Portals to New SU(3) Exotics
The Lepton-Gluon Portal

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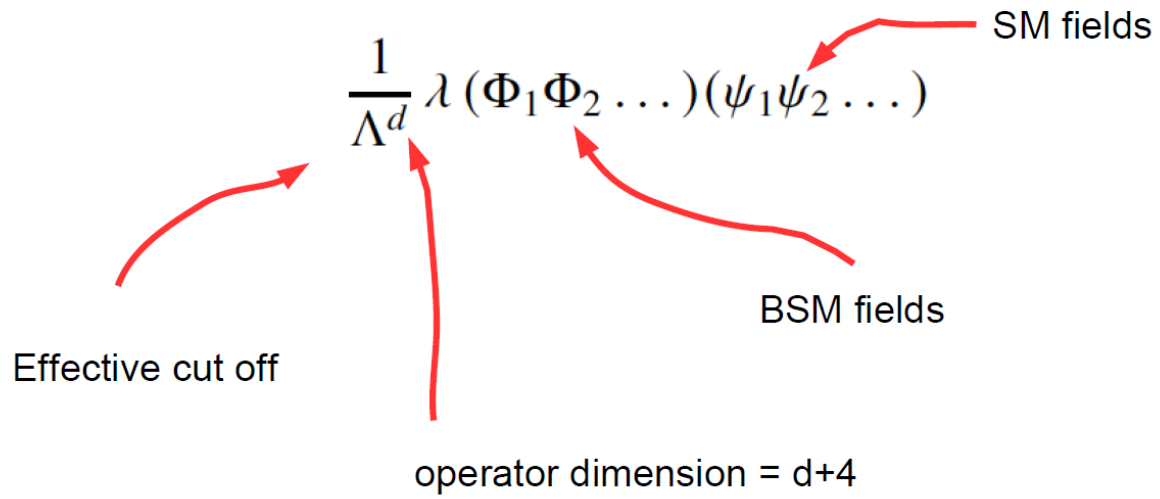
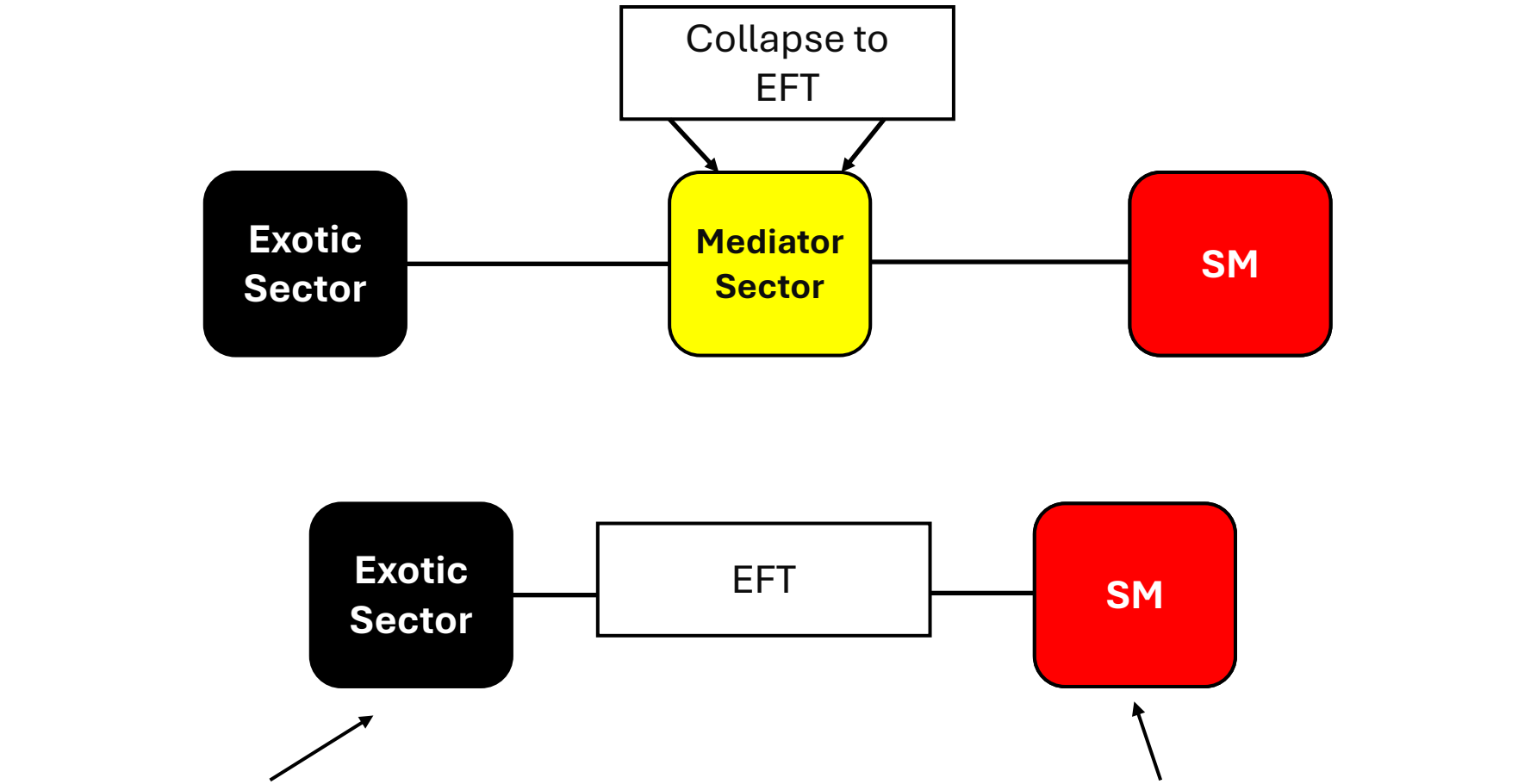
What Particles Could Be Accessed at Colliders?

