BREAKING SYMMETRY

Julien Barrat

Theory fellows meeting
06.12.2023

ABOUT ME

ABOUT ME

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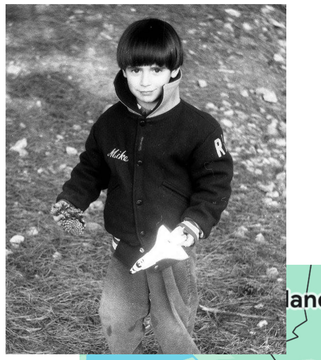
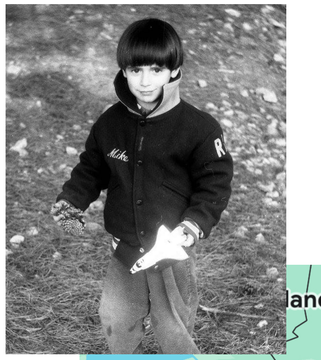
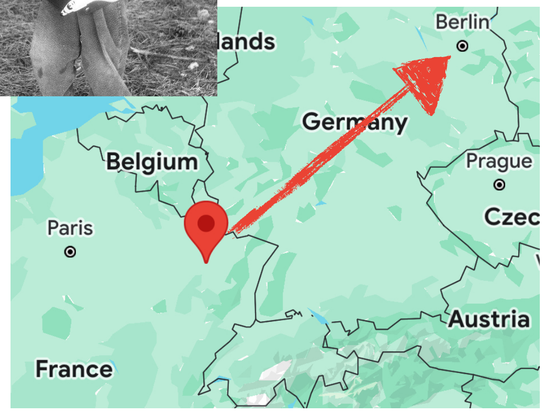


1986

Nancy
(France)

ABOUT ME





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2006

Berlin

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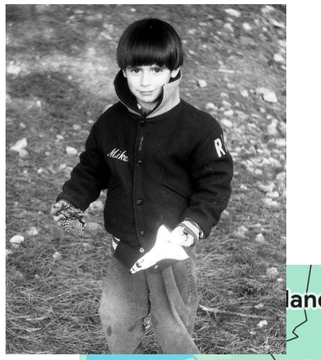

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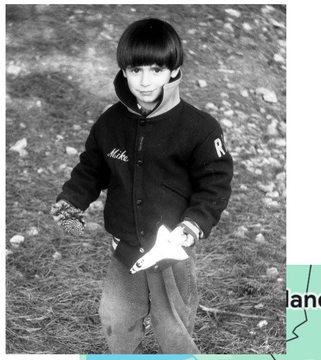

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2010

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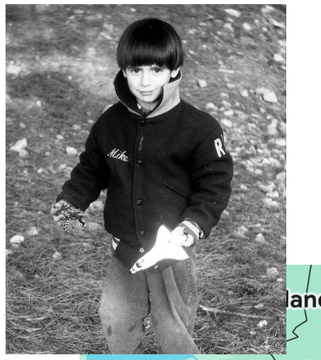

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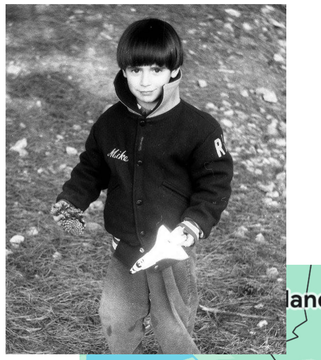
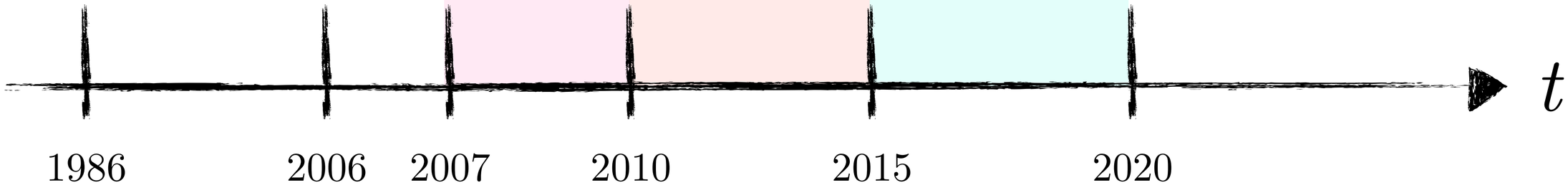



Canon
EOS 6D


Berlin
Germany
Belgium
Paris
France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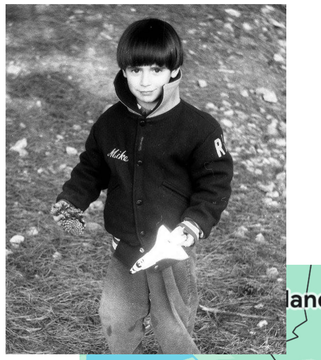
1986
2006
2007
2010
2015
2020
Nancy (France)
Berlin
Film science
Photography
Physics studies

