Is Conformal Technicolor Plausible?

Slava Rychkov

Université Pierre et Marie Curie
and
École Normale Supérieure, Paris

for the CFT Bounds Collaboration
(Riccardo Rattazzi, S.R., Alessandro Vichi)

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(b) RS

Dimension of the singlet $|H|^2$ perturbation controlled by Higgs mass in the bulk:

$$\Delta_H = 2 + \sqrt{4 + M^2_{bulk}}$$

$$\Delta_{H^\dagger H} \simeq 2\Delta_H \geqslant 4 \quad \text{– irrel.}$$

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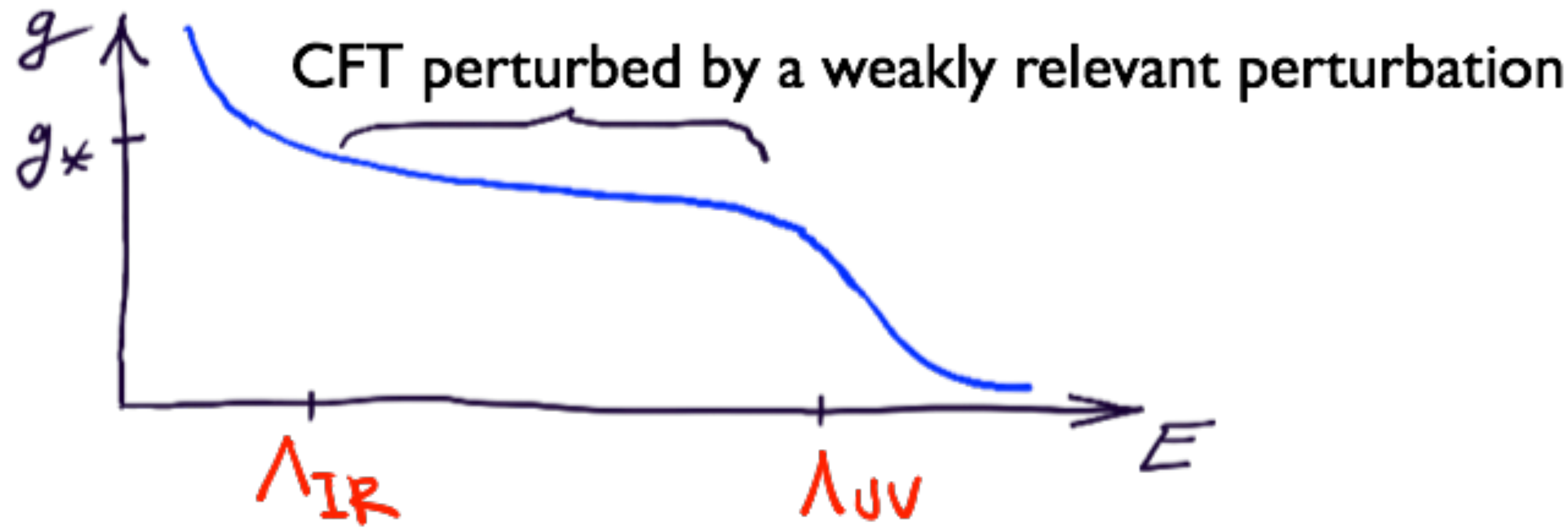
Impossible in weakly coupled or large N,
but a priori not excluded in general

Luty,Okui'04

Relation to Walking TC [Holdom'86]

Start with gauge theory in the UV; keep thinking in terms of gauge coupling and d.o.f.



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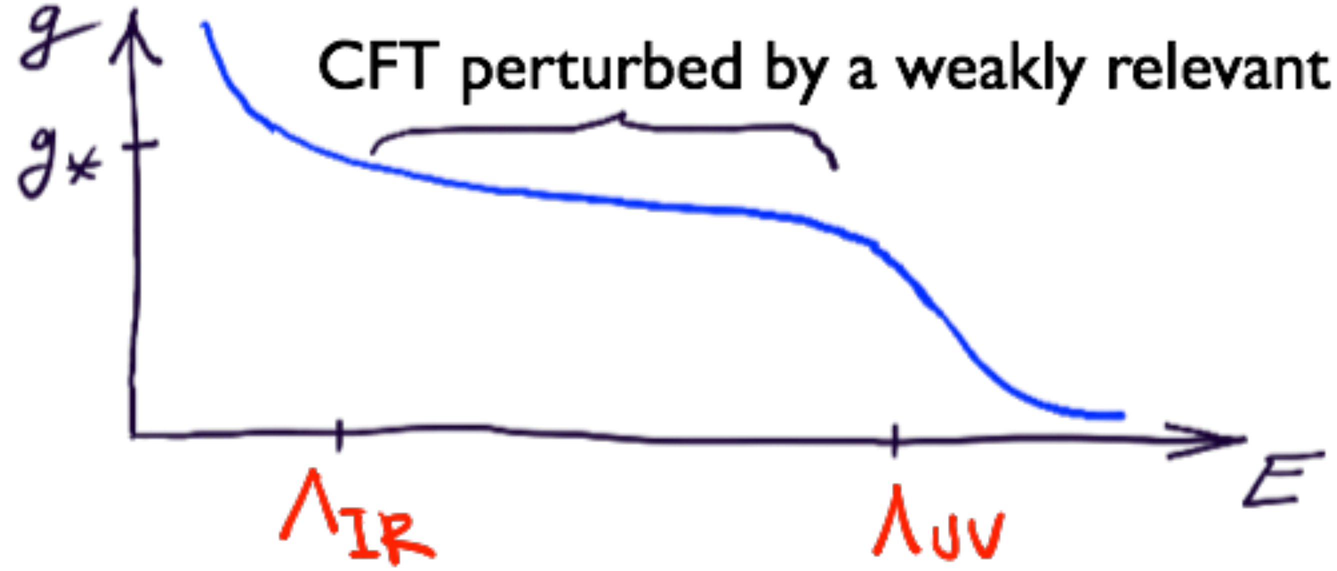

