Conformal Symmetry as an Organizing Principle for the Derivative Expansion

Jorge Ibañez,

Matthieu Tissier,

<u>Gonzalo De Polsi</u>

Facultad de Ciencias, Universidad de la Republica.

gonzalo.depolsi@fcien.edu.uy

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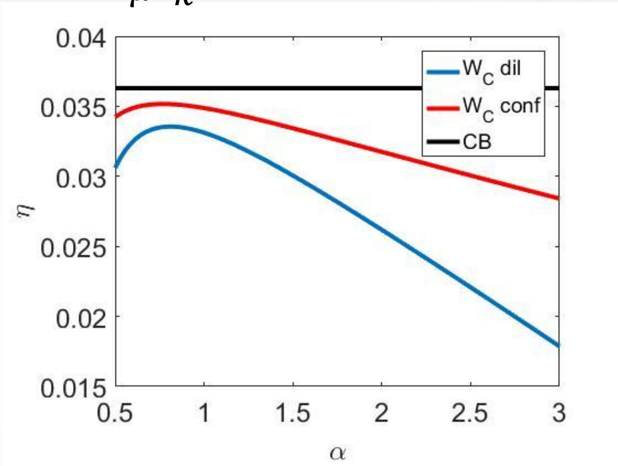
Two years ago… Les Diablerets, 15:05, 23/9/2024

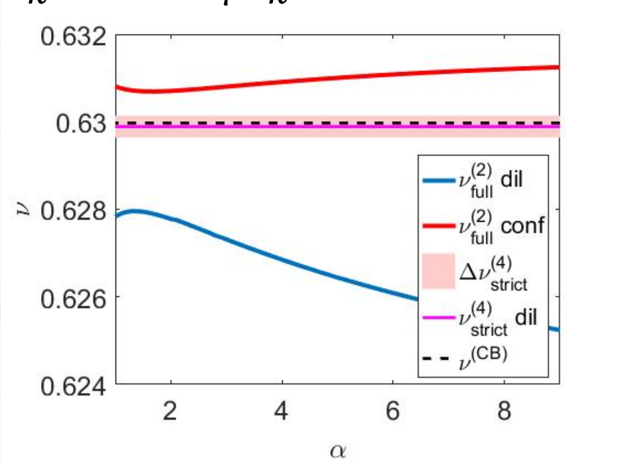
CAN WE INCORPORATE CONFORMAL SYMMETRY INTO THE DE?

$\mathcal{D}\Gamma_k^{(n,0)} = \mathcal{C}_\mu \Gamma_k^{(n,0)} = 0$ for $n \leq 3$

Eqs. set
$\mathcal{D}\Gamma_k^{(1,0)}$
$\mathcal{D}\Gamma_k^{(2,0)}$
$\mathcal{D}\Gamma_k^{(3,0)}$
$\mathcal{C}_\mu \Gamma_k^{(3,0)}$



$\mathcal{D}\Gamma_k^{(n,m)} = \mathcal{C}_\mu \Gamma_k^{(n,m)} = 0$ for $n + m \leq 2$



Eqs set
$\mathcal{D}\Gamma_k^{(1,0)}$
$\mathcal{D}\Gamma_k^{(2,0)}$
$\mathcal{D}\Gamma_k^{(1,1)}$
$\mathcal{C}_\mu \Gamma_k^{(1,1)}$

MORE ACCURATE AND LESS DEPENDENCE IN α

The DE compatible with conformal symmetry, seems significantly more robust and precise than the "standard" DE

How good? How robust? Still to be seen... stay tuned

Fast forward to present…

The hour has arrived.

OUTLINE

- The context: Critical phenomena and the FRG
- The hero: The derivative expansion
- A new armour: Conformal symmetry
- Taming the beast: A conformal DE
- Takeaways/Conclusions

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- **The context: Critical phenomena and the FRG**
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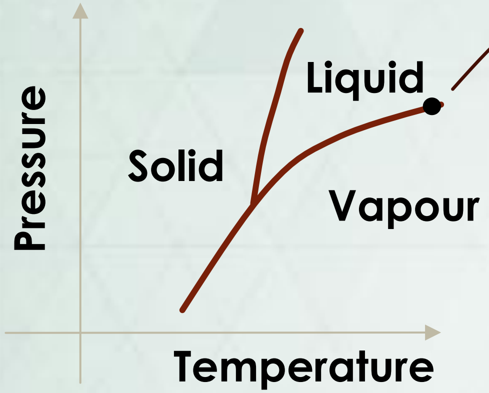
Once upon a time… critical phenomena

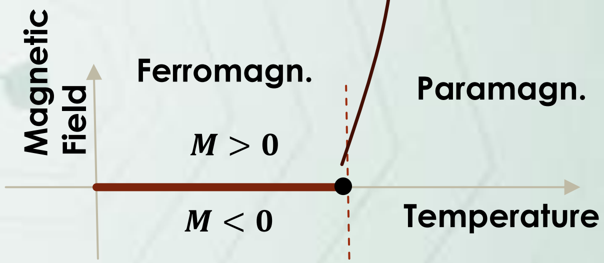


Critical point
(and surroundings)

Power law behaviour of many physical quantities

$$C \sim |T - T_c|^{-\alpha}$$

$$\langle \phi(0)\phi(r) \rangle \Big|_{\substack{T=T_c \\ r\to\infty}} \sim r^{2-d-\eta} \qquad \xi \sim |T - T_c|^{-\nu}$$



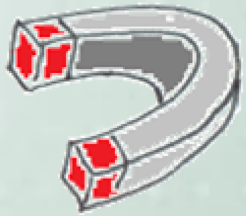
Density difference $\rho_l - \rho_g \sim |T - T_c|^{\beta}$

Compressibility bulk modulus $\kappa_T \sim |T - T_c|^{-\gamma}$

$T \sim T_c$
SAME UNIVERSALITY CLASS

Magnetization $M \sim |T - T_c|^{\beta}$

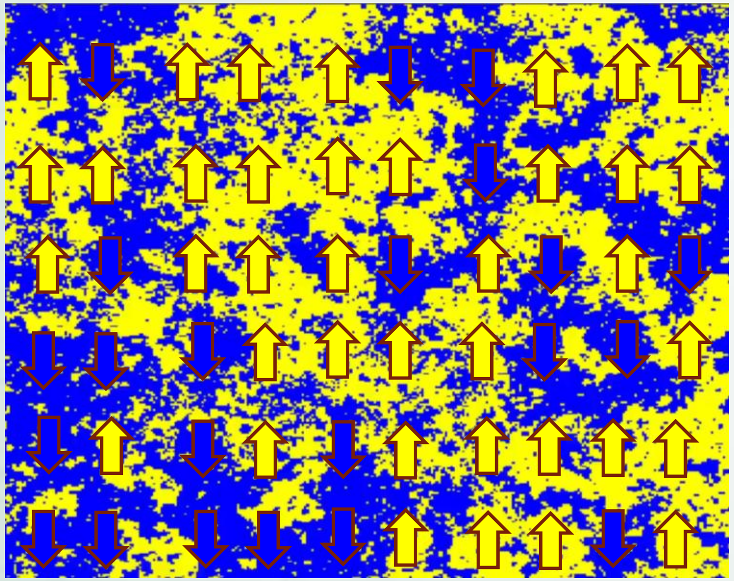
Suceptibility $\chi \sim |T - T_c|^{-\gamma}$