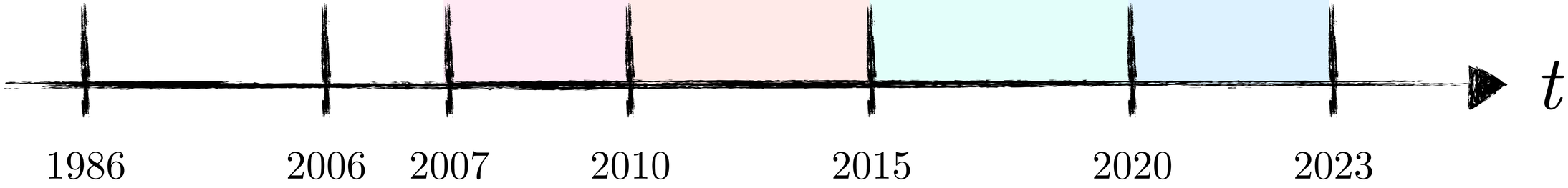
ABOUT ME




Canon
EOS 6D


HUMBOLDT-UNIVERSITÄT ZU BERLIN


Berlin
Germany
Belgium
Paris
France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PhD (advisor: Jan Plefka)

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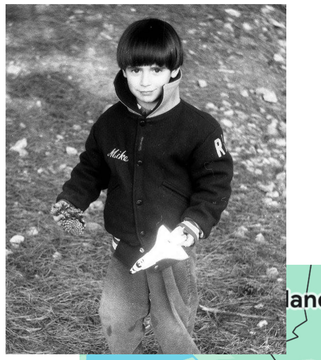

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Anne

Leonie

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professor of psychology
in Greifswald

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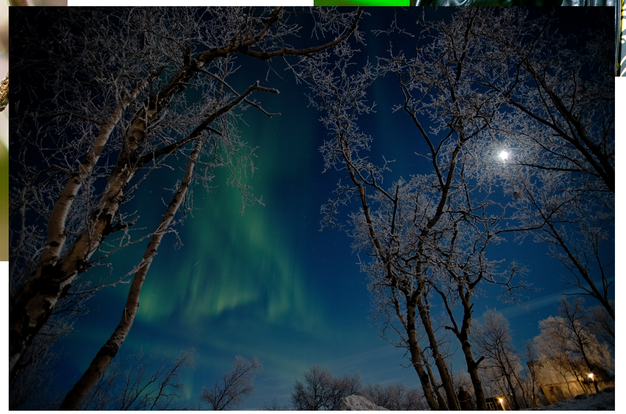


BREAKING SYMMETRY

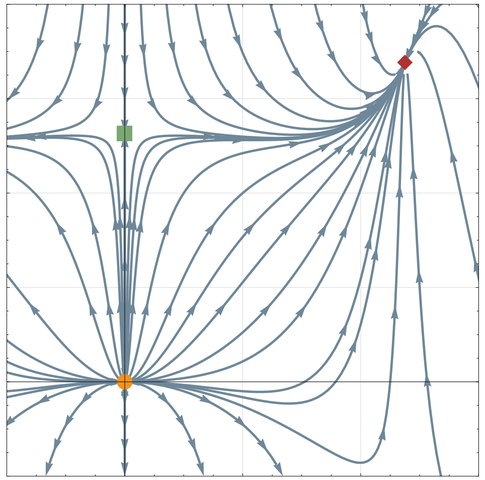
CONFORMAL FIELD THEORY

CONFORMAL FIELD THEORY

Phase transitions

CONFORMAL FIELD THEORY

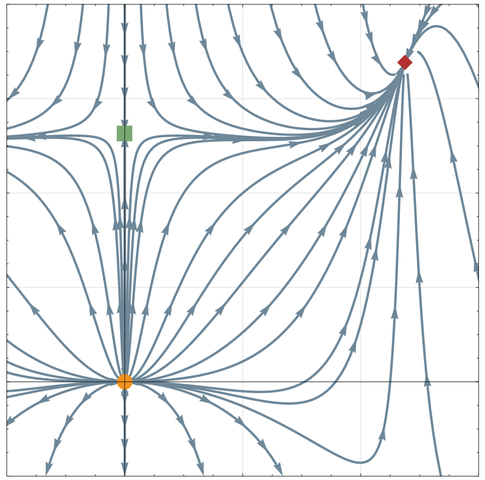
Phase transitions



RG flow

CONFORMAL FIELD THEORY

Phase transitions



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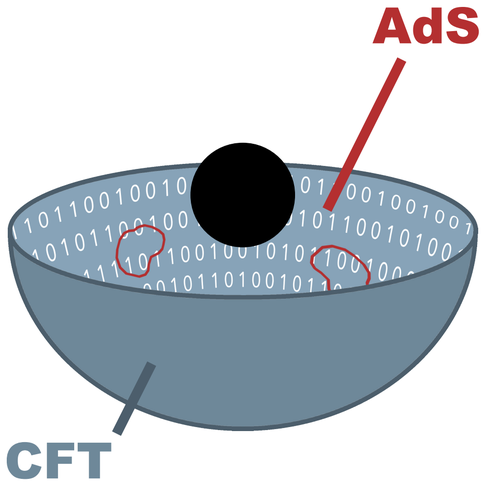
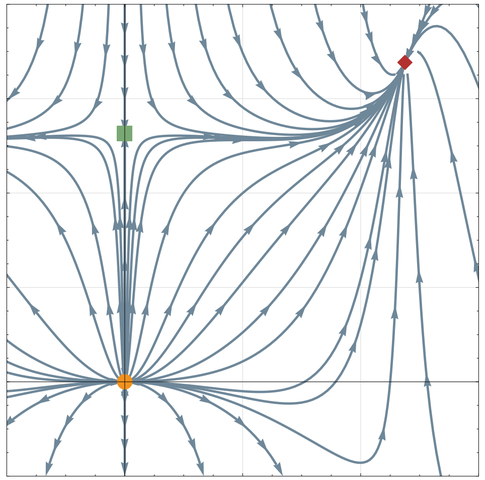


