

SHORT HW 8: Higher order interactions

COURSE: Physics 165, *Introduction to Particle Physics* (2018)

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DUE BY: **Thursday**, February 24

Note that this short assignment is due in class on Thursday.

1 Higher order interactions

Here's a summary of the fields in the Standard Model. (One generation of particles.)

	<u>SPIN</u>	<u>SU(3) COLOR</u>	<u>SU(2) WEAK</u>	<u>U(1) HYPER</u>
Q	Q^α	Q^m	$Q^a = \begin{pmatrix} u_L \\ d_L \end{pmatrix}$	$Y_Q = \frac{1}{6}$
\bar{U}	\bar{U}^α	\bar{U}_n	(none) $\bar{U} = u_R^\dagger$	$Y_{\bar{U}} = -\frac{2}{3}$
\bar{D}	\bar{D}^α	\bar{D}_n	(none) $\bar{D} = d_R^\dagger$	$Y_{\bar{D}} = +\frac{1}{3}$
L	L^α	(none)	$L^a = \begin{pmatrix} \nu_L \\ e_L \end{pmatrix}$	$Y_L = -\frac{1}{2}$
\bar{E}	\bar{E}^α	(none)	(none) $\bar{E} = e_R^\dagger$	$Y_{\bar{E}} = 1$
H	H	(none)	$H^a = \begin{pmatrix} H^1 \\ H^2 \end{pmatrix}$	$Y_H = \frac{1}{2}$
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G	G_μ	$G^m (T^m)^n_a$	(none)	(none)
W	W_μ	(none)	$W^a (T^a)^a_b$	(none)
B	B_μ	(none)	(none)	(none)

[**Flip:** Correction 3/1: Fixed hypercharge of \bar{D} , sign error. $Y_{\bar{D}} = +1/3$. Thanks Sergio.]

Write down three interactions that are gauge invariant (indices all contracted, net hypercharge zero) that we have *not* written in class. The net dimension of the fields should be greater than 4. For example, $|L^a \varepsilon_{ab} H^b|^2$ is a term with mass dimension 5.

Extra credit: once you get the hang of this, it's easy to make up arbitrarily crazy ones. Write down five more.

2 Reading

Read Prof. John Baez's article on **renormalizability**¹. Explain why the higher order interactions in problem 1 are only 'effective' interactions and not fundamental.

¹<http://math.ucr.edu/home/baez/renormalizability.html>