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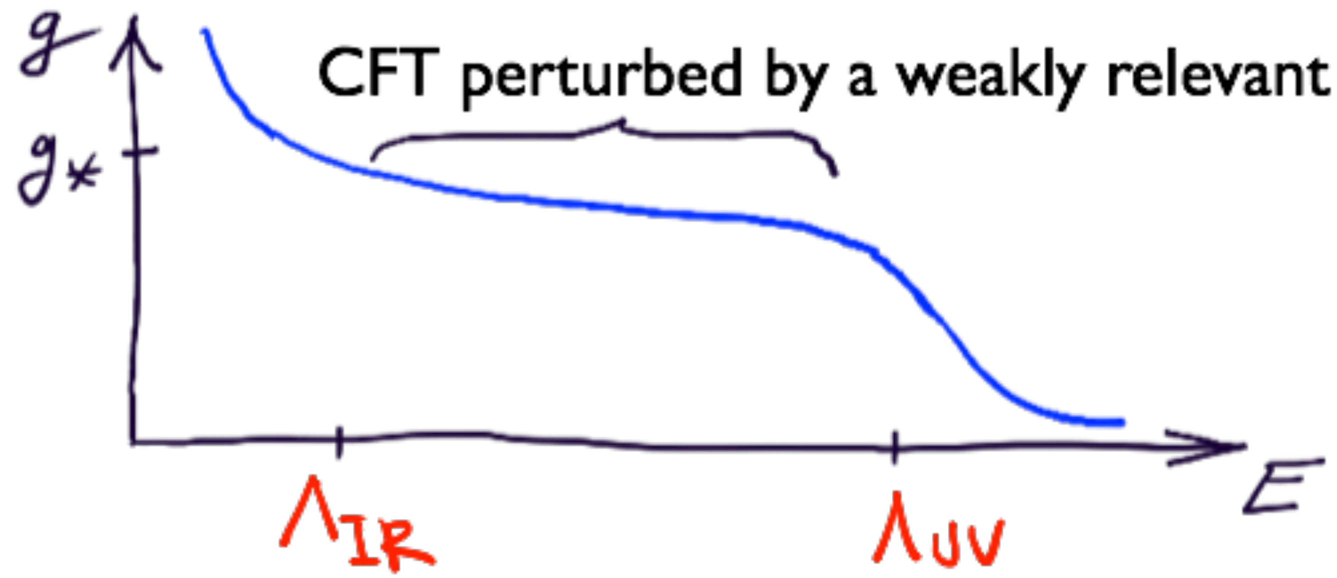

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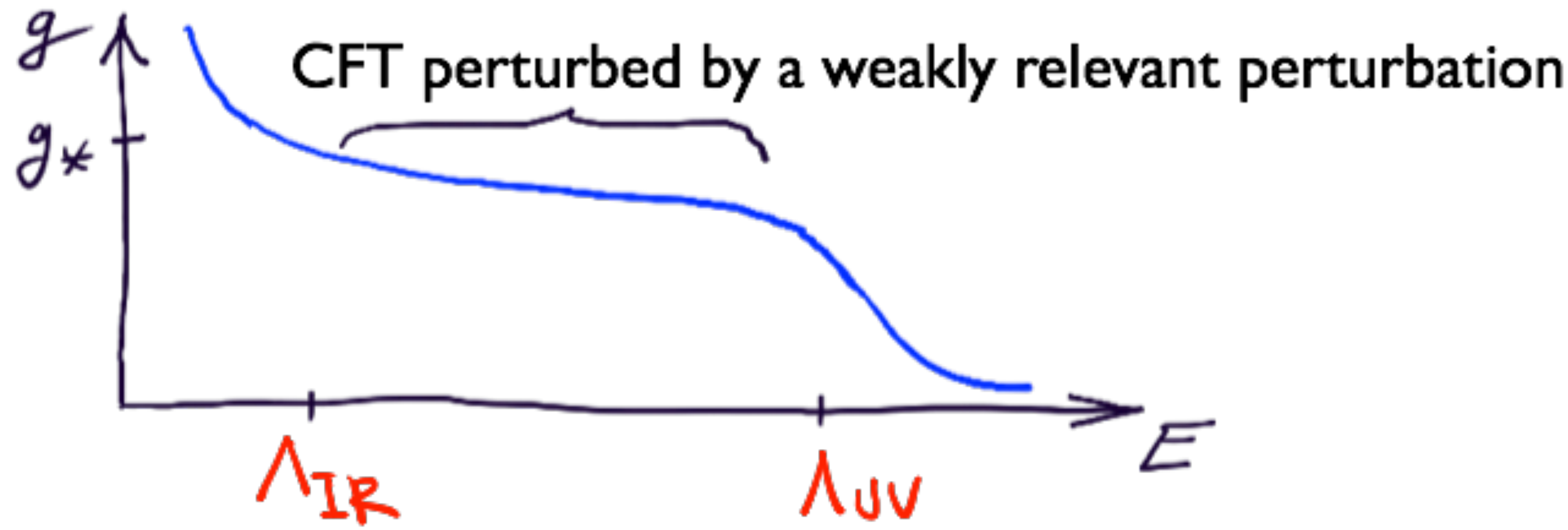

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$$\Lambda_{IR} = c^{\frac{1}{4-\Delta}} \Lambda_{UV} \ll \Lambda_{UV} \quad \text{if} \quad \Delta \to 4$$

'power-like' dimensional transmutation

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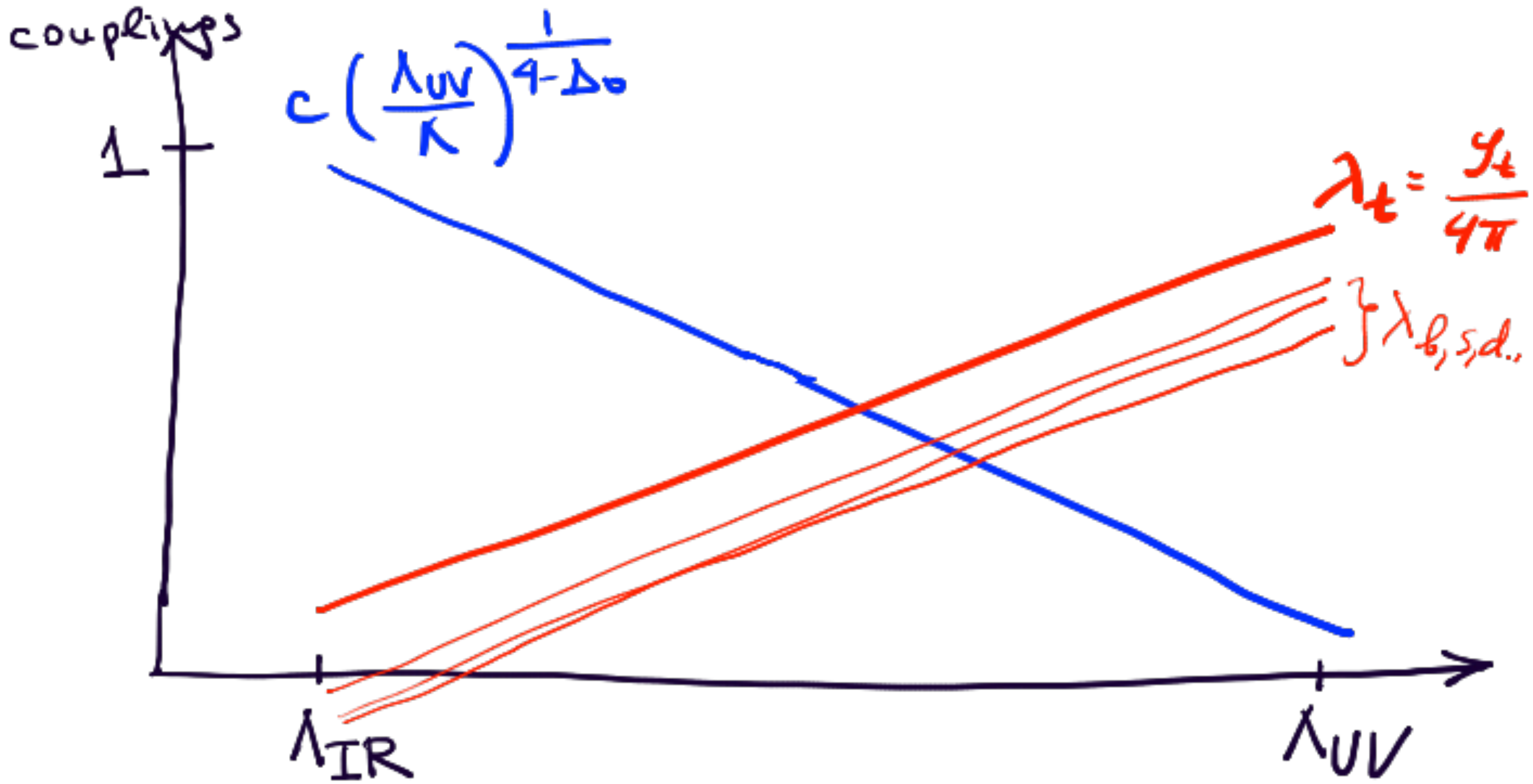
If $\Delta_S > 4$, CFT could break via a