AdS/CFT

CONFORMAL FIELD THEORY

Phase transitions



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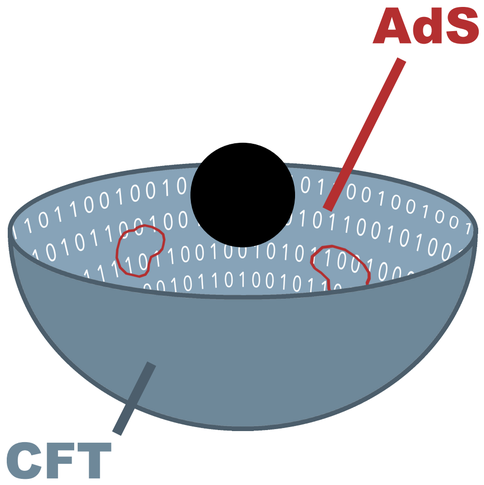
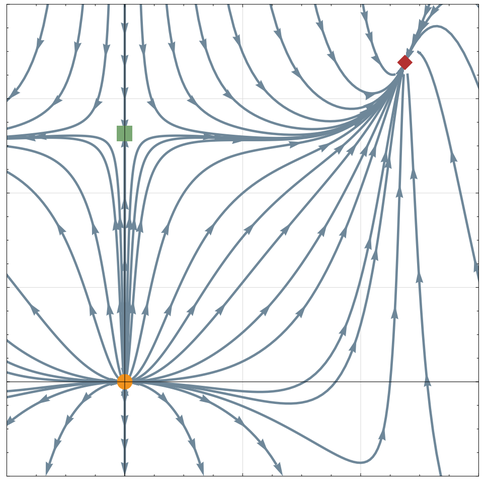


AdS/CFT

Low-energy physics

CONFORMAL FIELD THEORY

Phase transitions



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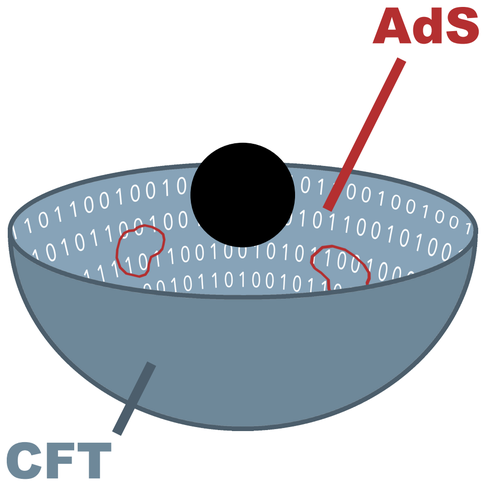


AdS/CFT

Low-energy physics

High-energy physics

CONFORMAL SYMMETRY

CONFORMAL SYMMETRY

Poincaré group

CONFORMAL SYMMETRY

Poincaré group + scale invariance

CONFORMAL SYMMETRY

Poincaré group + scale invariance

$(4d)$ (10 generators)

CONFORMAL SYMMETRY

	Poincaré group	+	scale invariance
$(4d)$	(10 generators)		(15 generators)

CONFORMAL SYMMETRY

	Poincaré group	+	scale invariance
$(4d)$	(10 generators)		(15 generators)

Take-home message:

The observables of a CFT are highly constrained

CONFORMAL SYMMETRY

	Poincaré group	+	scale invariance
$(4d)$	(10 generators)		(15 generators)

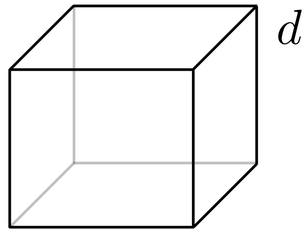
Take-home message:

The observables of a CFT are highly constrained

↓

Conformal bootstrap: non-perturbative study of these constraints

BREAKING SYMMETRY



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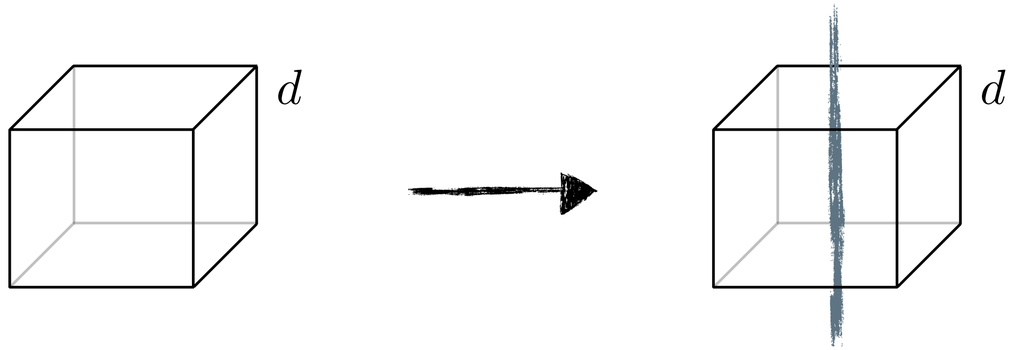