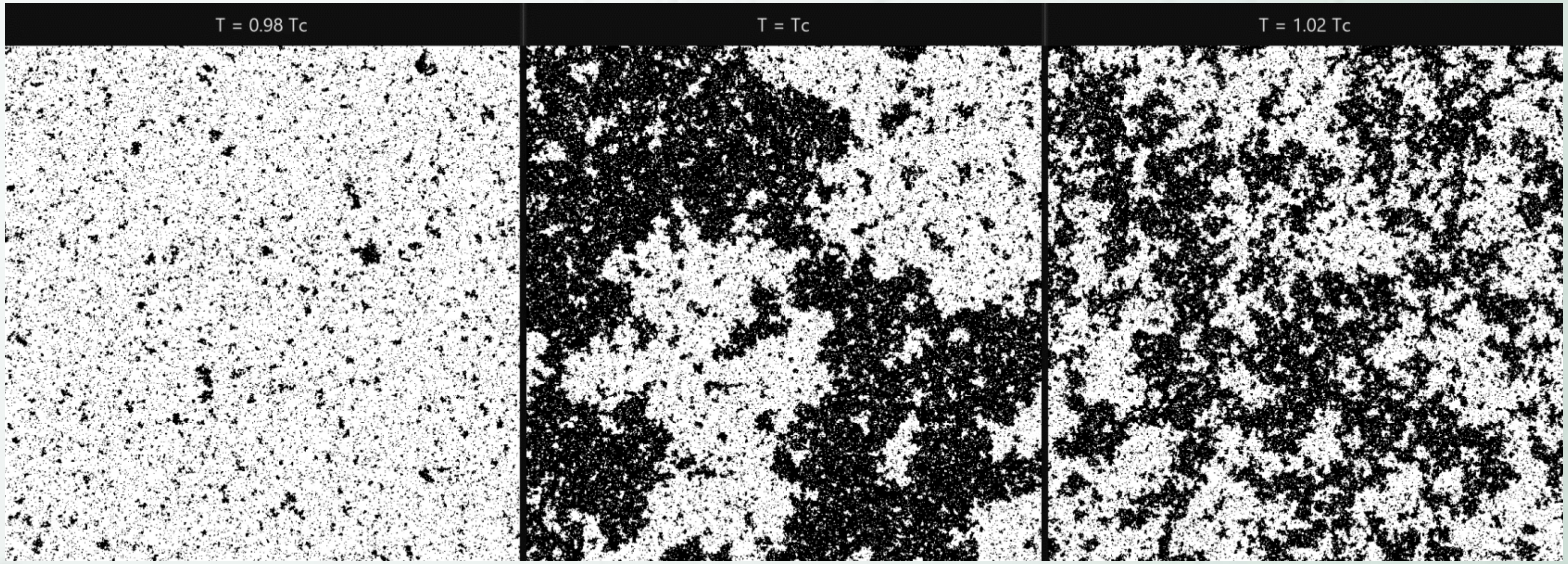
Once upon a time… critical phenomena

Simplest magnet: Ising model $H = -J \sum_{\langle i,j \rangle} S_i S_j$

$T = T_c$

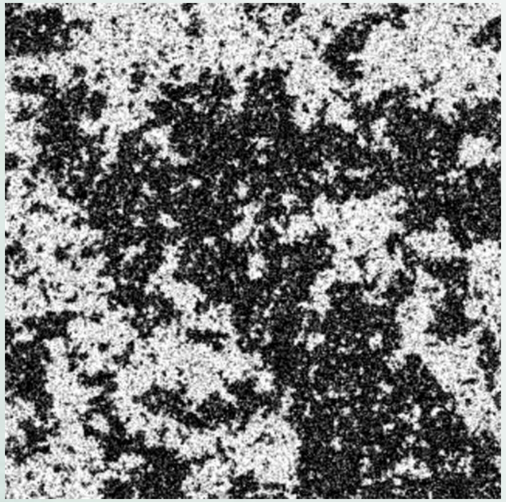


$\bullet$ $\mathbf{S} = +1$ $\bullet$ $\mathbf{S} = -1$

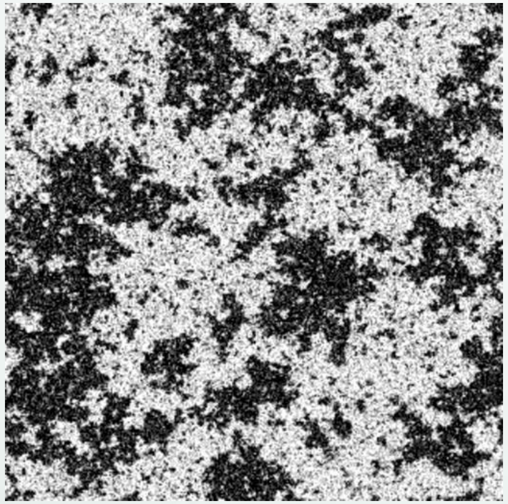


Once upon a time… critical phenomena

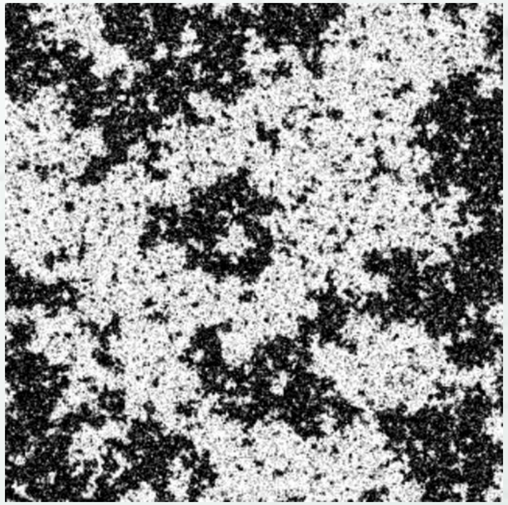
Translation



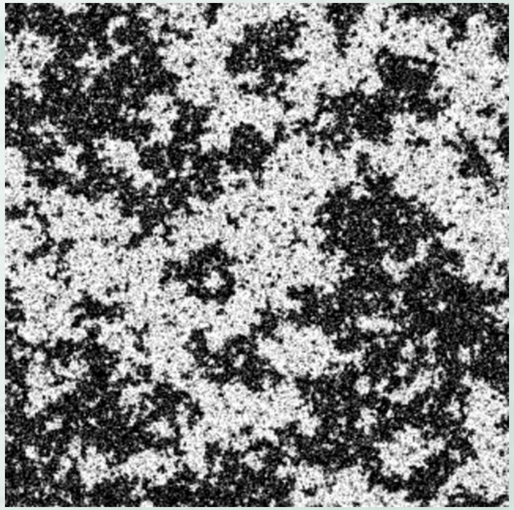
Rotations



Dilatations



Special Conformal



Once upon a time… renormalization group

IN THE FRG

$$e^{-W_k[J,K]} = \int \mathfrak{D}\phi\, e^{-S[\phi]-\Delta S_k[\phi]+\int_x J\cdot\phi+\int_x K\cdot\mathcal{O}}$$

$$\Delta S_k[\phi] = \frac{1}{2}\int_q \phi(q)R_k(|q|)\phi(-q)$$

EFFECTIVE ACTION Γ_k

GENERALIZED LEGENDRE TRANSFORM OF $W_k[B]$

$\downarrow$

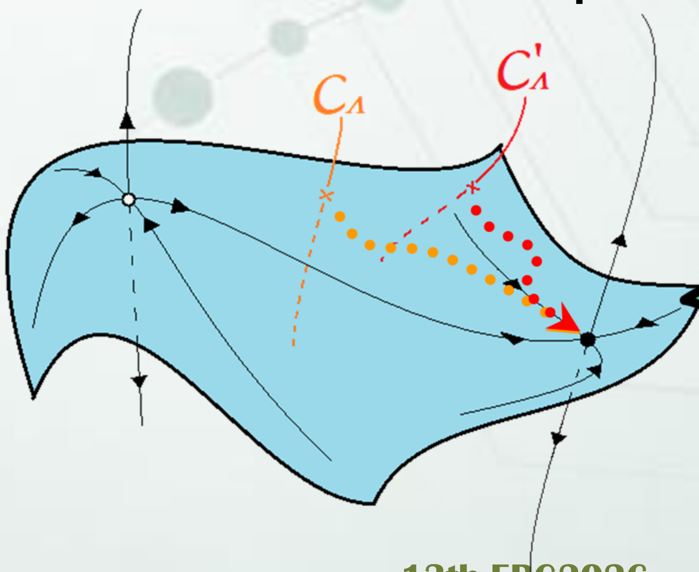
$$\Gamma_k[\varphi, K] = -W_k[J,K] - \Delta H_k[\varphi] + \int_x J\cdot\varphi$$

$$\boxed{\partial_k\Gamma_k[\varphi, K] = \frac{1}{2}\int_{x,y}\partial_k R_k(x-y)G_k(x,y)}$$

$$\int_z G_k(x,z)\left(\frac{\delta^2\Gamma_k}{\delta\varphi_i(z)\delta\varphi_j(y)} + R_k(z-y)\right) = \delta(x-y)$$

$$\boxed{\partial_t\Gamma_k[\varphi] = \int_x \frac{\delta\Gamma_k}{\delta\varphi(x)}(D_\varphi + x_\mu\partial_\mu)\varphi(x) - \int_x K(x)(D_{\mathcal{O}} + x_\mu\partial_\mu)\frac{\delta\Gamma_k}{\delta K(x)} + \frac{1}{2}\int_{x,y}\partial_t R_k(|x-y|)G_k(x,y)}$$