R - relevant scalar which is NOT G-singlet:

- Requires G strictly larger than SO(4)
- Hierarchy technically natural even if **R** strongly relevant.

Running couplings



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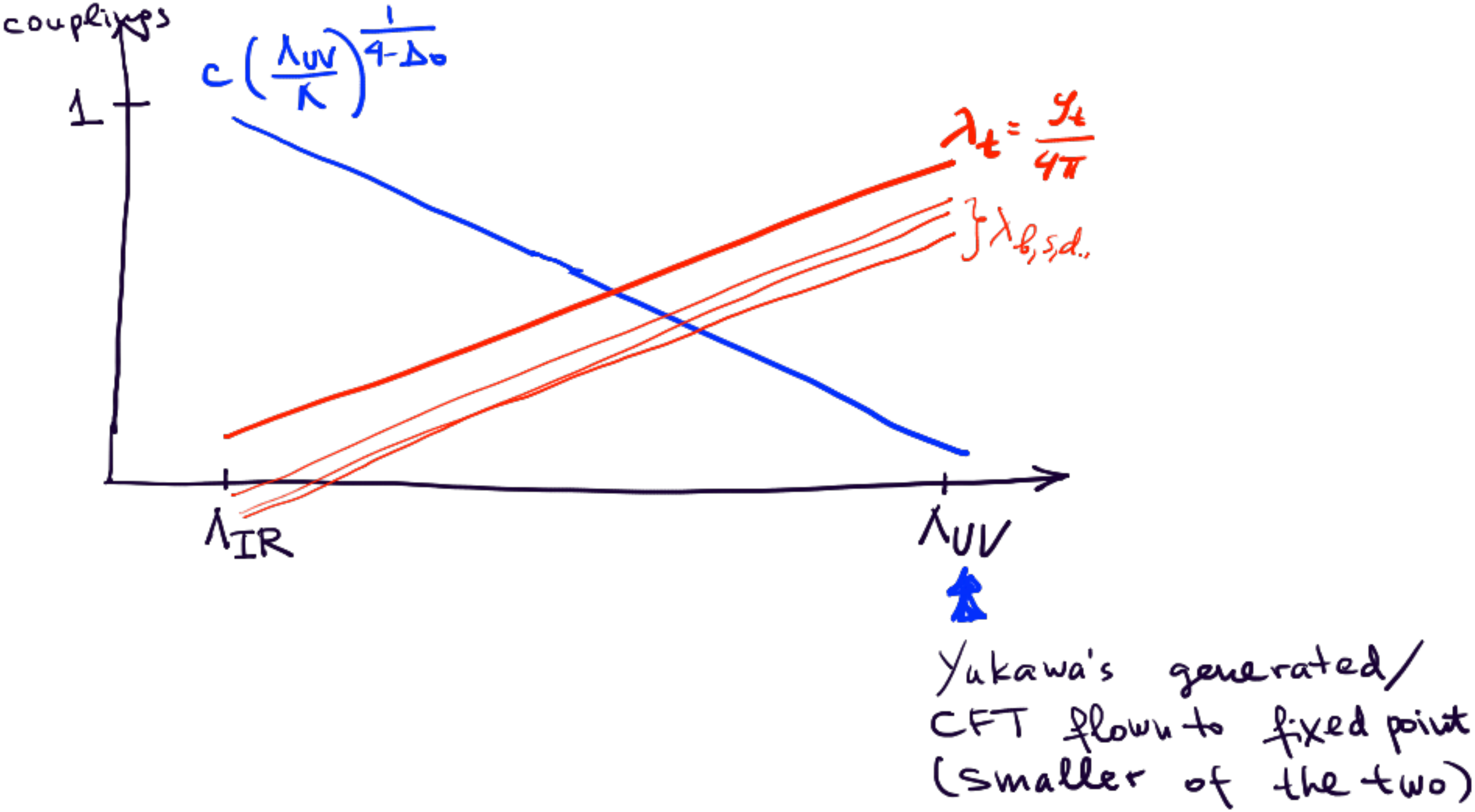

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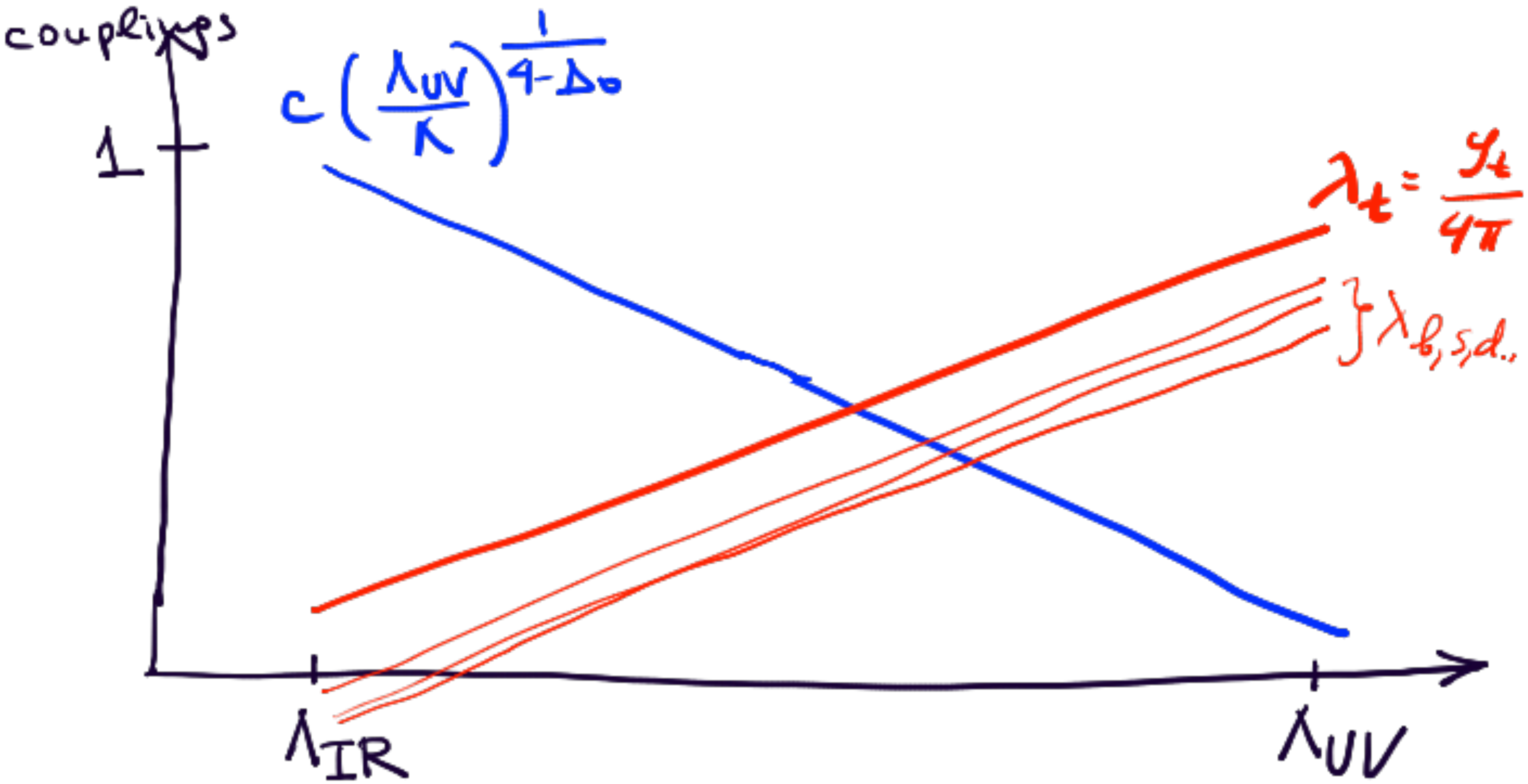