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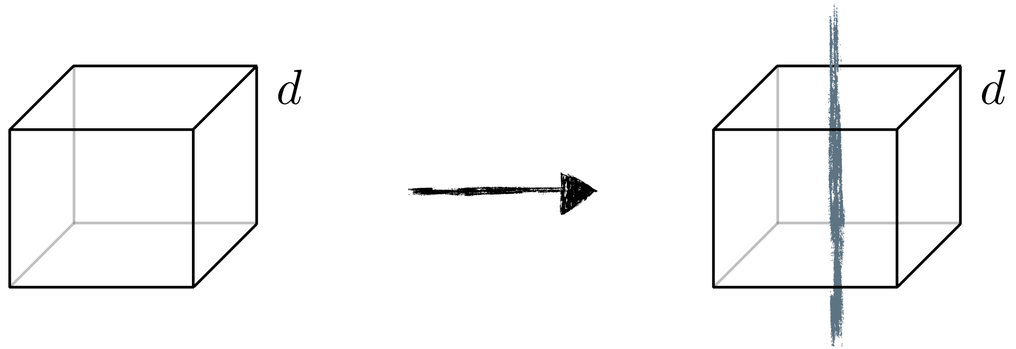
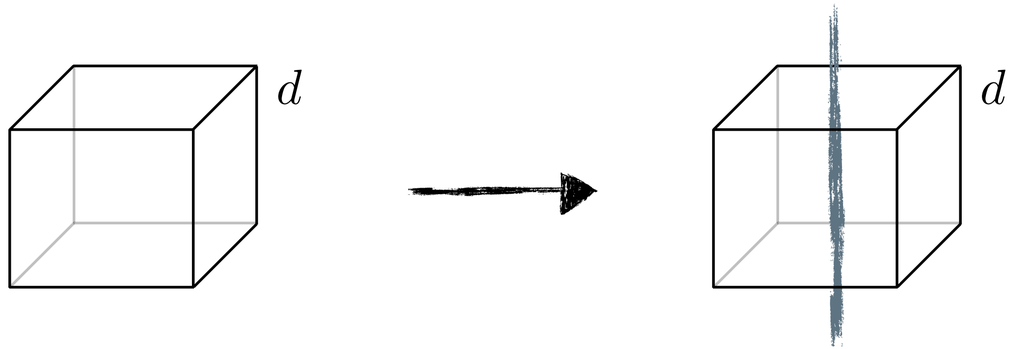


Conformal defects: extended operators, which break the symmetry in a controlled manner

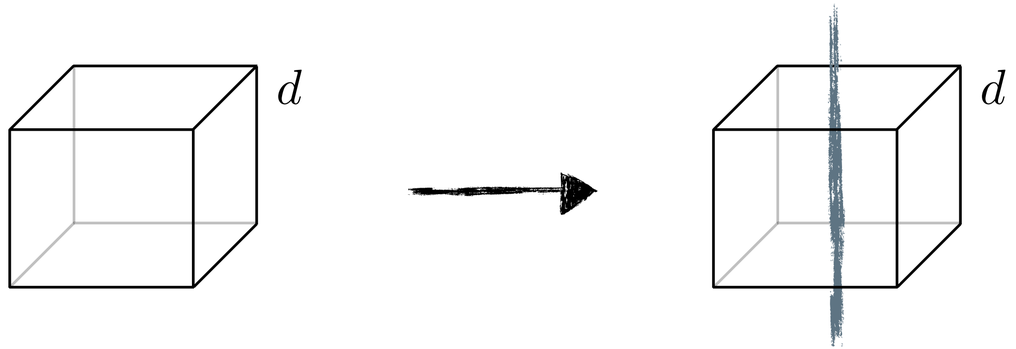
BREAKING SYMMETRY



Conformal defects: extended operators, which break the symmetry in a controlled manner

$$SO(d+1,1) \longrightarrow SO(p+1,1) \times SO(d-p)$$

BREAKING SYMMETRY



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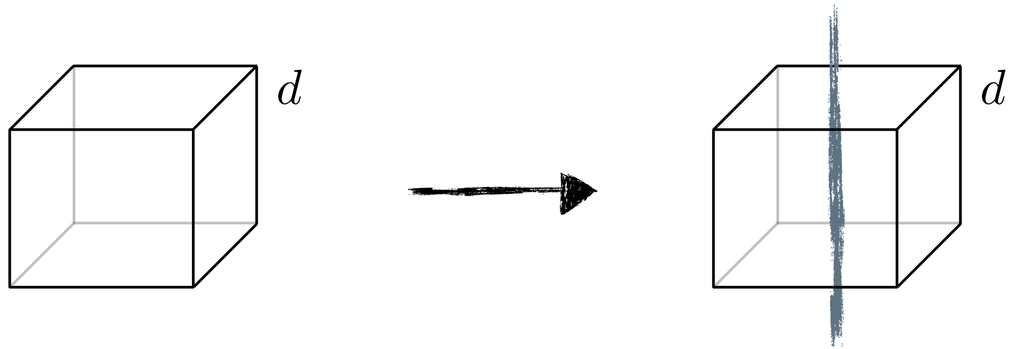
CFT in d dimensions