Critical phenomena



The dragon ∂_t has the princess Γ as a hostage

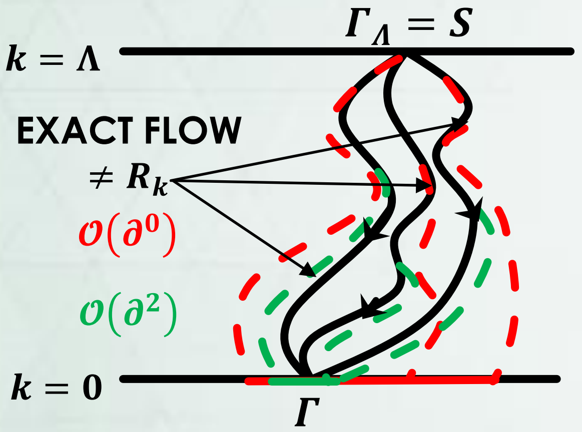
$$\partial_t\tilde{\Gamma}_k[\tilde{\varphi}] = 0$$

fixed point

OUTLINE

The derivative expansion… hold my beer

$R_k(q^2) = Z_k k^2 \alpha e^{-q^2/k^2}$



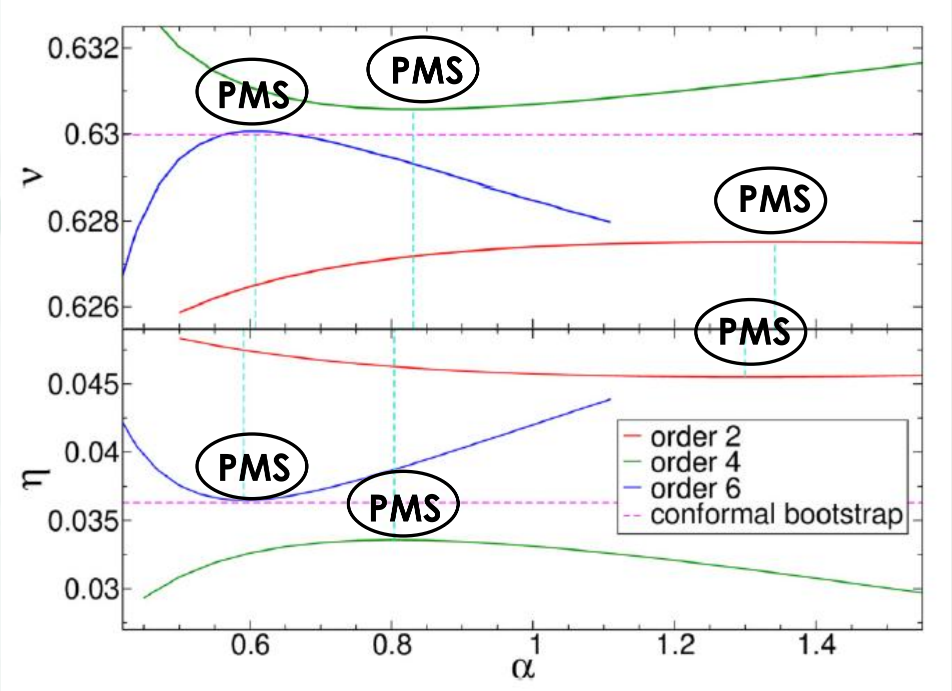
+

APPROXIMATIONS
(e.g. DERIVATIVE EXPANSION)

α-DEPENDENT RESULTS
(AND REGULATOR FAMILY)

PRINCIPLE OF MINIMAL SENSITIVITY **PMS**
(GOOD CONVERGENCE PROPERTIES)

Balog et al.



The derivative expansion… how it works?

$$\left(\sum_{i=1}^{n-1} D_\varphi^{p_i} + D_\varphi - d + \varphi D_\varphi \partial_\varphi\right)\Gamma_k^{(n,0)}(P_{n-1}) = \int_q \dot{R}(q)\, H^{(n,0)}(q, P_{n-1}, q')$$

$$\left(\sum_{i=1}^{n} D_\varphi^{p_i} - d + \varphi D_\varphi \partial_\varphi\right)\Gamma_k^{(n,1)}(P_n) = \int_q \dot{R}(q)\, H^{(n,1)}(q, P_n, q')$$

$\mathcal{D}\Gamma_k^{(\mathrm{n},0)}$

$\mathcal{D}\Gamma_k^{(\mathrm{n},1)}$

Typical diagrams

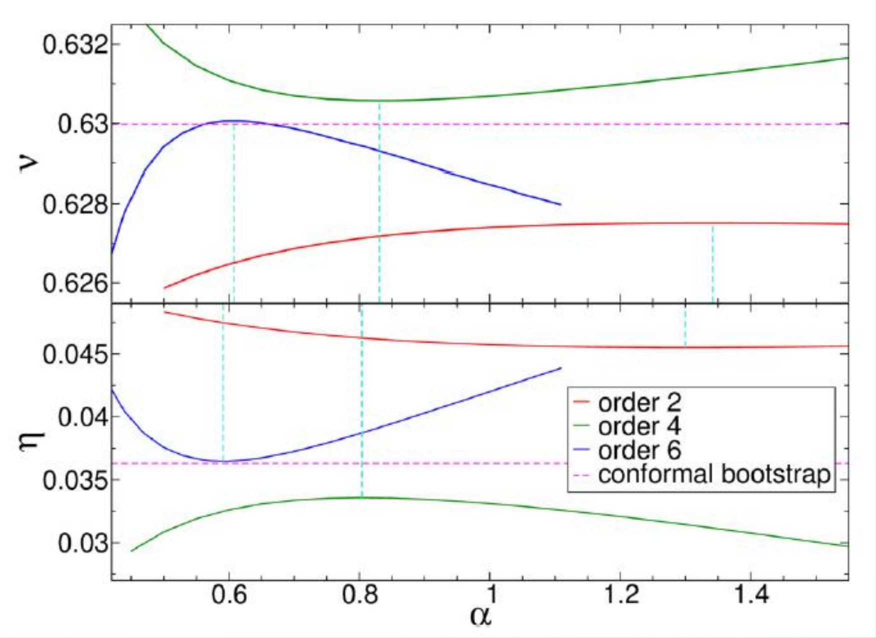
$\mathcal{O}(\partial^2)$

$$\Gamma_k[\varphi] = \int_x \Big\{ U_0(\rho) + \frac{1}{2} Z_0(\rho)\partial_\mu\varphi\partial_\mu\varphi + K(x)\left[U_1(\rho) + \frac{1}{2} Z_1(\rho)\partial_\mu\varphi\partial_\mu\varphi\right] - \Upsilon(\rho)\partial^2 K(x)\Big\}$$

STRUCTURE	FIXES
$\mathcal{D}\Gamma_k^{(1,0)}$	U_0'
$\mathcal{D}\Gamma_k^{(2,0)}$	Z_0
$\mathcal{D}\Gamma_k^{(1,1)}$	U_1', Υ'
$\mathcal{D}\Gamma_k^{(2,1)}$	Z_1

U_0', Z_0, U_1' and Z_1
yield
λ
(critical
exponents)

Υ decouples



The derivative expansion… how it works?

$$
\begin{aligned}
\Gamma_k[\varphi,K] = \int_x \, & U_0(\varphi) + U_1(\varphi)\,K(x) + \frac{1}{2}\left[Z_0(\varphi) + K(x)\,Z_1(\varphi)\right](\partial_\mu\varphi)^2 \\
& + \frac{1}{2}\left[W_{a0}(\varphi) + K(x)\,W_{a1}(\varphi)\right](\partial_\mu\partial_\nu\varphi)^2 \\
& + \frac{1}{2}\left[W_{b0}(\varphi) + K(x)\,W_{b1}(\varphi)\right]\varphi\,(\partial_\mu\varphi)(\partial_\nu\varphi)(\partial_\mu\partial_\nu\varphi) \\
& + \frac{1}{2}\left[W_{c0}(\varphi) + K(x)\,W_{c1}(\varphi)\right](\partial_\mu\varphi)^2(\partial_\nu\varphi)^2 \\
& + Y_a(\varphi)\,\varphi\,(\partial_\mu K(x))(\partial_\mu\varphi) + Y_b(\varphi)\,\varphi\,(\partial_\mu\partial_\nu K(x))(\partial_\mu\partial_\nu\varphi) \\
& + Y_c(\varphi)(\partial_\mu K(x))(\partial_\nu\varphi)(\partial_\mu\partial_\nu\varphi) + Y_d(\varphi)(\partial_\mu\varphi)(\partial_\nu\varphi)(\partial_\mu\partial_\nu K(x)) \\
& + Y_e(\varphi)\,\varphi\,(\partial_\mu\varphi)^2(\partial_\nu\varphi)(\partial_\nu K(x))
\end{aligned}
$$