Yukawa's generated/ CFT flown to fixed point (smaller of the two)

- $\Lambda_{UV} = \Lambda_{IR}\, c^{-\frac{1}{4-\Delta_0}}$

- $\lambda_{top}(\Lambda_{UV}) \lesssim 1 \iff \Lambda_{UV} \lesssim 10^{\frac{1}{d_H-1}}\,\mathrm{TeV}$

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unsuppressed flavor violating 4f at Λ_{UV} $\quad \frac{y_{top}^2(\Lambda_{UV})}{\Lambda_{UV}^2} \; q_i q_j q_k q_l$

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exp.

$F = 3 \div 5$

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from flavor

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$$\boxed{d_H < 1 + \frac{1}{1+F}}$$

$F=3$: $d<1.25$

$F=4$: $d<1.2$

$F=5$: $d<1.17$

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This corresponds to Λ_{UV}~100 TeV ⇒ short CTC window

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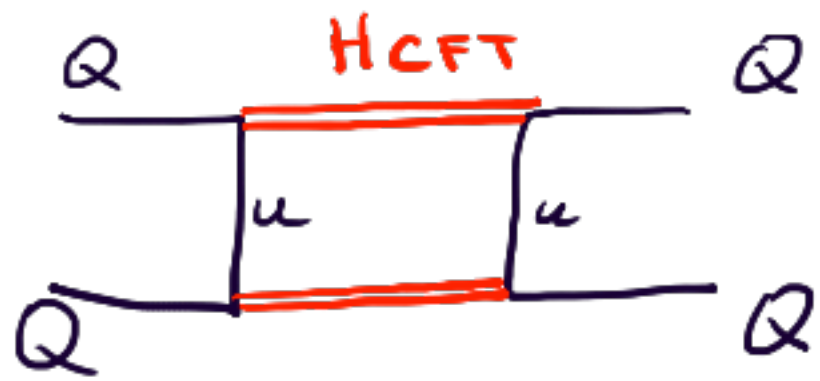
$(\bar{Q} \gamma^\mu Q)^2$ from



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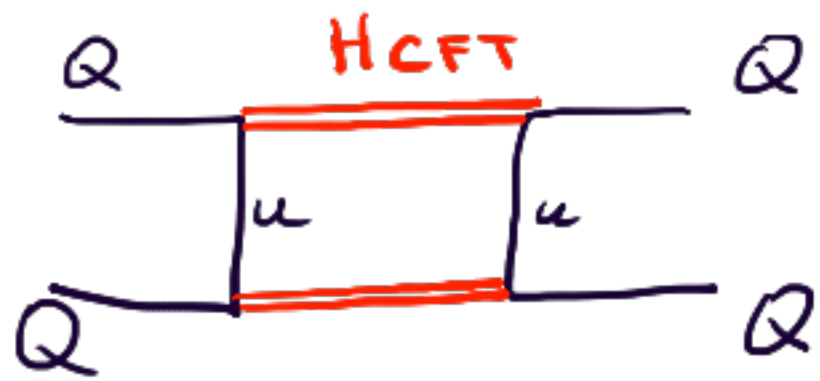

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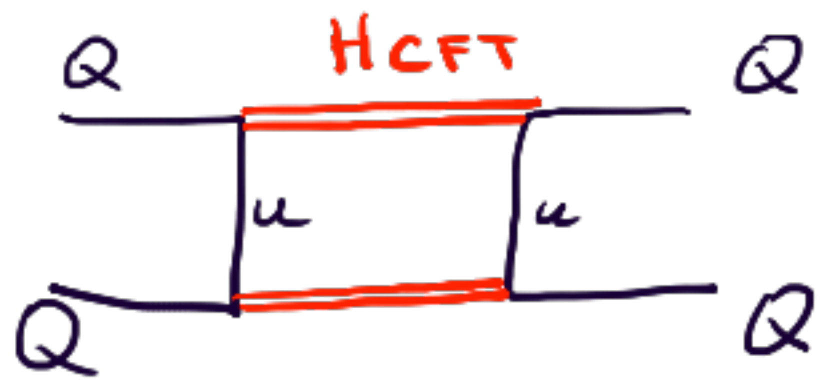

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$$\Rightarrow \boxed{\Lambda_{UV} \lesssim 3^{\frac{1}{2d_H-3}}\,\mathrm{TeV}} \qquad (d_H > 3/2)$$

disfavors $d_H > 1.5$ even further

Singlet dimension

(a) $\Delta_S < 4$

$\Delta\mathcal{L} = c\Lambda_{UV}^{\Delta-4} S_\Delta$, $c \sim 0.1$ $\Rightarrow$ $\Lambda_{UV} = \left(\frac{1}{c}\right)^{\frac{1}{4-\Delta}} \Lambda_{IR}$

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$$\boxed{4 - \Delta_S < \frac{2 - d_H}{F}}$$