BREAKING SYMMETRY



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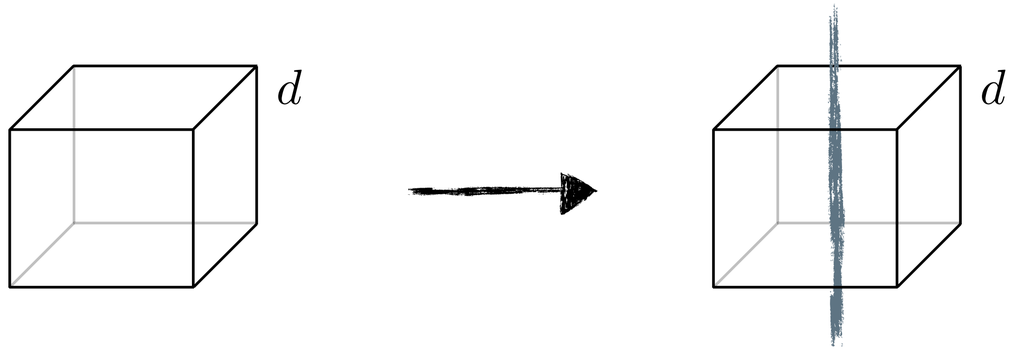
CFT in d dimensions

CFT in p dimensions

BREAKING SYMMETRY



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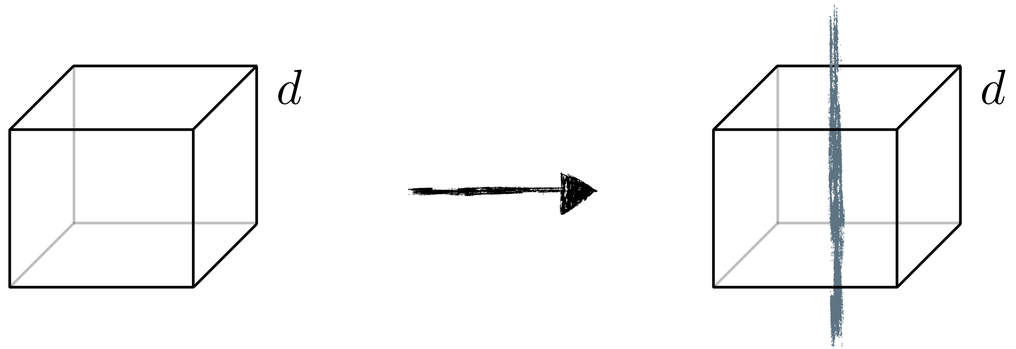
CFT in d dimensions — CFT in p dimensions — rotations

BREAKING SYMMETRY



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Broken symmetry ⟶ richer physics!

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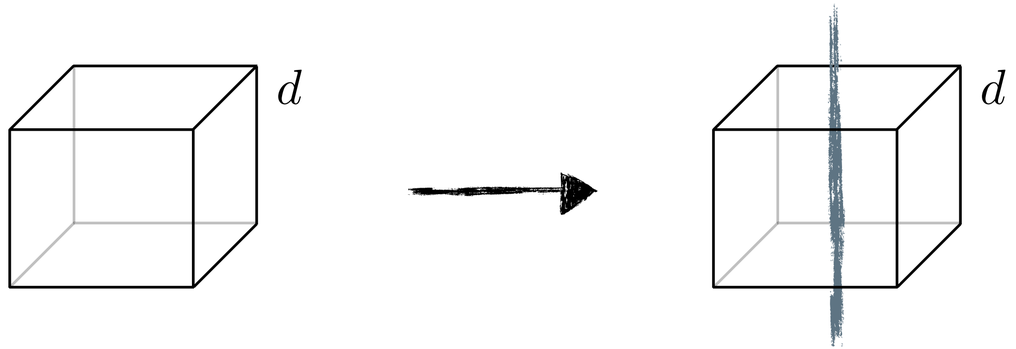

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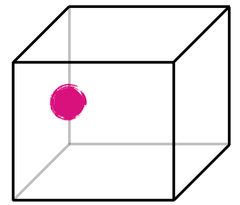

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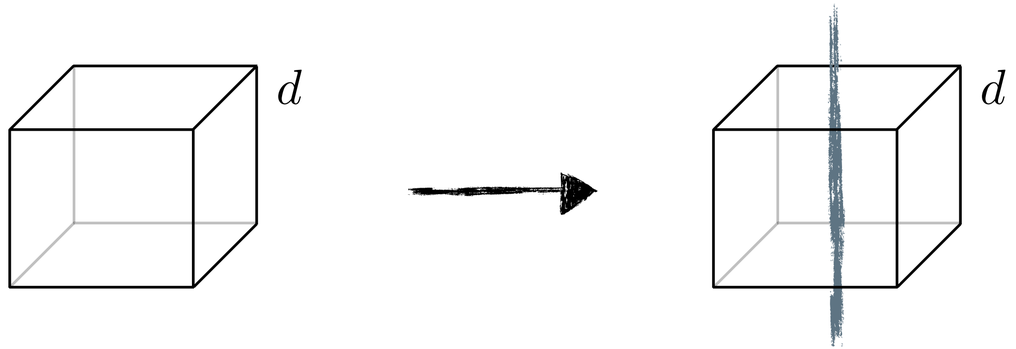


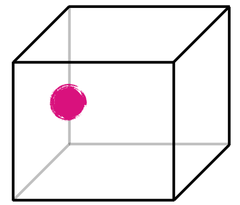
Conformal defects: extended operators, which break the symmetry in a controlled manner

$$SO(d+1,1) \longrightarrow SO(p+1,1) \times SO(d-p)$$

CFT in d dimensions — CFT in p dimensions — rotations

$$\langle\, \mathcal{O}(x) \,\rangle = 0$$

Broken symmetry ⟶ richer physics!