- Agnostic Phenomenological Approach
- Use Effective Operator Analysis(Light Exotics Effective Field Theory) to Discover which Exotics could be Produced
- At This Stage do not Hold Theoretical Prejudice Against Exotic Types

New PHENO



- **Portal based**, pick a SM portal and write all possible LEX states that can couple through that portal (eg Higgs portal, lepton portal)

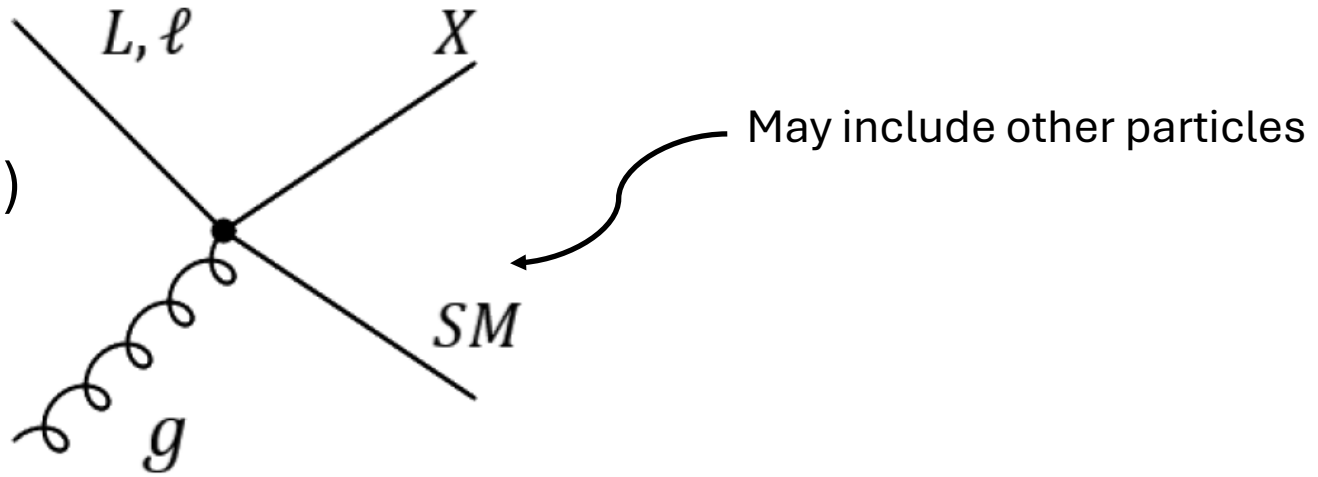


Find which exotic charges are reachable through collider processes

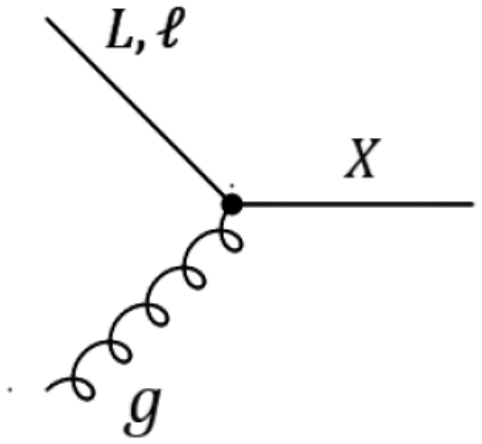
Lepton-Gluon Portal

Begin with unusual portals that allow access to fields of unusual color and weak charge

Must contain One LEX(Light Exotic State)
At least one Gluon And one Lepton