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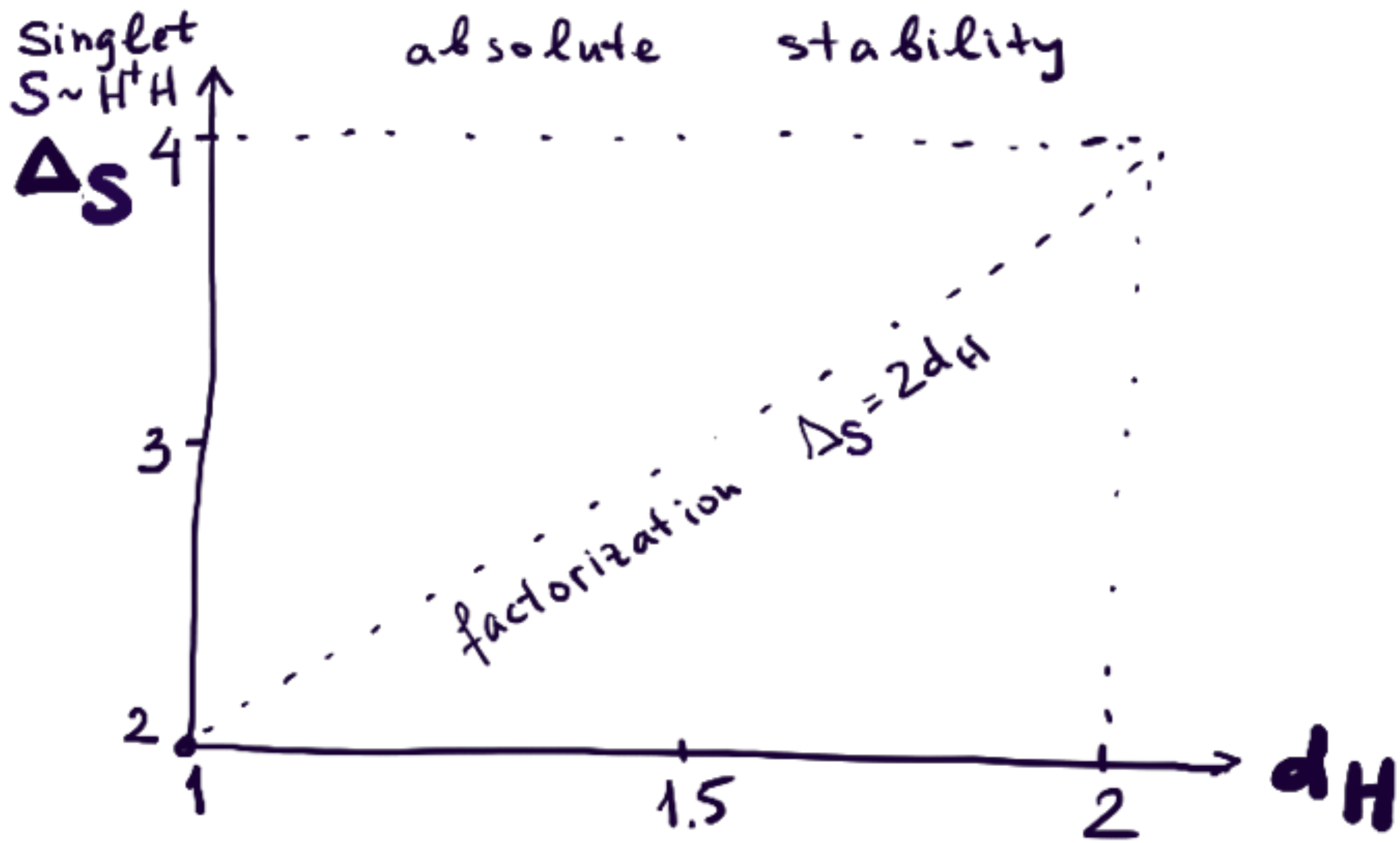

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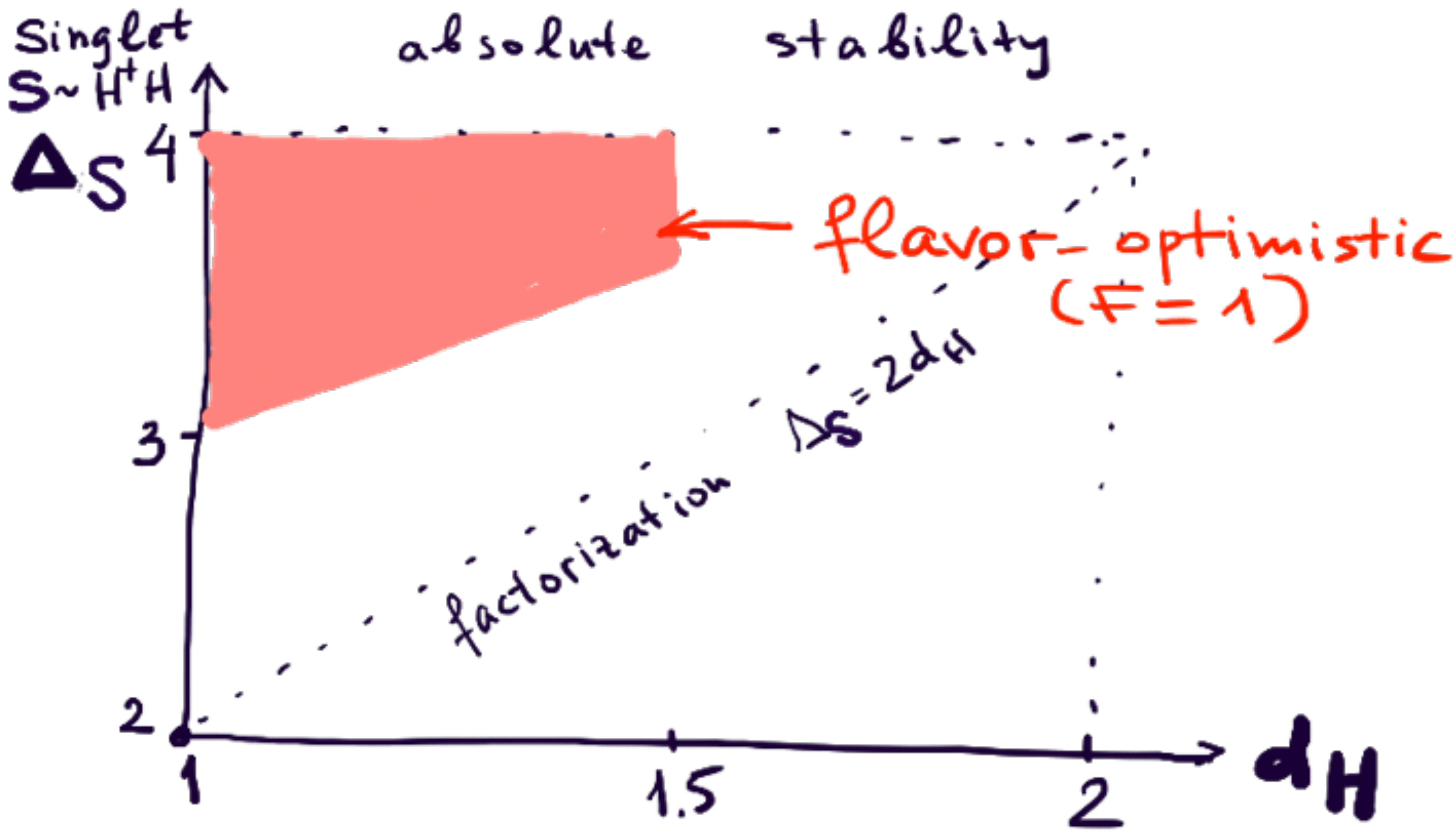