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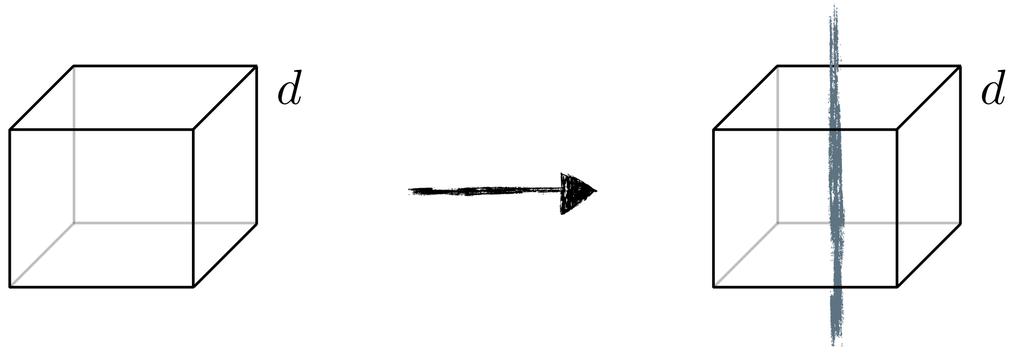

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CFT in d dimensions — CFT in p dimensions — rotations

$$\langle\, \mathcal{O}(x) \,\rangle = \frac{a}{|x^{\perp}|}$$

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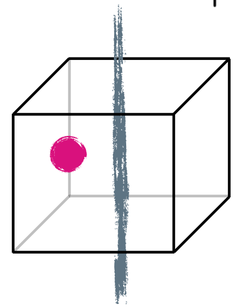

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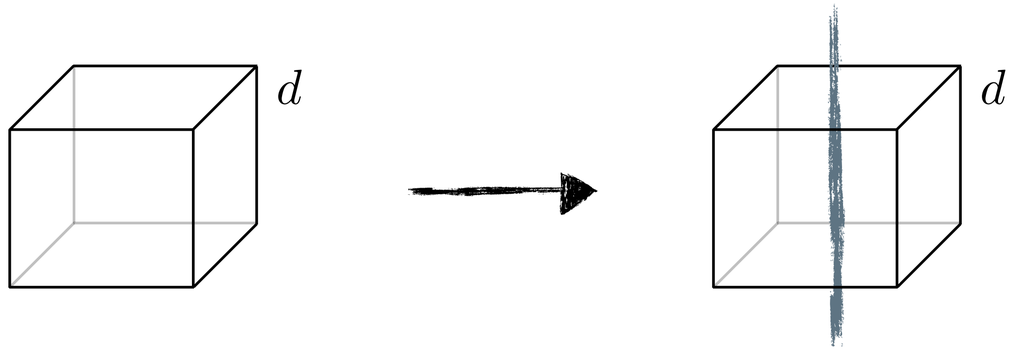

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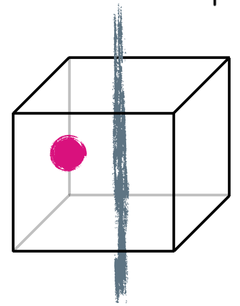
Broken symmetry ⟶ richer physics!

Some conformal symmetry preserved ⟶ defect conformal bootstrap



TWO EXAMPLES

Low-energy physics

High-energy physics

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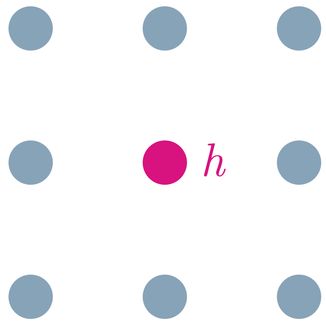
Low-energy physics

High-energy physics

Magnetic impurities



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Low-energy physics

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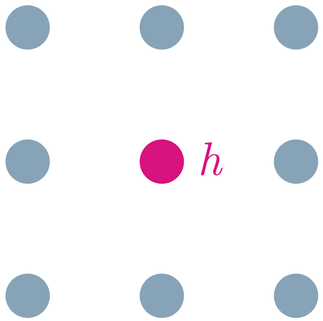
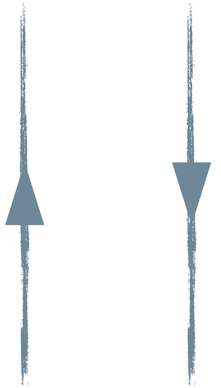


High-energy physics

Wilson lines



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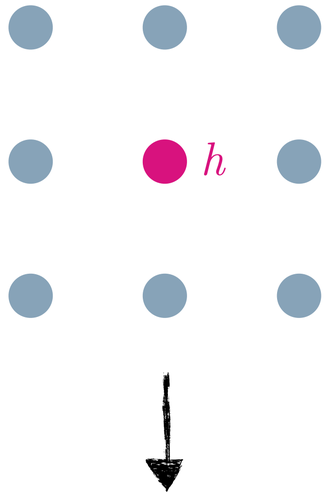

can be measured
experimentally

High-energy physics

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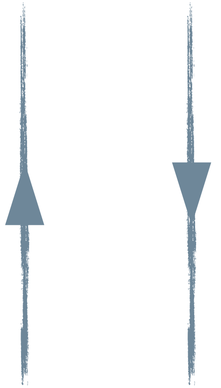