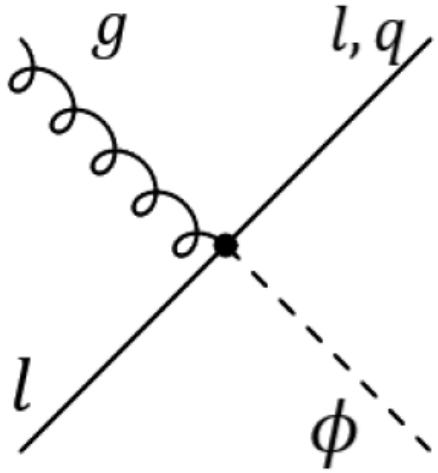
Guaranteed decay of exotic , also implies single production processes



Lepto-Gluons

$G_{\mu\nu}\bar{\ell}\sigma^{\mu\nu}\psi$	$(8,1,-1)$	0	1
$G_{\mu\nu}\bar{L}^{i}\sigma^{\mu\nu}\psi_i$	$(8,2,-1/2)$	0	1

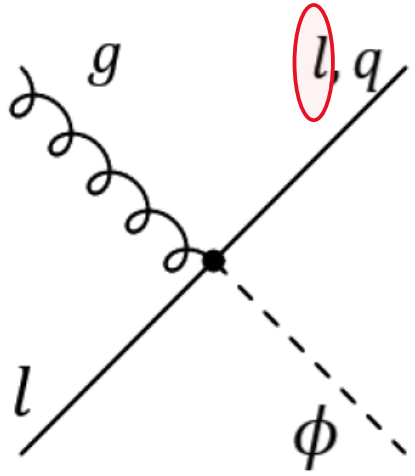
But There are More Unusual Exotics



Exotic Scalar Octets
Decays into SM particles-lepton +gluon+1 SM fermion

Very Exotic Scalar Octets

		B	L
$G_{\mu\nu}\overline{L^c}_i\sigma^{\mu\nu}L_j\phi^{ij}$	$(8,3,1)$	0	-2
$G_{\mu\nu}\bar{\ell}\sigma^{\mu\nu}L_i\phi^i$	$(8,2,-1/2)$	0	0
$G_{\mu\nu}\overline{L^c}^i\sigma^{\mu\nu}L_i\phi$	$(8,1,1)$	0	-2
$G_{\mu\nu}\overline{\ell^c}\sigma^{\mu\nu}\ell\phi$	$(8,1,2)$	0	-2