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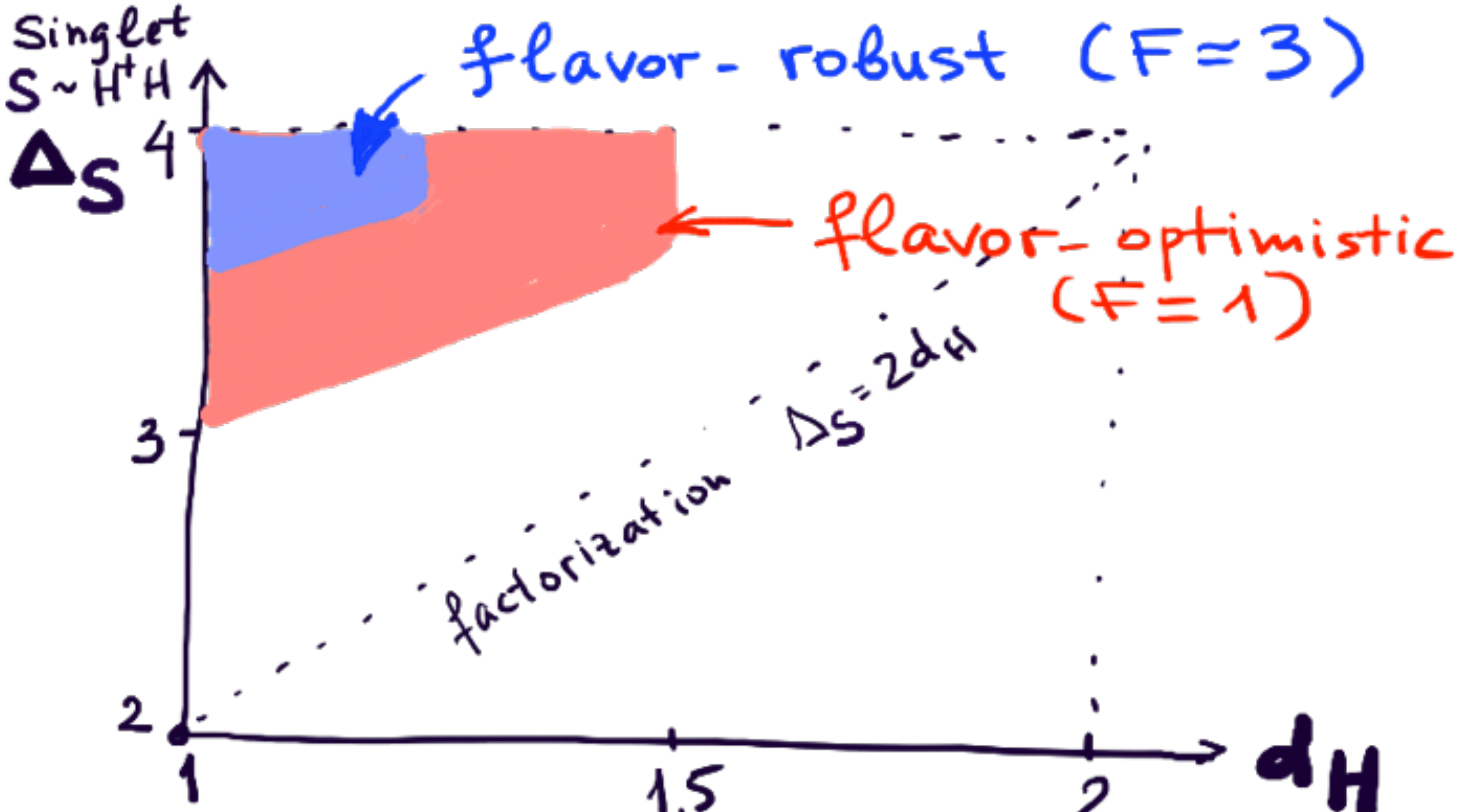

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A simple possibility: **R** is the SO(4)-neutral part of H_G
[Galloway, Evans, Luty, Tacchi'10]

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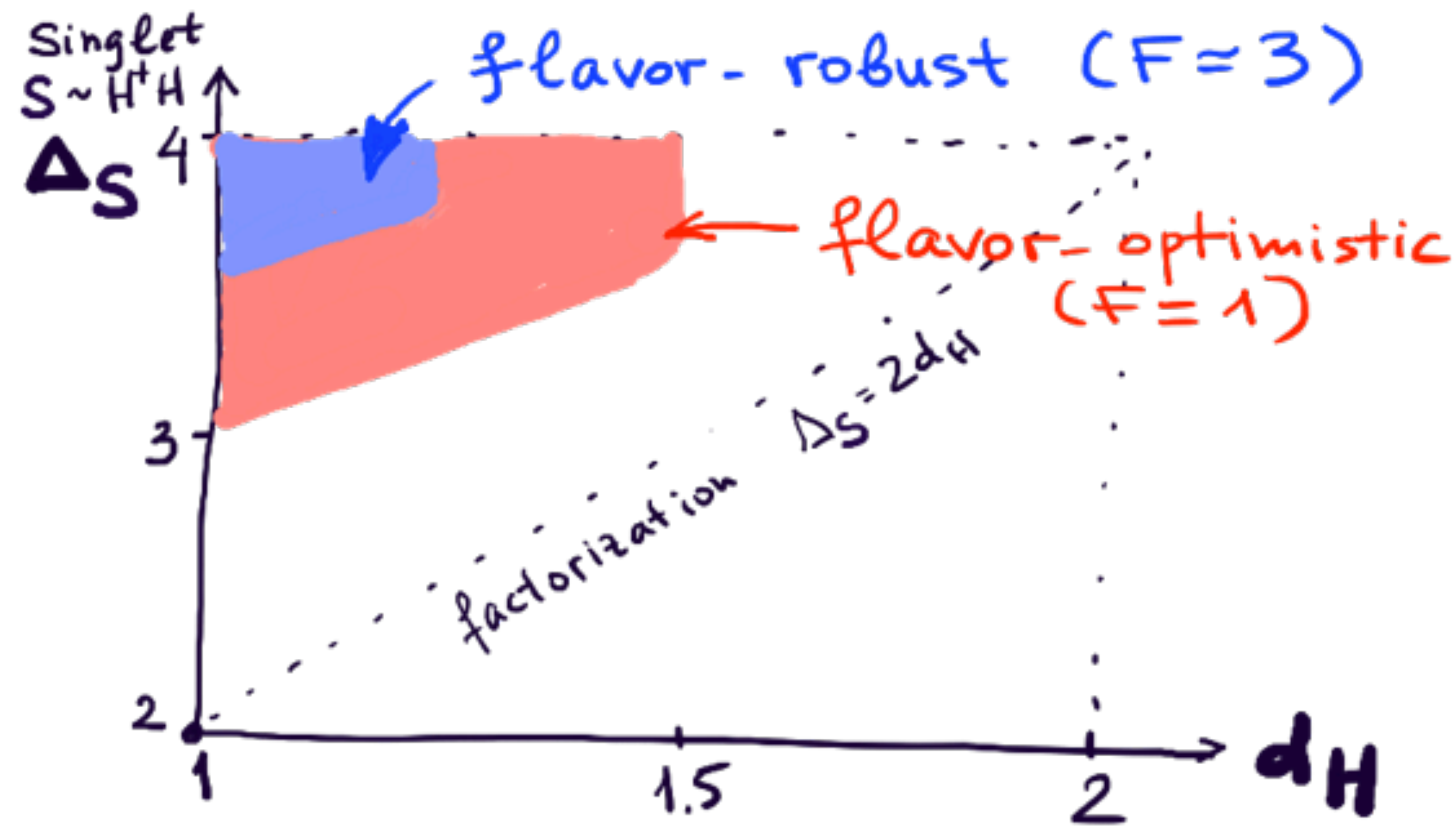
⇒ better EWPT, relaxes somewhat constraints on d_H

What can be said about d_H and d_S?



