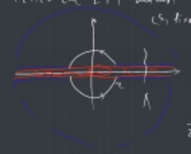
ithaca the EFT-bootstrap



$$\frac{1}{2\pi i}\oint \frac{A(p,t)}{p^3} = \int_1^\infty \frac{2\,dp}{\pi}\left(\frac{\mathrm{Im}\,A(p,t)}{p^3}\right)\Bigg|_{t=0}$$

$$A = g_2(s^2+t^2+u^2) + g_3\, stu + g_4(s^2+t^2+u^2)^2 + \dots$$

$$\frac{1}{2}A''(s)\Big|_{s=0,\,t=0} = g_2 = \int_1^\infty \frac{2}{\pi}\,dp\,\frac{\mathrm{Im}\,A(p,0)}{p^3} > 0$$

$$\frac{1}{2}(\partial\varphi)^2 + \alpha\varphi(\partial\varphi)^2 + \underbrace{\beta\varphi^4}_{g_2} \qquad \varphi \to \varphi + a_n x^n$$

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$$g_2^2 < 2g_4 \qquad \text{(1 01, 3987)}$$

(EFT)

$$M_n(t) = \frac{1}{2\pi i}\oint \frac{A(s,t)}{p^{n+1}}\,dp = \int_4^\infty \frac{\mathrm{Disc}\,A_s(p^2)}{p^{n+1}} + \int_4^\infty \frac{\mathrm{Disc}\,A_s(p,t)(-1)^n}{(p+t)^{n+1}} =$$

(a-anomalous)

$$T^\mu_\mu = \underline{a}E_4 - cW^2$$

$$0 < a_{35} < a_{34}$$

$$n=2, \to g_2 > 0$$

$$g_3$$

$$g_{2k} > 0$$

$$= \int_4^\infty dp\left(\frac{1}{p^{n+1}} + \frac{(-1)^n}{(p+t)^{n+1}}\right)(\mathrm{Disc})\sum_{\ell=0}^{\infty}(2\ell+1)\,\mathrm{Im}\,\delta_\ell(p)\,P_\ell\left(1+\frac{2t}{p}\right) =$$

$$\underline{M_n = \left[\left(\frac{1}{p^{n+1}} + \frac{1}{(p+t)^{n+1}}\right)P_\ell\left(1+\frac{2t}{p}\right)\right]} \qquad \left[X(p,t)\right] = \int_1^\infty dp\sum_{\ell=0}^{\infty}\mathrm{Im}\,\delta_\ell(p)(2\ell+1)\cdot X$$

$$M_2 = 2g_2 - g_3 t + 12 g_4 t^2 + \dots = \qquad M_2(t=0) = \left[\frac{2}{p^3}\right]$$

$$= \left[\frac{2}{p^3}\right] + \left[\frac{2\ell(\ell+1)-3}{p^4}\right]t + \left[\frac{\ell^4+2\ell^3-7\ell^2-8\ell+12}{2p^5}\right]t^2 + \dots$$

$$M_4 = 4g_4 = \left[\frac{2}{p^3}\right] + \dots \qquad g_2 = \left[\frac{2}{p^3}\right] > 0, \quad g_3 = \left[\frac{3-2\ell(\ell+1)}{p^4}\right], \quad g_4 = \left[\frac{1}{2p^5}\right]$$

$$M_6 = 8g_6 = \left[\frac{2}{p^3}\right] + \dots \qquad \left(\int fg\right)^2 < \left[f^2\right]\left(g^2\right)$$

$$g_6(s^2+t^2+u^2)^3 \qquad |A_{2,2}| < 18^2$$

$$\left(\frac{1}{\sqrt{M_2+\frac{1}{2}}}\right)\left(2-\frac{1}{p^2}+\frac{t^2}{p^4}\right) \qquad 6M_4 = \frac{\partial^2}{\partial t^2}M_2 \qquad \left[\frac{12}{p^5}\right] = \left[\frac{\ell^4+2\ell^3-7\ell^2-8\ell+12}{p^5}\right]$$

