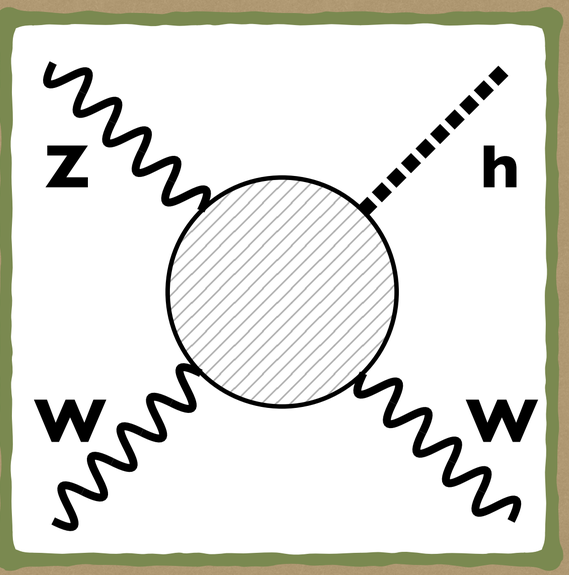
AMPLITUDES FOR BEYOND STANDARD MODEL PHYSICS

In three papers, w/ my collaborators (Arzate, Bradshaw, Chen, Jacobo, Liu, Luty) fully characterized 3, 4-pt interactions of SM particles using Hilbert series and numerics, giving complete amplitude basis

(See also work by Shadmi et.al. and Dong et.al.)

E.g. Amplitudes for ZW→Wh for Wh production at Muon Collider

i	$\mathcal{O}_i^{hWWZ}$
1	$h\widetilde{W}^+_{\mu\nu}W^{-\mu}Z^{\nu}+\text{h.c.}$
2	$ih\widetilde{W}^+_{\mu\nu}W^{-\mu}Z^{\nu}+\text{h.c.}$
3	$ih\widetilde{Z}_{\mu\nu}W^{+\mu}W^{-\nu}+\text{h.c.}$
4	$ihD^{\mu}W^{+\nu}W^-_{\mu}Z_{\nu}+\text{h.c.}$
5	$hD^{\mu}W^{+\nu}W^-_{\mu}Z_{\nu}+\text{h.c.}$
6	$ihD^{\mu}W^{+\nu}W^-_{\nu}Z_{\mu}+\text{h.c.}$
7	$hD^{\mu}W^{+\nu}W^-_{\nu}Z_{\mu}+\text{h.c.}$
8	$ihZ^{\mu\nu}W^+_{\mu}W^-_{\nu}$
9	$h\partial^{\mu}Z^{\nu}W^+_{\mu}W^-_{\nu}+\text{h.c.}$
10	$h\partial_{\mu}W^+_{\alpha\beta}\widetilde{W}^{-\alpha\beta}Z^{\mu}+h.c.$
11	$ih\partial_{\mu}W^+_{\alpha\beta}\widetilde{W}^{-\alpha\beta}Z^{\mu}+\text{h.c.}$
12	$h\partial^{\mu}W^+_{\alpha\beta}\widetilde{Z}^{\alpha\beta}W^-_{\mu}+h.c.$
13	$ih\partial^{\mu}W^+_{\alpha\beta}\widetilde{Z}^{\alpha\beta}W^-_{\mu}+\text{h.c.}$
14	$h\partial^{\mu}Z_{\alpha\beta}\widetilde{W}^{+\alpha\beta}W^-_{\mu}+h.c.$
15	$ih\partial^{\mu}Z_{\alpha\beta}\widetilde{W}^{+\alpha\beta}W^-_{\mu}+\text{h.c.}$
16	$h\partial^{\mu}W^{+\alpha}\widetilde{W}^-_{\alpha\beta}\partial^{\beta}Z_{\mu}+\text{h.c.}$
17	$ih\partial^{\mu}W^{+\alpha}\widetilde{W}^-_{\alpha\beta}\partial^{\beta}Z_{\mu}+\text{h.c.}$
18	$ih\partial^{\alpha}W^+_{\mu}\widetilde{W}^-_{\alpha\beta}\partial^{\mu}Z^{\beta}+\text{h.c.}$
19	$ih\partial^{\delta}W^+_{\mu}\widetilde{W}^-_{\beta\delta}\partial^{\beta}Z^{\mu}+\text{h.c.}$
20	$ih\partial^{\mu\nu}W^+_{\rho}\partial^{\rho}W^-_{\mu}Z_{\nu}+\text{h.c.}$
21	$h\partial^{\mu\nu}W^+_{\rho}\partial^{\rho}W^-_{\mu}Z_{\nu}+\text{h.c.}$
22	$ih\partial^{\mu\nu}W^+_{\rho}\partial^{\rho}Z_{\mu}W^-_{\nu}+\text{h.c.}$
23	$h\partial^{\mu\nu}W^+_{\rho}\partial^{\rho}Z_{\mu}W^-_{\nu}+\text{h.c.}$
24	$ih\partial^{\mu\nu}Z_{\rho}\partial^{\rho}W^+_{\mu}W^-_{\nu}+\text{h.c.}$
25	$h\partial^{\mu\nu}Z_{\rho}\partial^{\rho}W^+_{\mu}W^-_{\nu}+\text{h.c.}$
26	$ih\partial^{\mu}W^+_{\nu}\partial^{\nu}W^-_{\rho}\partial^{\rho}Z_{\mu}+\text{h.c.}$
27	$h\partial^{\mu}W^+_{\nu}\partial^{\nu}W^-_{\rho}\partial^{\rho}Z_{\mu}+\text{h.c.}$