$\boldsymbol{\beta_0}$

$$
\begin{aligned}
\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} &= 0\\
\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} &= 0\\
\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} &= 0\\
\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} &= 0\\
\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)} &= 0
\end{aligned}
$$

$\boldsymbol{\beta_1}$

$$
\begin{aligned}
\mathcal{D}_{U_1'}\Gamma_k^{(1,1)} &= 0\\
\mathcal{D}_{Z_1}\Gamma_k^{(2,1)} &= 0\\
\mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} &= 0\\
\mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} &= 0\\
\mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)} &= 0
\end{aligned}
$$

β_0 and β_1 yield λ's (crit. exp)
(it yields F.P. and perturbations)

$\boldsymbol{\beta_Y}$

$$
\begin{aligned}
\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} &= 0\\
\mathcal{D}_{Y_b}\Gamma_k^{(1,1)} &= 0\\
\mathcal{D}_{Y_c}\Gamma_k^{(2,1)} &= 0\\
\mathcal{D}_{Y_d}\Gamma_k^{(2,1)} &= 0\\
\mathcal{D}_{Y_e}\Gamma_k^{(3,1)} &= 0
\end{aligned}
$$

β_Y spares and decouples

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A new armour… conformal symmetry constraints

$$\left(\sum_{i=1}^{n-1} K^{\mu}_{p_i,\varphi} - 2\varphi D_\varphi \partial_{q_\mu}\right) \Gamma_k^{(n,0)}(q, P_{n-1})\Big|_{q=0} = -\int_q \dot{R}(q)\left(\partial_{q_\mu} + \partial_{q'_\mu}\right) H^{(n,0)}(q, P_{n-1}, q')\Big|_{q'=-q}$$

$$\mathcal{C}_\mu \, \Gamma_k^{(3,0)} = 0$$

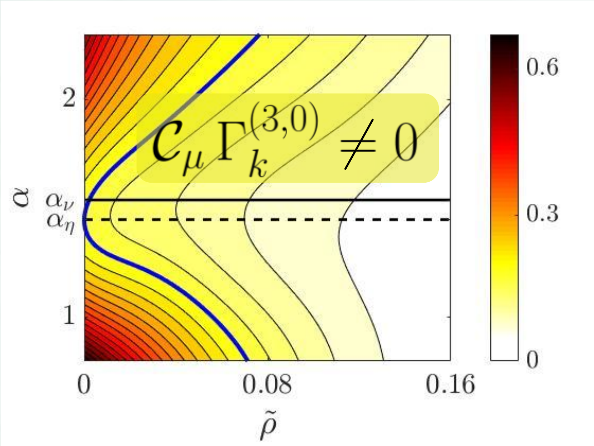
Constraints

See J. Ibañez poster

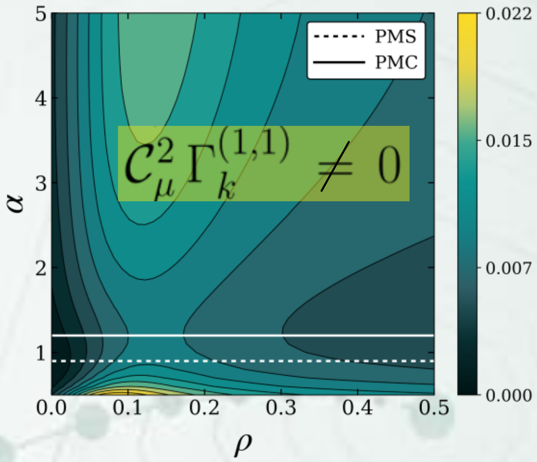
$$\left(\sum_{i=1}^{n} K^{\mu}_{p_i,\varphi} - 2\varphi D_\varphi \partial_{q_\mu}\right) \Gamma_k^{(n,1)}(q, P_n)\Big|_{q=0} = -\int_q \dot{R}(q)\left(\partial_{q_\mu} + \partial_{q'_\mu}\right) H^{(n,1)}(q, P_n, q')\Big|_{q'=-q}$$

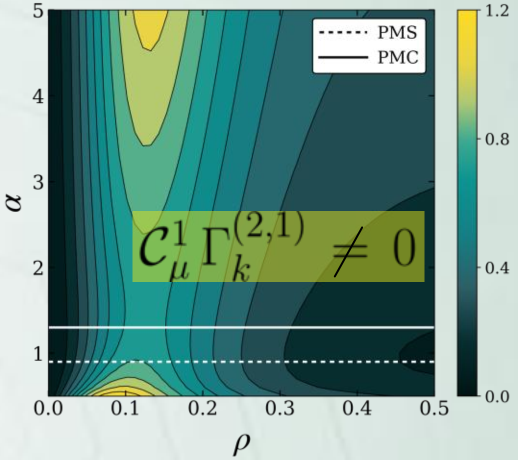
$$\begin{aligned}
\mathcal{C}^1_\mu \, \Gamma_k^{(1,1)} &= 0\\
\mathcal{C}^2_\mu \, \Gamma_k^{(1,1)} &= 0\\
\mathcal{C}^1_\mu \, \Gamma_k^{(2,1)} &= 0\\
\mathcal{C}^2_\mu \, \Gamma_k^{(2,1)} &= 0\\
\mathcal{C}_\mu \, \Gamma_k^{(3,1)} &= 0
\end{aligned}$$

A new armour… conformal symmetry constraints

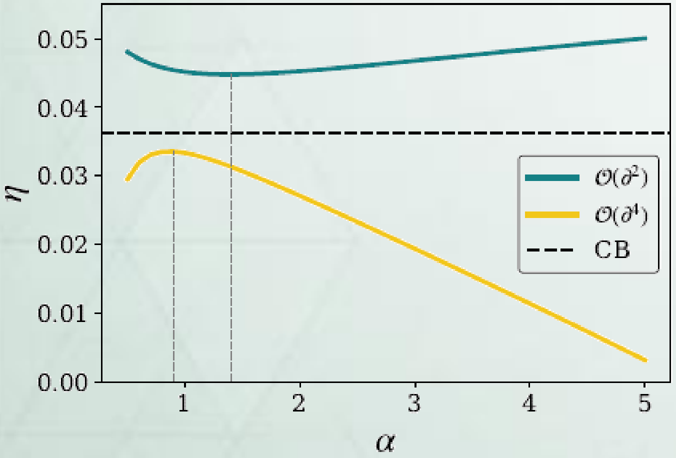


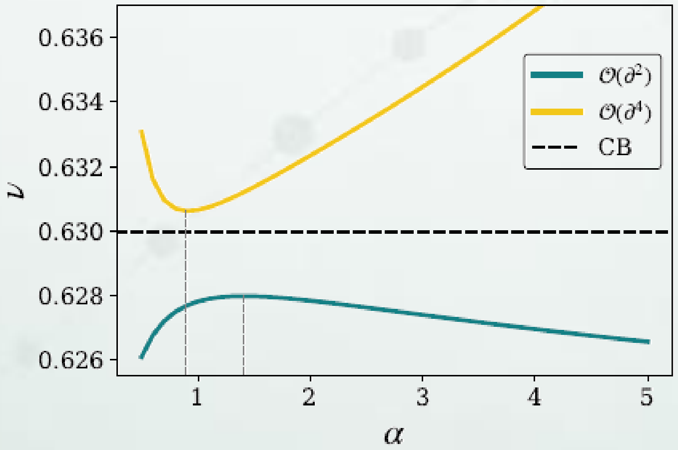
So… where's the armour?