null constraint

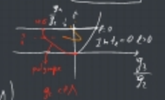
$$\left[\frac{\ell^2}{p^3}\right]^2 < \left[\frac{1}{p^3}\right]\left[\frac{\ell^4}{p^5}\right] \qquad \left[\frac{\ell(\ell+1)(\ell(\ell+1)-2)}{p^5}\right] = 0$$

$$\left[\frac{1}{p^3}\right]^2 < \left[\frac{1}{p^3}\right]\left[\frac{1}{p^5}\right] \qquad g_3 = \left[\frac{3}{p^4}\right] - 2\left[\frac{\ell(\ell+1)}{p^4}\right] < \left[\frac{3}{p^4}\right] \quad g_3$$

$$(2g_3)^2 < g_2 \cdot 4g_4 \qquad g_3 < \left[\frac{3}{p^4}\right] < 3\sqrt{\left[\frac{1}{p^3}\right]\left[\frac{1}{p^5}\right]} = 3\sqrt{g_2 \cdot 2g_4}$$

$$t>0$$

$$[f] = \int_1^\infty dp(\dots) \qquad \frac{1}{p^3} > \frac{1}{p^4} \qquad M>2$$



$$\int\frac{1}{p^3} > \int\frac{2\ell(\dots)}{p^5}$$

$$\left[\frac{1}{p^3}\right] > \left[\frac{1}{p^5}\right] \qquad \left[\frac{1}{p^3}\right] > \left[\frac{1}{p^4}\right] \quad (2\cdot 1 = 1)$$

$$\underline{g_3 < \frac{1}{2}g_2} \quad (2=1=1) \qquad \left[\frac{(\ell(\ell+1))^n}{p^{n+1}}\right] = \underline{a_{n0}} \text{ - moment} \qquad 0 < \mathrm{Im}\,\delta_\ell(2) \qquad a_{10}$$

$$2=1=1$$

1) positivity $a_{n0} > 0$

2) relaxing boundaries $a_{20} > a_{30} > a_{40} \dots a_{31} > a_{42} \dots$

3) $\begin{vmatrix} a_{00} & a_{10} & a_{20} \\ a_{10} & a_{20} & a_{30} \\ a_{20} & a_{30} & a_{40} \end{vmatrix} > 0, \quad \begin{vmatrix} a_{00} & a_{10} \\ a_{10} & a_{20} \end{vmatrix} > 0, \quad \begin{vmatrix} a_{20} & a_{21} \\ a_{21} & a_{22} \end{vmatrix} > 0$

Gram mat.

4) Polytope boundaries $L^2 = \ell(\ell+1) = 0, 6, 20$

$$\left[\frac{(L^2-6)(L^2-20)}{p^5}\right] > 0 \qquad (L^2-6)(L^2-20) > 0, \; L \in \qquad (L^2-20)(L^2-62) > 0$$

5) null constraints, $g_2, g_3, g_4 \to a_{52}, h_4, h_5 \dots$

lower bound on g_2

$$a_{40} - 26a_{41} + 120a_{42} \geq 0 \qquad a_{42} = 9a_{41}$$

$$a_{40} - 8a_{41} = 0 \text{ — null constraint} \qquad a_{41} = \frac{5}{20}a_{40}$$

$$\tilde{a} = \frac{a}{a_{00}} \qquad \tilde{a}_{32}^2 - \frac{40}{3}\tilde{a}_{30}\tilde{a}_{34} + \frac{160}{3}\tilde{a}_{30}^2 - \frac{80}{9}\tilde{a}_{40} < 0 \qquad \begin{vmatrix} 3\times 3 \end{vmatrix} > 0$$

$$0 < a_{10} < 1 \text{ — to project out}$$

$$\tilde{a}_{31} < f(\tilde{a}_{30}) \qquad \max(f)$$

$$0 < a_{32} < \sqrt{\frac{160}{3}\tilde{a}_{30}} \qquad 0 < \tilde{a}_{30} < \frac{5}{6} \qquad (\tilde{a}_{30} < 1)\; f'(\tilde{a}_{30}) = 0$$

$$a_{31} < \sqrt{\frac{80}{9}\left(\tilde{a}_{40} - 2\tilde{a}_{30}^2\right) + \frac{20}{3}\tilde{a}_{30}}, \quad \frac{5}{6} < \tilde{a}_{40} < 1$$