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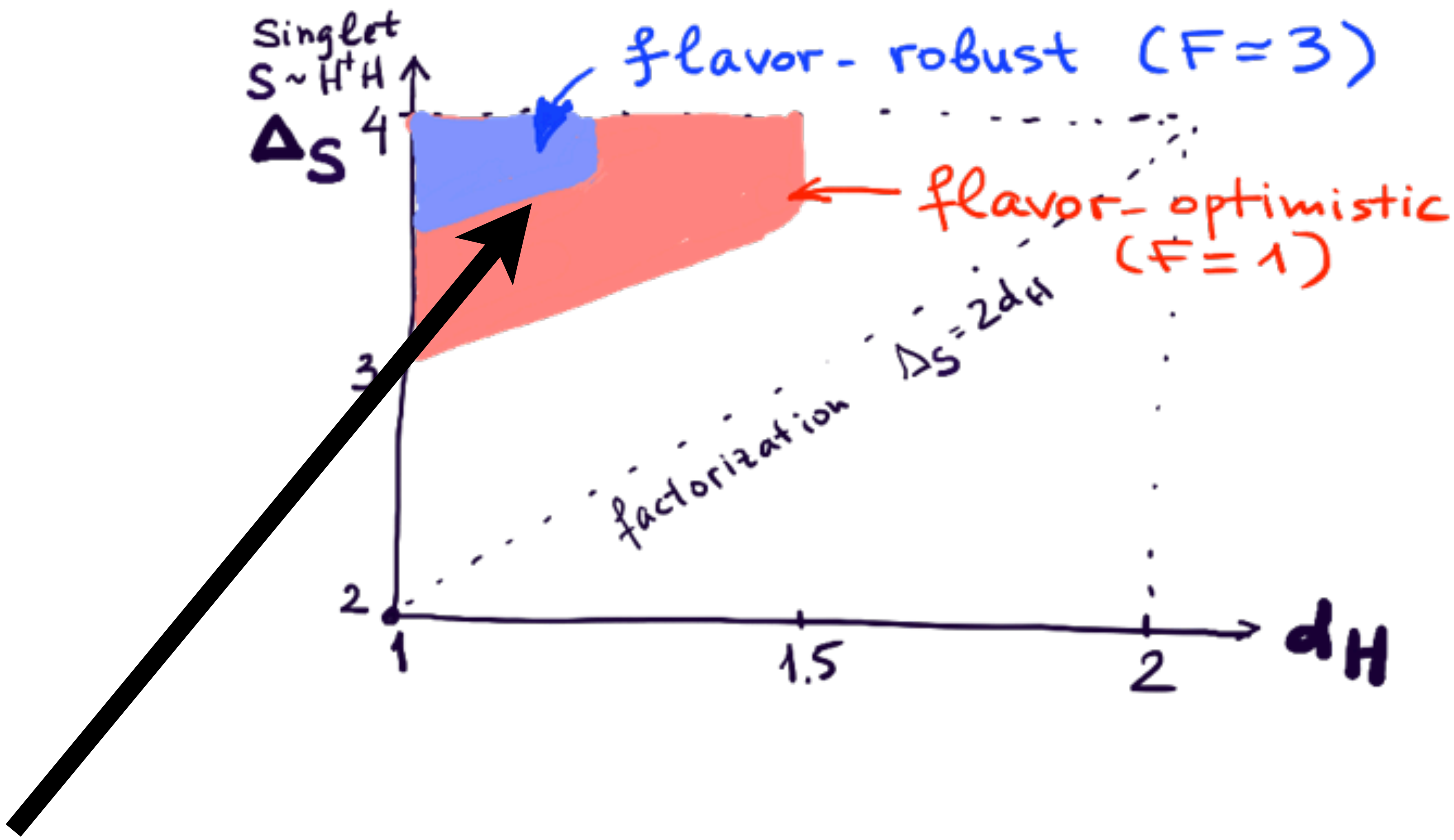

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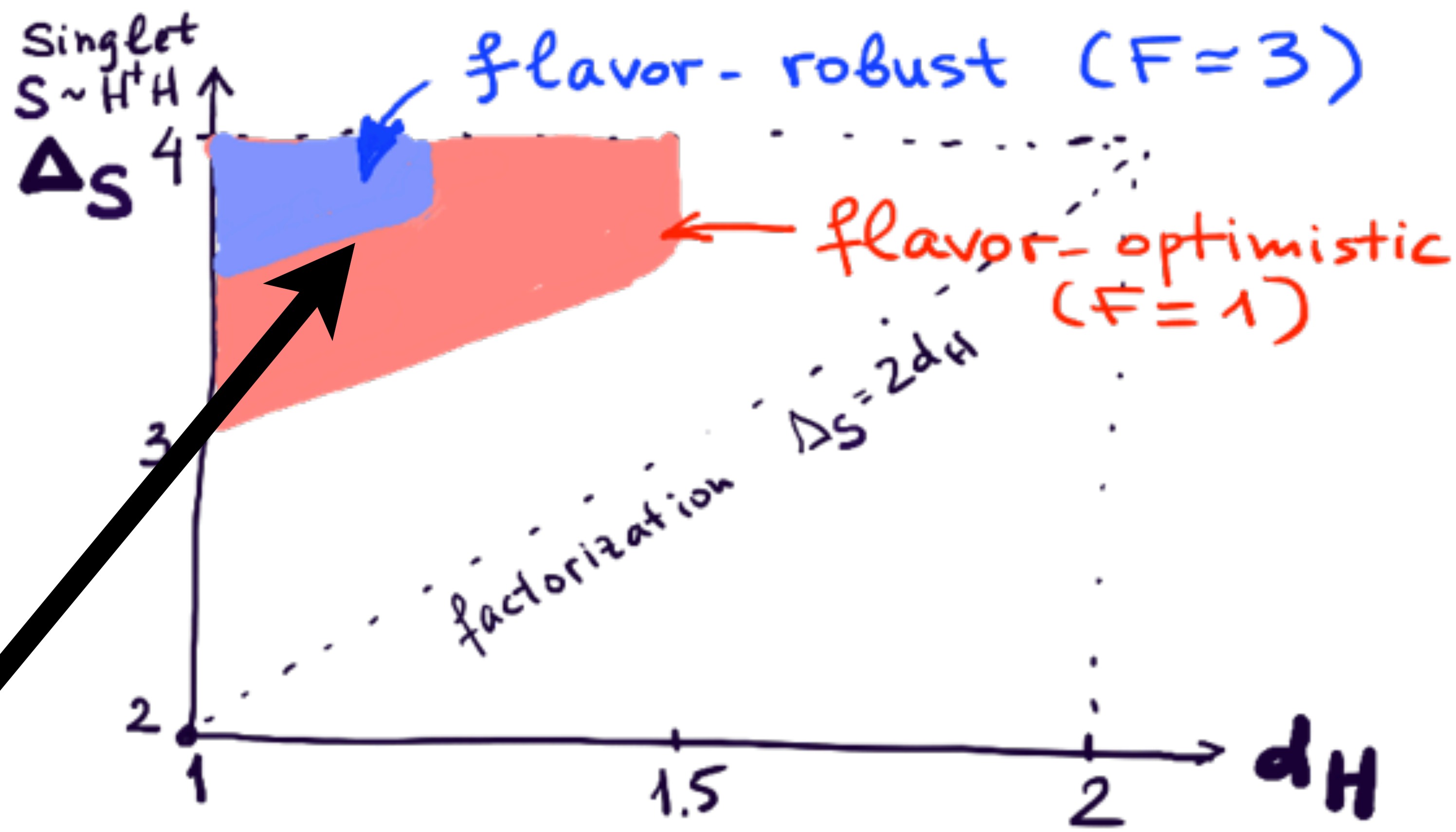