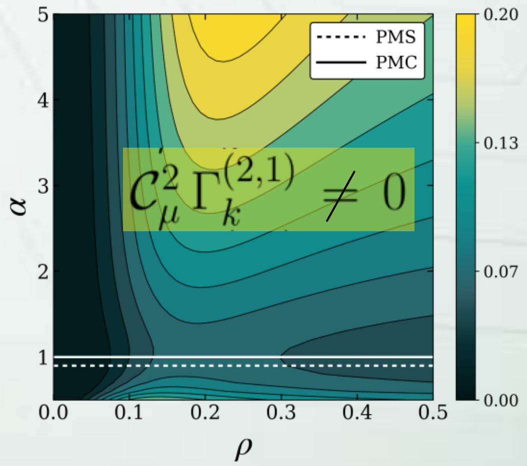


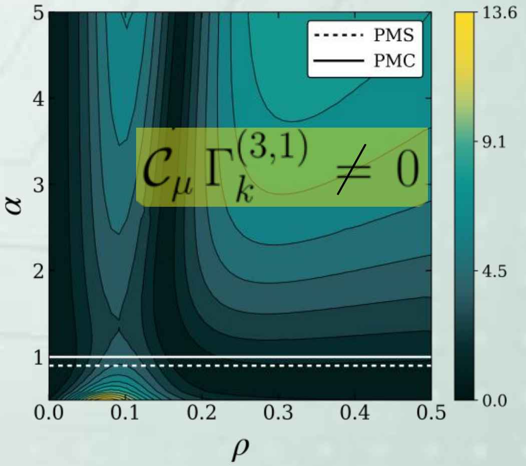


See arxiv:2401.02517









A new armour… conformal symmetry constraints

Fixed point and homog. perturb.

$$\mathcal{D}_{U'_0}\Gamma_k^{(1,0)} = 0 \qquad \mathcal{D}_{U'_1}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{Z_1}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0 \qquad \mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} = 0$$

$$\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)} = 0 \qquad \mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)} = 0$$

$$\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Y_b}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Y_c}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{Y_d}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{Y_e}\Gamma_k^{(3,1)} = 0$$

$$\mathcal{C}^1_\mu\,\Gamma_k^{(1,1)} = 0$$

$$\mathcal{C}^2_\mu\,\Gamma_k^{(1,1)} = 0$$

$$\mathcal{C}^1_\mu\,\Gamma_k^{(2,1)} = 0$$

$$\mathcal{C}^2_\mu\,\Gamma_k^{(2,1)} = 0$$

$$\mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0$$

$$\mathcal{C}_\mu\,\Gamma_k^{(3,1)} = 0$$

OUTLINE

The context: Critical phenomena and the FRG

The hero: The derivative expansion

A new armour: Conformal symmetry

Taming the beast: A conformal DE

Takeaways/Conclusions

A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0 \qquad \mathcal{D}_{U_1'}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{Z_1}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0 \qquad \mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} = 0$$

$$\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)} = 0 \qquad \mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)} = 0$$

$$\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} = 0 \qquad \mathcal{C}_\mu^1\,\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Y_b}\Gamma_k^{(1,1)} = 0 \qquad \mathcal{C}_\mu^2\,\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Y_c}\Gamma_k^{(2,1)} = 0 \qquad \mathcal{C}_\mu^1\,\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{Y_d}\Gamma_k^{(2,1)} = 0 \qquad \mathcal{C}_\mu^2\,\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{Y_e}\Gamma_k^{(3,1)} = 0 \qquad \mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0$$

$$\mathcal{C}_\mu\,\Gamma_k^{(3,1)} = 0$$

Replace higher order vertices dilatation constraint by lower order vertices conformal constraints

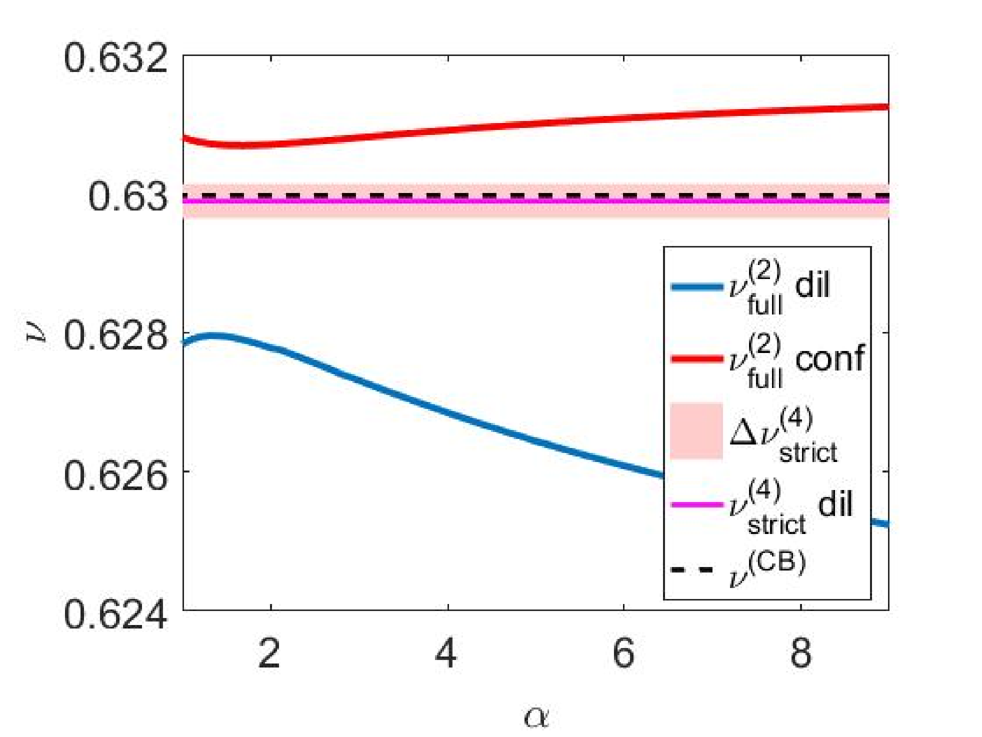
A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0 \qquad \mathcal{D}_{U_1'}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0 \qquad \cancel{\mathcal{D}_{Z_1}\Gamma_k^{(2,1)}} = 0$$

DE vs CDE at $O(\partial^2)$

$$\boxed{\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} = 0} \qquad \boxed{\mathcal{C}_\mu^1\,\Gamma_k^{(1,1)} = 0}$$



A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0$$

$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0$$

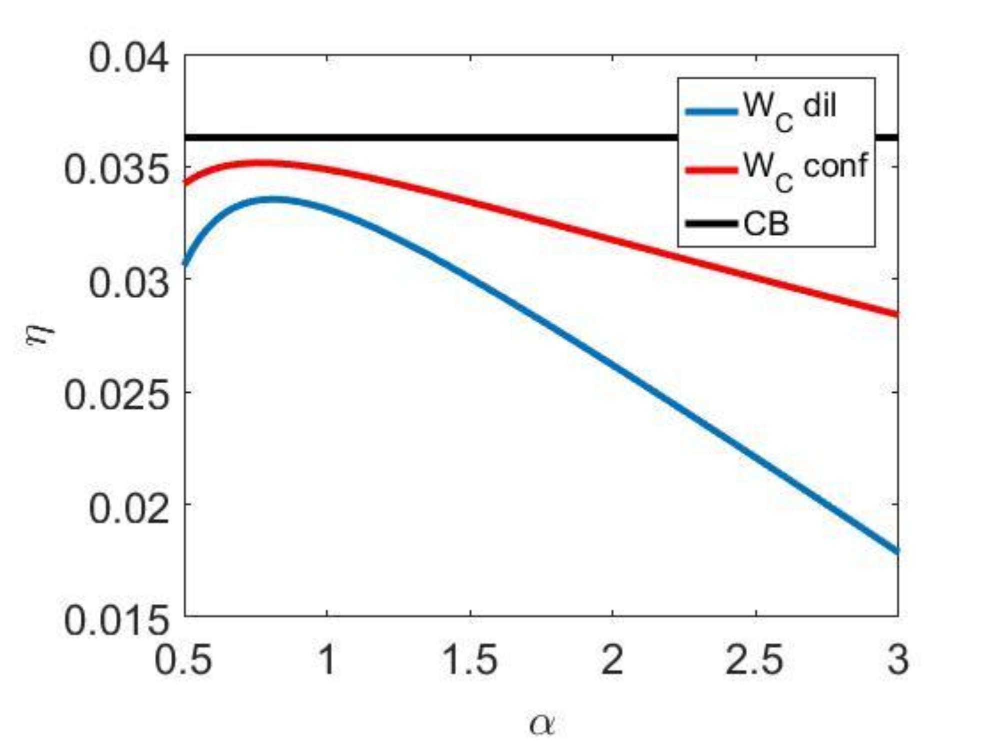
$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0$$