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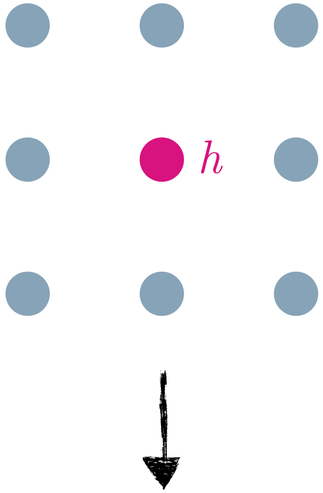

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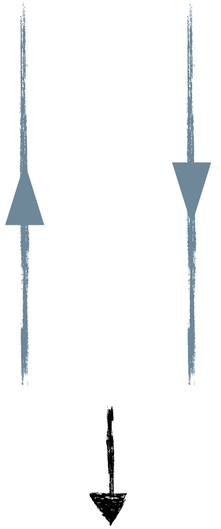

probes confinement
in gauge theories

TWO EXAMPLES

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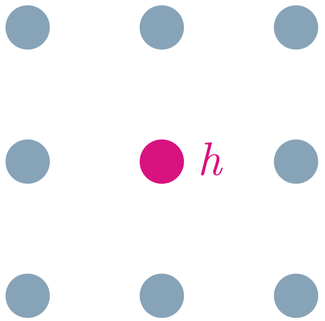

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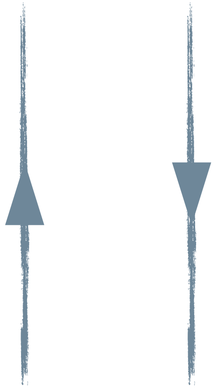


My PhD: study the weak and strong-coupling regimes of these defects

Elli Pomoni

Elli Pomoni

ERC

Exact results from broken symmetries

Elli Pomoni

ERC
Exact results from broken symmetries

↓

Conformal field theory at finite temperature

Elli Pomoni

ERC

Exact results from broken symmetries

Conformal field theory at finite temperature

$$T = 0 \longrightarrow T = \beta^{-1}$$

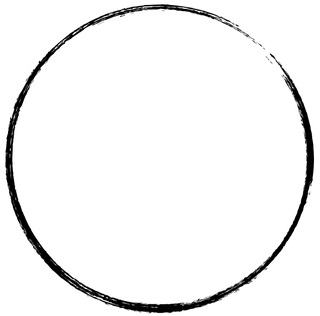
THERMAL CFT

THERMAL CFT

$T = 0$

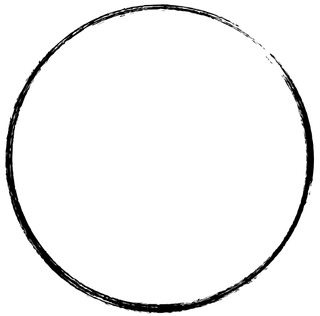
THERMAL CFT

$$T = 0 \longrightarrow T = \beta^{-1}$$



THERMAL CFT

$$T = 0 \longrightarrow T = \beta^{-1}$$



$$S^1 \times \mathbb{R}^{d-1}$$

THERMAL CFT

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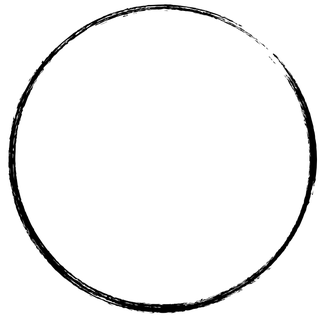


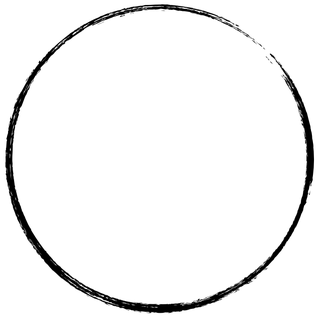
$$S^1 \times \mathbb{R}^{d-1}$$

Low-energy physics

Experiments happen
at finite T

THERMAL CFT

$$T = 0 \longrightarrow T = \beta^{-1}$$



$$S^1 \times \mathbb{R}^{d-1}$$

Low-energy physics	High-energy physics
Experiments happen at finite T	AdS/CFT: corresponds to black holes