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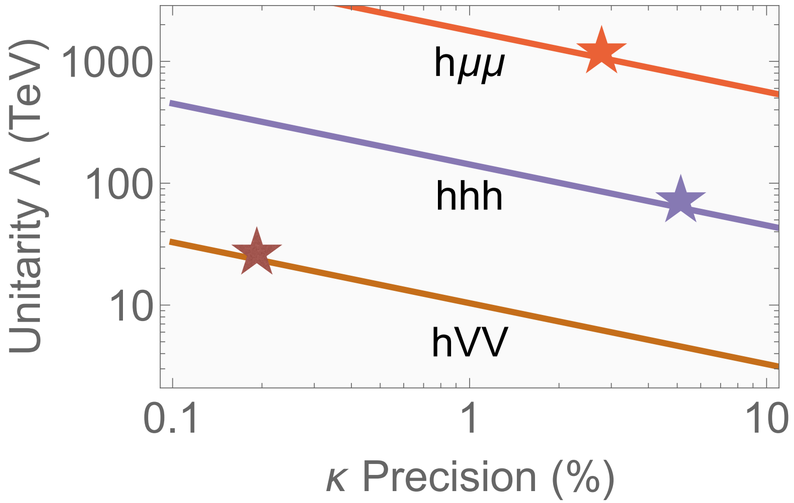
APPLICATIONS FOR NEW PHYSICS SEARCHES

Unitarity bounds (w/ Abu-Ajamieh, Chen, Luty)

Nonstandard interactions predict max energy scale for new physics



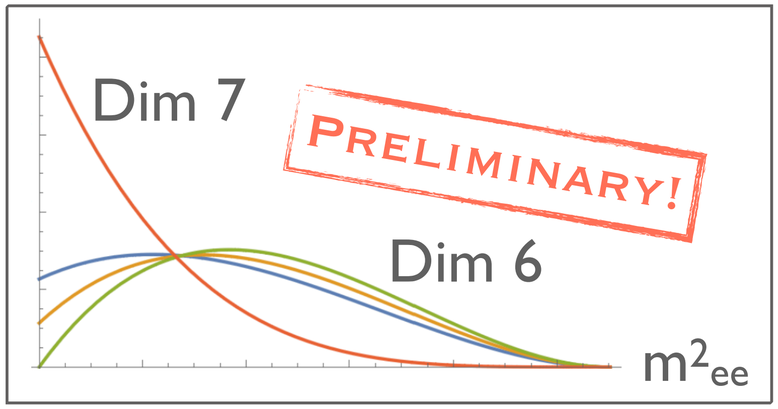
(See also muon no lose theorem)

General searches for new physics (In progress w/ Driscoll)

$\mu \to e e \bar{e}$

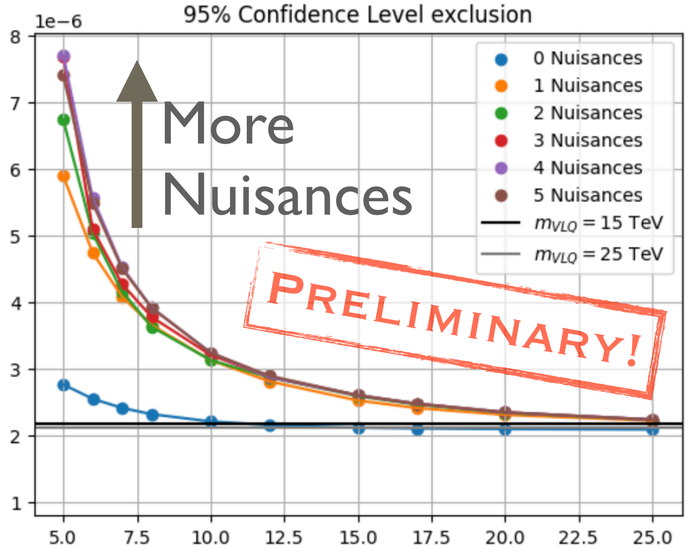
Dimension 7 operators have distinctive distributions, e.g.

$$(\bar{\mu}_L \gamma^\alpha e_L)(\bar{e}_L D_\alpha e_R)$$



Higher order uncertainties (In progress w/ Bozzone, Luty, Ma, Wulzer)

Marginalize over higher order Uncertainties



EFT Cutoff

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Thanks!!!!

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2) Unitarity bounds: SC, Luty 1902.05556; Fałkowski, Rattazzi 1902.05936; Abu-Ajamieh, SC, Chen, Luty 2009.11293; Abu-Ajamieh 2112.13529, 2203.07410

3) g-2 Muon no lose theorem as an example of nonstandard interaction leading to bounded new physics: Capdevilla et.al. 2006.16277, 2101.10334, 2112.08377

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