$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0$$

$$\mathcal{D}_{W_{c0}}\cancel{\Gamma_k^{(4,0)}} = 0$$

DE vs CDE at $\mathcal{O}(\partial^4)$

without comp. op.



$$\boxed{\mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0}$$

A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0 \qquad \mathcal{D}_{U_1'}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{Z_1}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0 \qquad \mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} = 0$$

$$\cancel{\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)}} = 0 \qquad \cancel{\mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)}} = 0$$

$$\boxed{\begin{aligned} \mathcal{D}_{Y_a}\Gamma_k^{(1,1)} &= 0 \\ \mathcal{D}_{Y_b}\Gamma_k^{(1,1)} &= 0 \\ \mathcal{D}_{Y_c}\Gamma_k^{(2,1)} &= 0 \\ \mathcal{D}_{Y_d}\Gamma_k^{(2,1)} &= 0 \\ \mathcal{D}_{Y_e}\Gamma_k^{(3,1)} &= 0 \end{aligned}}$$

$$\boxed{\mathcal{C}_\mu^1\,\Gamma_k^{(1,1)} = 0}$$

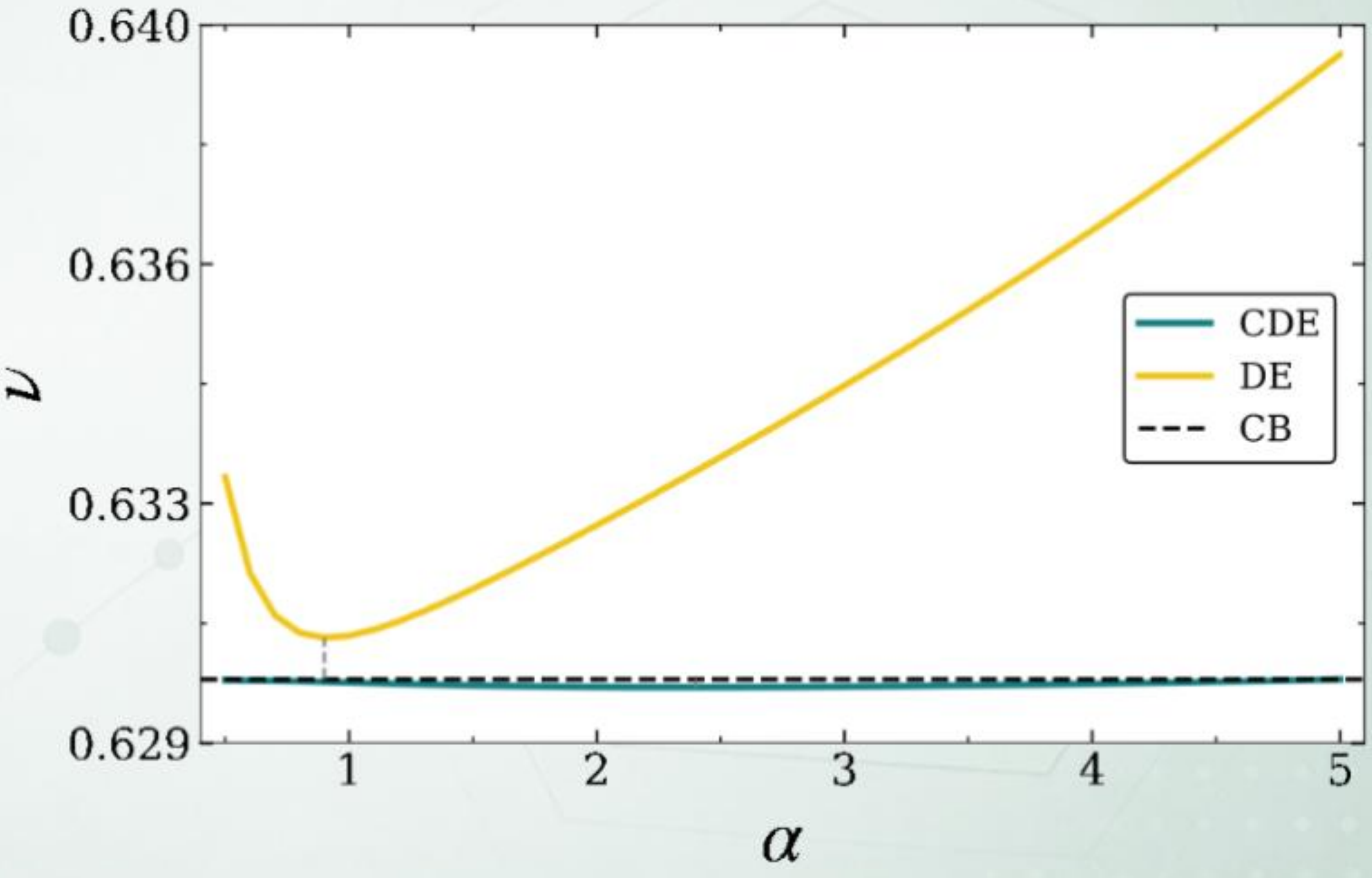
$$\mathcal{C}_\mu^2\,\Gamma_k^{(1,1)} = 0$$

$$\mathcal{C}_\mu^1\,\Gamma_k^{(2,1)} = 0$$

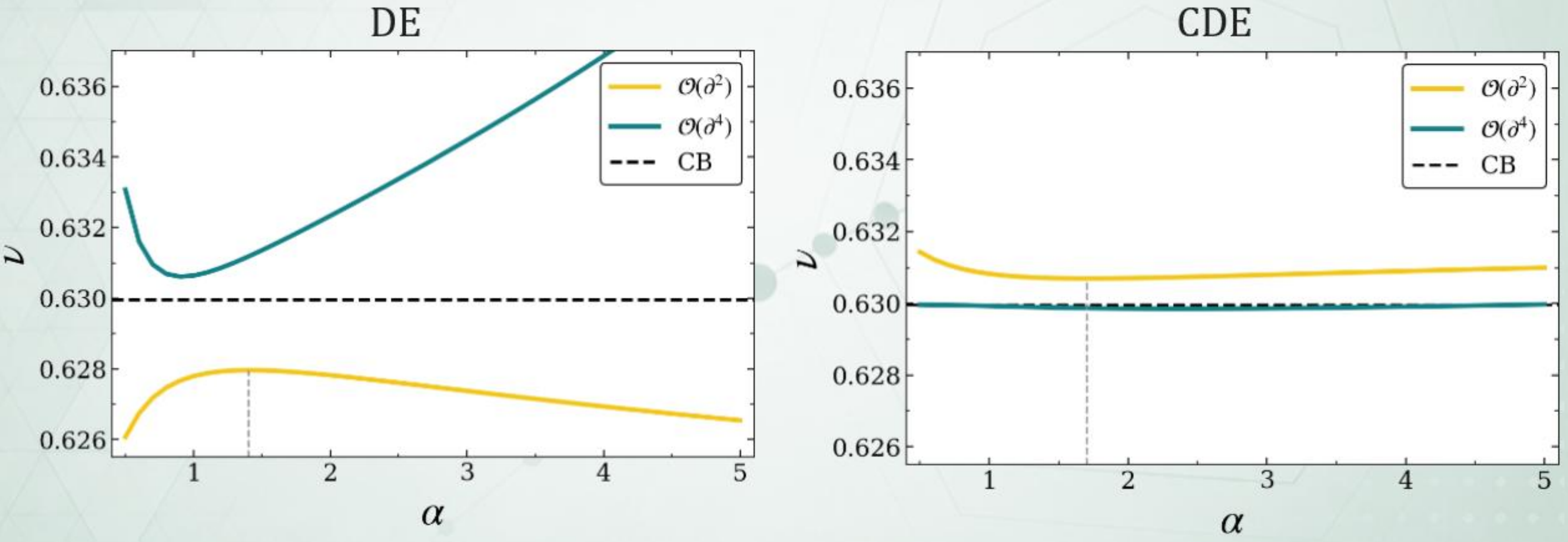
$$\mathcal{C}_\mu^2\,\Gamma_k^{(2,1)} = 0$$

$$\boxed{\mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0}$$

$$\mathcal{C}_\mu\,\Gamma_k^{(3,1)} = 0$$



A conformal derivative expansion (CDE)