IMPORTANT QUESTIONS

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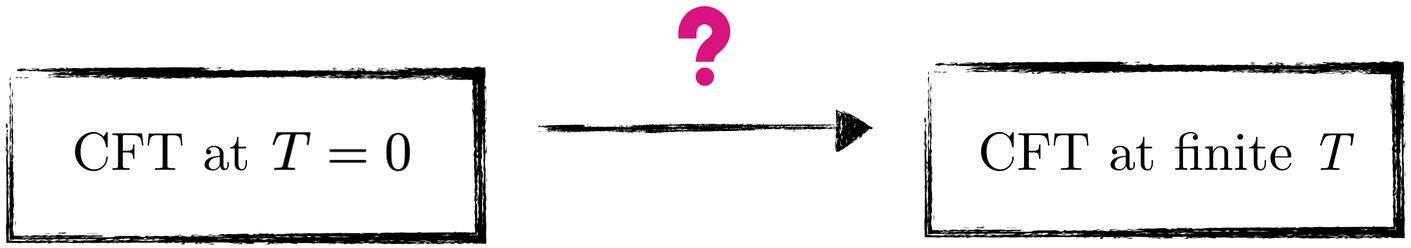
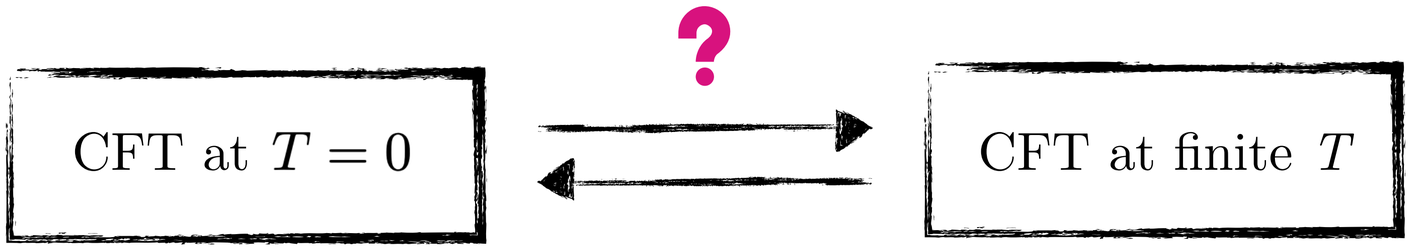
CFT at $T = 0$

CFT at finite T

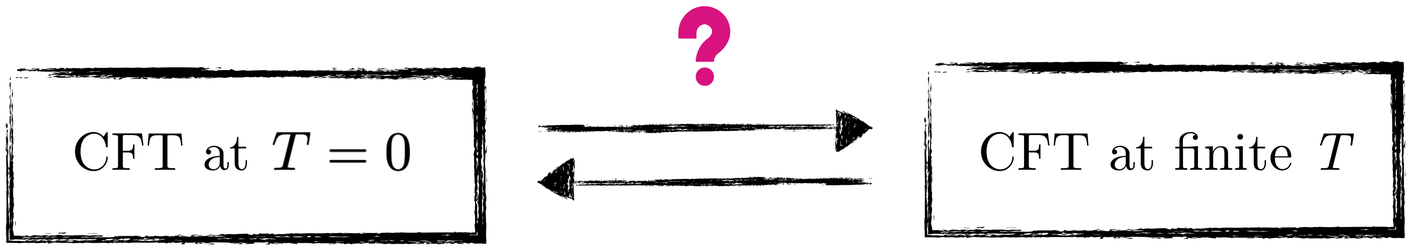
IMPORTANT QUESTIONS



IMPORTANT QUESTIONS

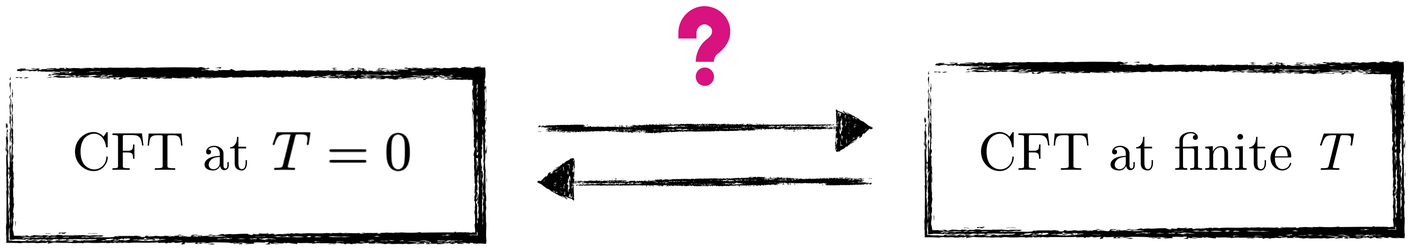


IMPORTANT QUESTIONS



What happens to conformal defects at finite T?

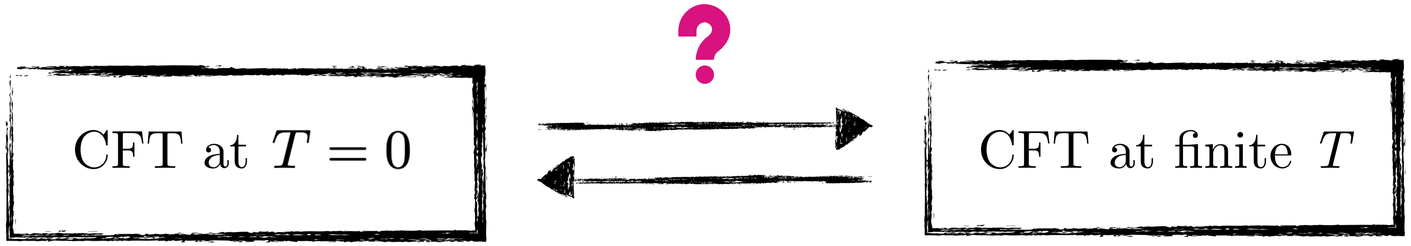
IMPORTANT QUESTIONS



What happens to conformal defects at finite T?

What can we learn about confinement (and black holes) in thermal AdS/CFT?

IMPORTANT QUESTIONS



What happens to conformal defects at finite T?

What can we learn about confinement (and black holes) in thermal AdS/CFT?

THANK YOU