Theoretical comments on generic Z'

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Model building

•SM Yukawa couplings

$$y_d \bar{Q}_L H d_R + y_u \bar{Q}_L H^c u_R + y_l \bar{L}_L H e_R$$
$$H^c = i\sigma_2 H^*$$

$$Q = \begin{pmatrix} u \\ d \end{pmatrix} \qquad L = \begin{pmatrix} e \\ \nu \end{pmatrix}$$

•Consider set of U(1) charges for fermion fields and Higgs:

$$Z_{Q_L}, Z_{dR}, Z_{uR}, Z_{L_L}, Z_{eR}, Z_H$$
$$Z_{Hc} = -Z_H$$

•Consistency conditions (invariance of Yukawas)

$$Z_{Q_L} = Z_H + Z_{dR} = -Z_H + Z_{uR}$$
$$Z_{L_L} = Z_H + Z_{eR}$$

•Examples: hypercharge:

	Q_L	u_R	d_R	L_L	e_R	H
Y	$\frac{1}{6}$	$\frac{2}{3}$	$-\frac{1}{3}$	$-\frac{1}{2}$	-1	$\frac{1}{2}$

B-L:

	Q_L	u_R	d_R	L_L	e_R	H
$B-L$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	1	1	0

•Final step: add U(1) gauge boson Z' which gauges this symmetry with an arbitrary couling g(Z'), add by hand mass term $M^2_{Z'}(Z'_\mu)^2$

Comments on SSM

• (uL, dL) necessarily have equal Z' couplings
(same for (eL, νL))
=> sequential SM Z' (with couplings equal to those of Z) makes no sense

More precisely: differences between (uL, dL) couplings should be suppressed by $\frac{M_Z}{M_{Z'}} \to 0 \text{ as } v \to 0$

I.e. differences in couplings may appear only due to mixings

ElectroWeak Precision Tests

- Z-pole data (irrelevant if ZH=0)
- LEP2 data (4-fermion operators)

The Minimal Set of Electroweak Precision Parameters

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U(1)	universal?	Z_H	Z_L	Z_D	Z_U	Z_Q	Z_E	full
B'	yes	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{3}$	$-\frac{2}{3}$	$\frac{1}{6}$	1	6.7
$B-L$	no	0	-1	$-\frac{1}{3}$	$-\frac{1}{3}$	$\frac{1}{3}$	1	6.7
L	no	0	1	0	0	0	-1	6.3

99% CL *bounds on the ratio* $M_{Z'}/g_{Z'}$ *in* TeV