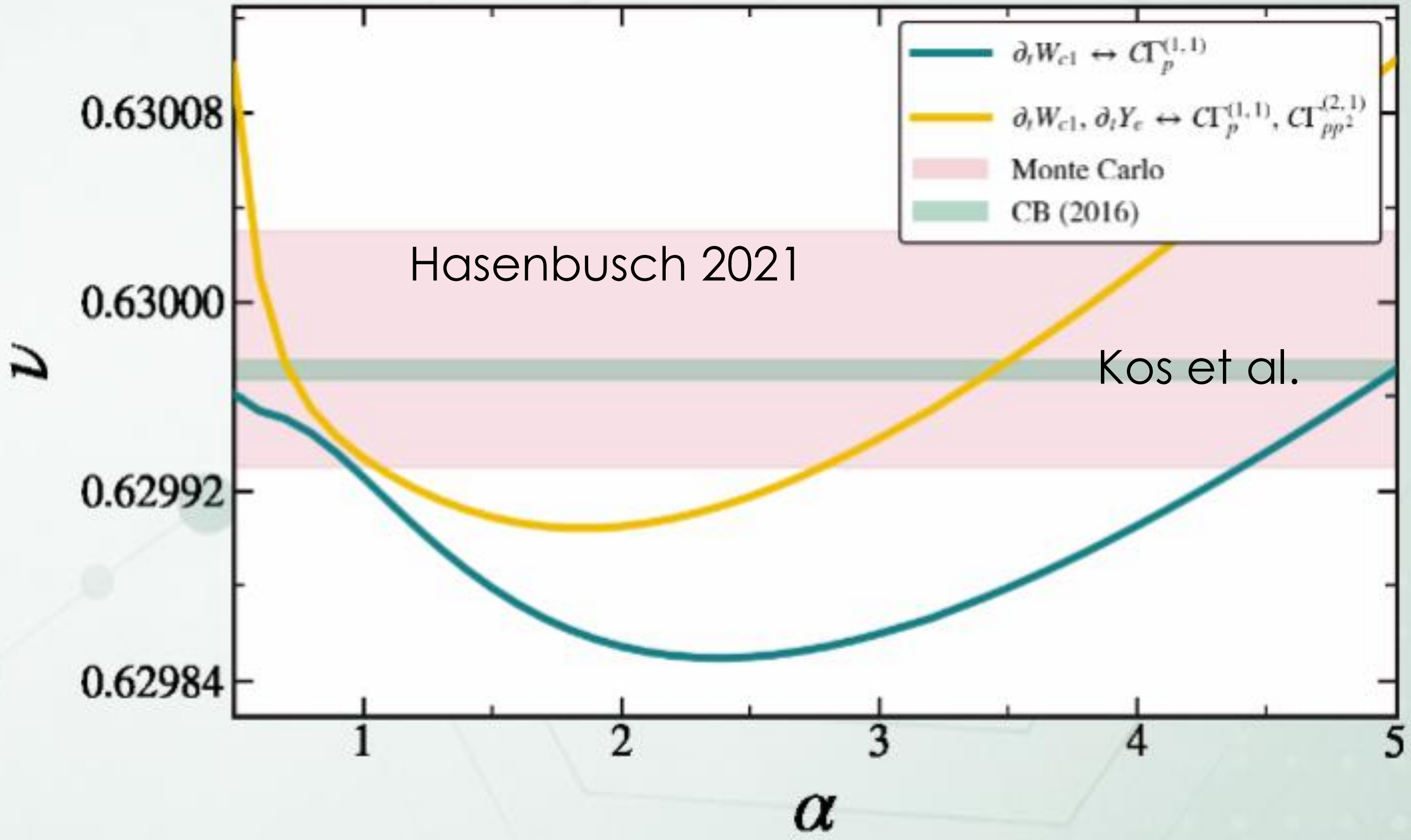


A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0 \qquad \mathcal{D}_{U_1'}\Gamma_k^{(1,1)} = 0$$
$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{Z_1}\Gamma_k^{(2,1)} = 0$$
$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} = 0$$
$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0 \qquad \mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} = 0$$
$$\cancel{\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)}} = 0 \qquad \cancel{\mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)}} = 0$$

$$\boxed{\begin{aligned}\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} &= 0\\ \mathcal{D}_{Y_b}\Gamma_k^{(1,1)} &= 0\\ \mathcal{D}_{Y_c}\Gamma_k^{(2,1)} &= 0\\ \mathcal{D}_{Y_d}\Gamma_k^{(2,1)} &= 0\end{aligned}}$$
$$\cancel{\mathcal{D}_{Y_e}\Gamma_k^{(3,1)}} = 0$$

$$\boxed{\mathcal{C}^1_\mu\,\Gamma_k^{(1,1)} = 0}$$
$$\mathcal{C}^2_\mu\,\Gamma_k^{(1,1)} = 0$$
$$\boxed{\mathcal{C}^1_\mu\,\Gamma_k^{(2,1)} = 0}$$
$$\mathcal{C}^2_\mu\,\Gamma_k^{(2,1)} = 0$$
$$\boxed{\mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0}$$
$$\mathcal{C}_\mu\,\Gamma_k^{(3,1)} = 0$$



Not shown: Chang et al. (2025, ~30x better)

A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0 \qquad \mathcal{D}_{U_1'}\Gamma_k^{(1,1)} = 0$$

$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{Z_1}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0 \qquad \mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} = 0$$

$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0 \qquad \mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} = 0$$

$$\cancel{\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)}} = 0 \qquad \cancel{\mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)}} = 0$$

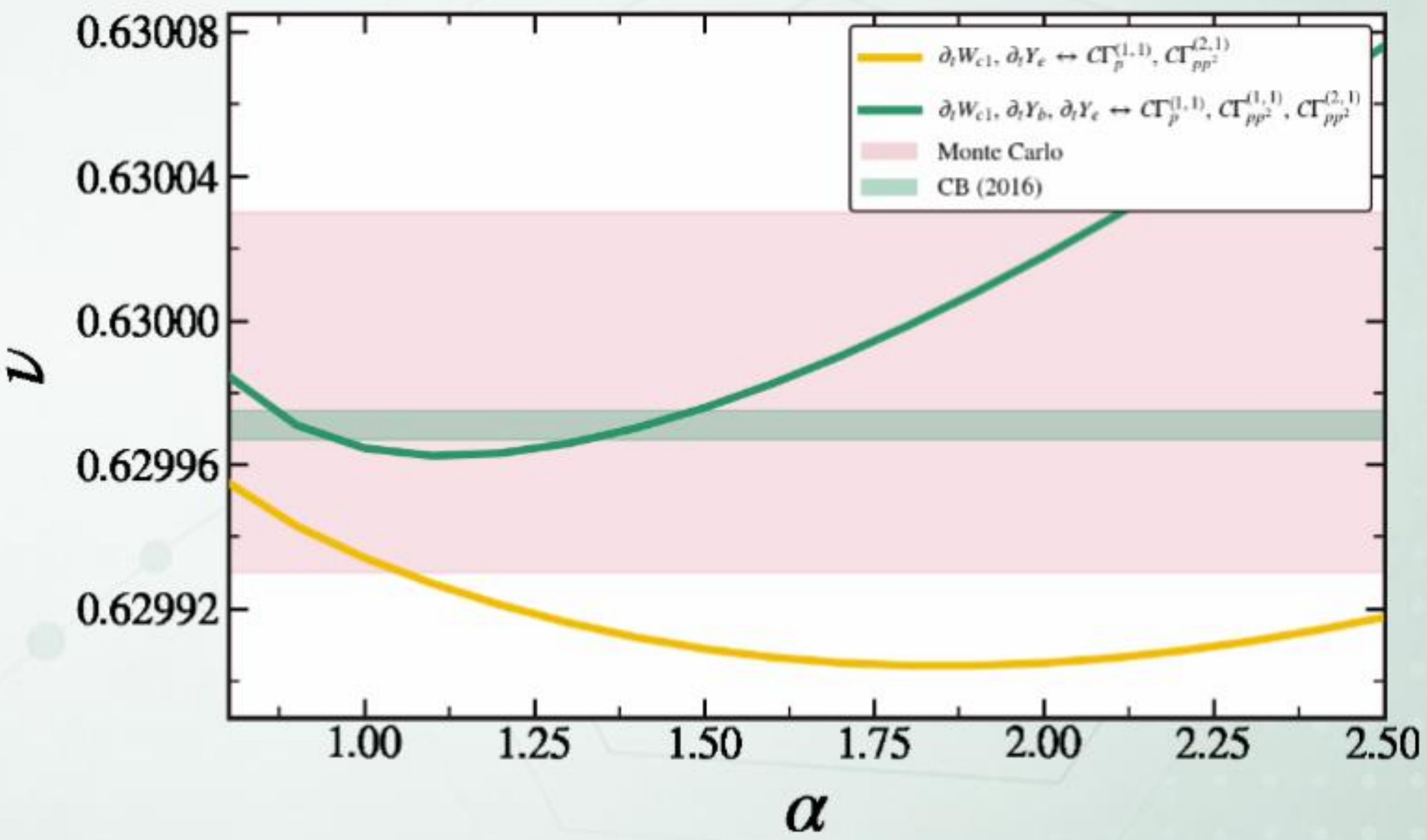
$$\boxed{\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} = 0} \qquad \boxed{\mathcal{C}_\mu^1\,\Gamma_k^{(1,1)} = 0}$$