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Do we know a reason why these CFTs might not exist?
Since 2008, we do.

[CFT Bounds Coll + Tonni. 2008]

OPE Higgs* x Higgs in SO(4) notation:

$$\varphi_a \times \varphi_b = \delta_{ab} \mathbb{1} + \sum \delta_{ab} S^i \quad \text{(singlets, even spin)}$$
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Conformal block dec. of 4-point function:

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$$+ \left(\delta_{ac}\delta_{bd} + \delta_{ad}\delta_{bc} - \tfrac{1}{2}\delta_{ab}\delta_{cd}\right) \sum_T c_j^2 G_j$$
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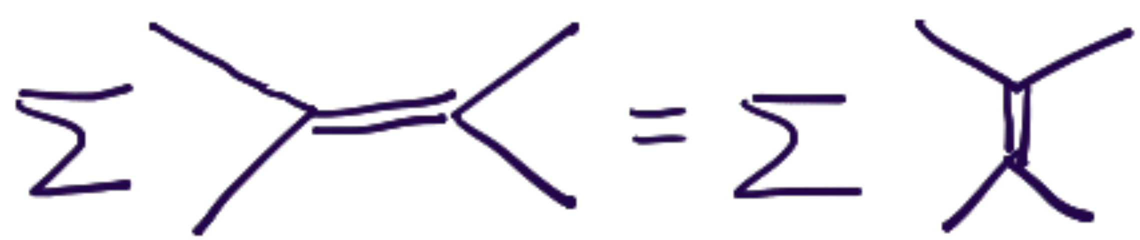
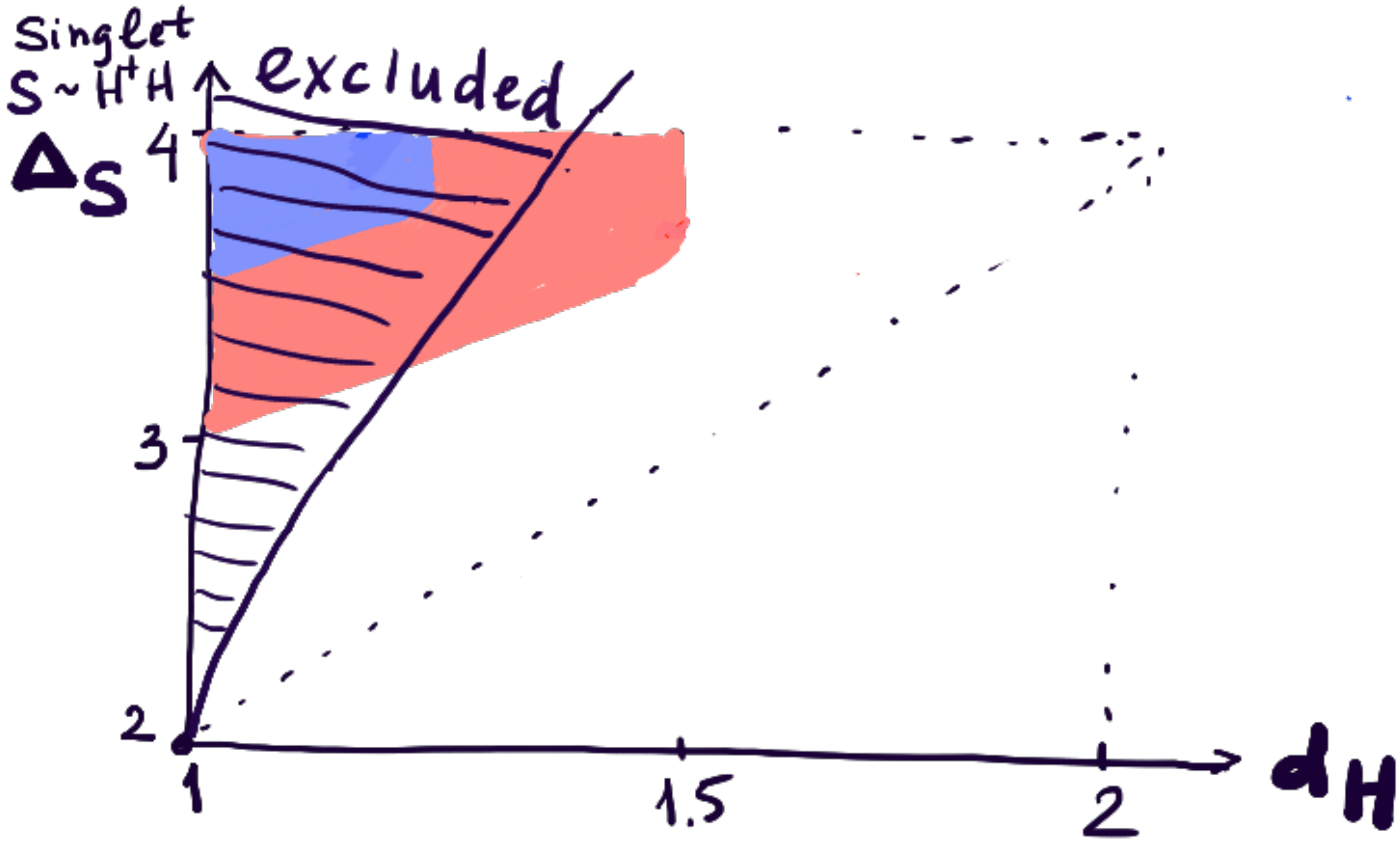
c^2 - squares of OPE coeffs; $G(u,v)$ conformal blocks

Crossing symmetry:



Best current results

CFT Bounds Coll.(2010) + work in progress



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3. General method to study strongly coupled physics; more applications to come