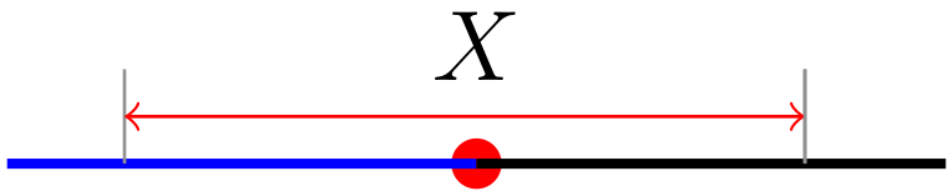


Figure: Brane profile with trivial scalar field.

Figure: Brane profiles with non-trivial scalar field.

RG flow on the interface: $g-$theorem



$g-$function

$$\log g(\sigma) \equiv S_{\mathrm{E}}(\sigma,\sigma) - \frac{c_{\mathrm{I}}}{3}\log\frac{2\sigma}{\epsilon_{\mathrm{I}}} - \frac{c_{\mathrm{II}}}{3}\log\frac{2\sigma}{\epsilon_{\mathrm{II}}}.$$

$g-$theorem,

$$\log g(\sigma) \geq 0, \quad \frac{d}{d\sigma}\log g(\sigma) \leq 0.$$

$g-$function and RG flow: [G. Cuomo, Z. Komargodski and A. Raviv-Moshe, 2022]

$g-$theorem and strong subadditivity: [J. Harper, H. Kanda, T. Takayanagi and K. Tasuki, 2024]

Recover BCFT: BCFT limit

BCFT limit

$$\nu \equiv \frac{L_{\rm II}}{L_{\rm I}} \to 0, \quad L_{\rm I} \text{ is finite},$$

the resulting system

$$S_{\text{holographic BCFT}} = \int_{N_{\rm I}} d^3x\sqrt{-g_{\rm I}}\left[\frac{1}{16\pi G}\left(R_{\rm I}+\frac{2}{L_{\rm I}^2}\right)\right] + \frac{1}{8\pi G}\int_{Q} d^2y\sqrt{-h}\left[K_{\rm I}-\frac{1}{2}(\partial\phi)^2-\frac{1}{2}V(\phi)\right].$$

$CFT_{\rm I}$ and $CFT_{\rm II}$ are completely decoupled.

$g-$function describes a boundary RG flow.

[H. Kandaa, M. Satoa, Yu-ki Suzukia, T. Takayanagi, et, al. , 2023]

Recover BCFT: Folding trick

Setting

$$L_{\mathrm{I}} = L_{\mathrm{II}},$$

and the same embedding of the brane, the resulting system

$$S_{\text{holographic BCFT}} = \int_{N_{\mathrm{I}}} d^3x\sqrt{-g_{\mathrm{I}}}\left[\frac{1}{16\pi G}\left(R_{\mathrm{I}} + \frac{2}{L_{\mathrm{I}}^2}\right)\right] + \frac{1}{8\pi G}\int_{Q} d^2y\sqrt{-h}\left[K_{\mathrm{I}} - 2(\partial\phi)^2 - 2V(\phi)\right].$$

The two CFTs couple only at the boundary.
$g-$function describes a boundary RG flow.
[H. Kandaa, M. Satoa, Yu-ki Suzukia, T. Takayanagi, et, al. , 2023]

Finite temperature

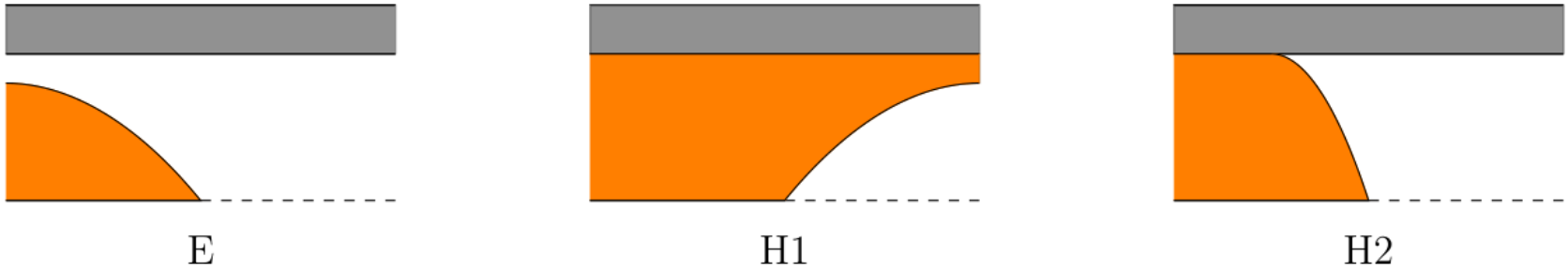


Figure: All possible profiles for single bulk.

	E	H1	H2
E	$\surd$	$\surd$	$\times$
H1	$\surd$	$\times$	$\times$
H2	$\times$	$\times$	$\surd$

Table: All possible solution with a nontrivial scalar.

Compact ICFT case: [C. Bachas and V. Papadopoulos, 2021]

Recover BCFT at finite temperature

Recover the holographic BCFT by

- BCFT limit: $\frac{L_{\text{II}}}{L_{\text{I}}} \to 0$ while L_{I} is finite, and $T_{\text{I}} = T_{\text{II}}$.
- Folding trick: $L_{\text{I}} = L_{\text{II}}, T_{\text{I}} = T_{\text{II}}$, same embedding of the brane.

Summary

We construct a holographic ICFT model. By introducing a dynamical brane-localized scalar field, we find

- more brane profile;
- a nontrivial RG flow at the interface;
- recover BCFT by BCFT limit and folding trick.

Thanks for listening !