$$\cancel{\mathcal{D}_{Y_b}\Gamma_k^{(1,1)}} = 0 \qquad \boxed{\mathcal{C}_\mu^2\,\Gamma_k^{(1,1)} = 0}$$

$$\boxed{\begin{aligned}\mathcal{D}_{Y_c}\Gamma_k^{(2,1)} &= 0 \\ \mathcal{D}_{Y_d}\Gamma_k^{(2,1)} &= 0\end{aligned}} \qquad \begin{aligned}&\boxed{\mathcal{C}_\mu^1\,\Gamma_k^{(2,1)} = 0} \\ &\mathcal{C}_\mu^2\,\Gamma_k^{(2,1)} = 0\end{aligned}$$

$$\cancel{\mathcal{D}_{Y_e}\Gamma_k^{(3,1)}} = 0 \qquad \boxed{\mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0}$$

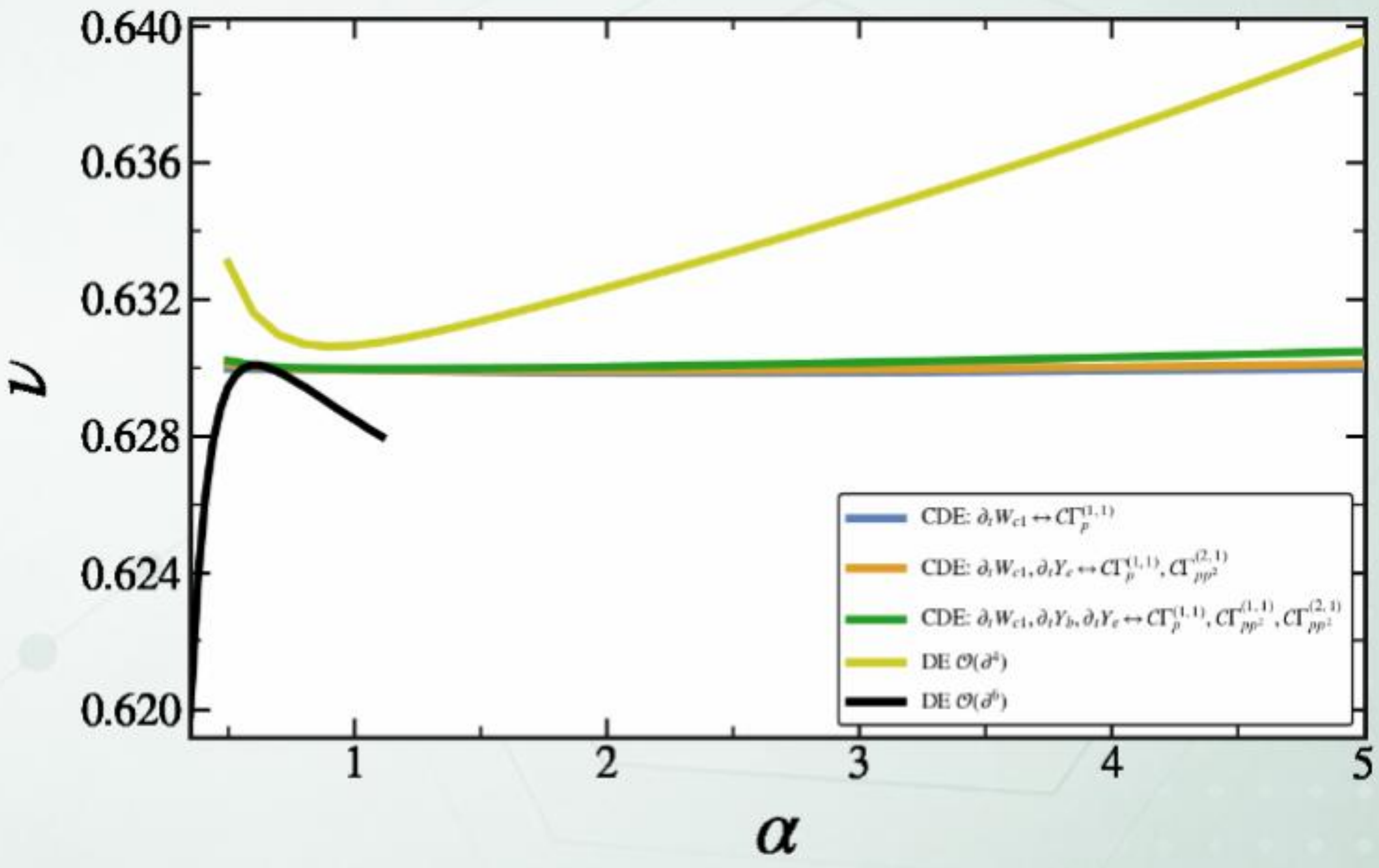
$$\mathcal{C}_\mu\,\Gamma_k^{(3,1)} = 0$$



A conformal derivative expansion (CDE)

$$\mathcal{D}_{U_0'}\Gamma_k^{(1,0)} = 0$$
$$\mathcal{D}_{Z_0}\Gamma_k^{(2,0)} = 0$$
$$\mathcal{D}_{W_{a0}}\Gamma_k^{(2,0)} = 0$$
$$\mathcal{D}_{W_{b0}}\Gamma_k^{(3,0)} = 0$$
$$\cancel{\mathcal{D}_{W_{c0}}\Gamma_k^{(4,0)}} = 0$$
$$\boxed{\mathcal{D}_{Y_a}\Gamma_k^{(1,1)} = 0}$$
$$\cancel{\mathcal{D}_{Y_b}\Gamma_k^{(1,1)}} = 0$$
$$\boxed{\begin{aligned}\mathcal{D}_{Y_c}\Gamma_k^{(2,1)} &= 0\\ \mathcal{D}_{Y_d}\Gamma_k^{(2,1)} &= 0\end{aligned}}$$
$$\cancel{\mathcal{D}_{Y_e}\Gamma_k^{(3,1)}} = 0$$

$$\mathcal{D}_{U_1'}\Gamma_k^{(1,1)} = 0$$
$$\mathcal{D}_{Z_1}\Gamma_k^{(2,1)} = 0$$
$$\mathcal{D}_{W_{a1}}\Gamma_k^{(2,1)} = 0$$
$$\mathcal{D}_{W_{b1}}\Gamma_k^{(3,1)} = 0$$
$$\cancel{\mathcal{D}_{W_{c1}}\Gamma_k^{(4,1)}} = 0$$
$$\boxed{\mathcal{C}_\mu^1\,\Gamma_k^{(1,1)} = 0}$$
$$\boxed{\mathcal{C}_\mu^2\,\Gamma_k^{(1,1)} = 0}$$
$$\boxed{\mathcal{C}_\mu^1\,\Gamma_k^{(2,1)} = 0}$$
$$\mathcal{C}_\mu^2\,\Gamma_k^{(2,1)} = 0$$
$$\boxed{\mathcal{C}_\mu\,\Gamma_k^{(3,0)} = 0}$$
$$\mathcal{C}_\mu\,\Gamma_k^{(3,1)} = 0$$



OUTLINE

Takeaways

- Conformal symmetry incorporation plays a determinant role for approximations to behave nicely.
- Results reduce their dependence with regulator profile (PMS is less crutial).
- Bonus: Numerical demand reduces with respect to the standard approach!! (better and cheaper!)
- **Future work:** Consider other universality classes and order $O(\partial^6)$, take it to BMW approximation, other ways of incorporating conformal symmetry

THANK YOU FOR YOUR ATTENTION

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