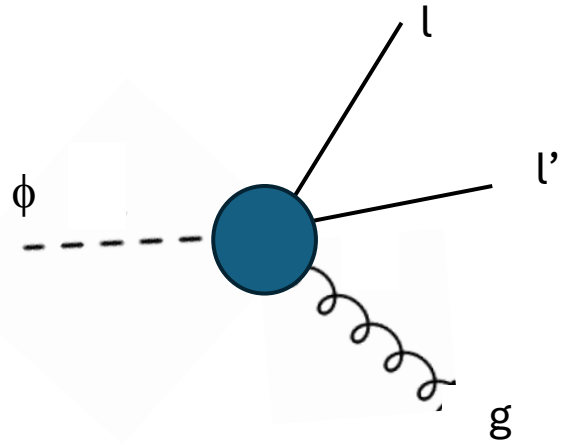


Vertex-LEX state 2 leptons 1 gluon

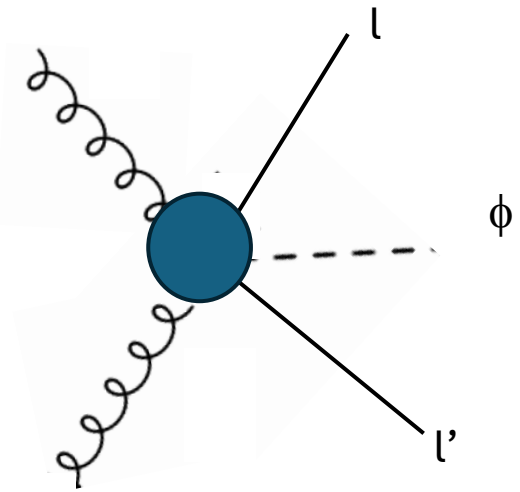
1) Color-Weak Bi-adjoint
2) Manohar Wise Field
3) Pure Color Octet
4) Doubly Charged color octet

Some exotic octets have multiple lepton number
The two leptons may be any flavor

Exotic Decay and Production Phenomenology



Three Body Decay of Octet Scalar to 2 leptons+jet
Possible Like-sign di-leptons from multiply charges object
Possible multi-flavor decay

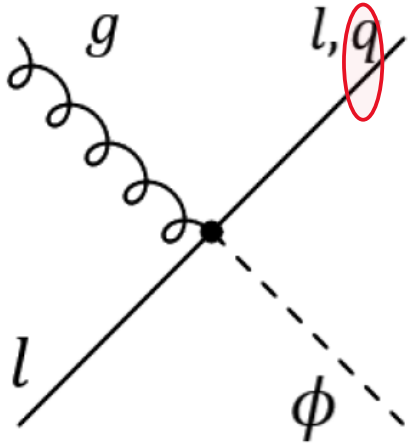


New Possible Decays for Manohar-Wise particle

2-3 single production process from gluon fusion
Possible multi-flavor production
Possible same sign leptons in event

		B	L
$G_{\mu\nu}\overline{L^c}_i\sigma^{\mu\nu}Q_{Lj}\phi^{ij}$	$(\overline{15},3,1/3),\ (6,3,1/3),\ (\overline{3},3,1/3)$	$-1/3$	-1
$G_{\mu\nu}\bar{\ell}\sigma^{\mu\nu}Q_{Li}\phi^{i}$	$(\overline{15},2,-7/6),\ (6,2,-7/6),\ (\overline{3},2,-7/6)$	$-1/3$	1
$G_{\mu\nu}\overline{L}^{i}\sigma^{\mu\nu}u\phi_i$	$(\overline{15},2,-7/6),\ (6,2,-7/6),\ (\overline{3},2,-7/6)$	$-1/3$	1
$G_{\mu\nu}\overline{L}^{i}\sigma^{\mu\nu}d\phi_i$	$(\overline{15},2,-1/6),\ (6,2,-1/6),\ (\overline{3},2,-1/6)$	$-1/3$	1
$G_{\mu\nu}\overline{\ell^c}\sigma^{\mu\nu}u\phi$	$(\overline{15},1,1/3),\ (6,1,1/3),\ (\overline{3},1,1/3)$	$-1/3$	-1
$G_{\mu\nu}\overline{\ell^c}\sigma^{\mu\nu}d\phi$	$(\overline{15},1,4/3),\ (6,1,4/3),\ (\overline{3},1,4/3)$	$-1/3$	-1
$G_{\mu\nu}\overline{L^c}^{i}\sigma^{\mu\nu}Q_{Li}\phi$	$(\overline{15},1,1/3),\ (6,1,1/3),\ (\overline{3},1,1/3)$	$-1/3$	-1

B

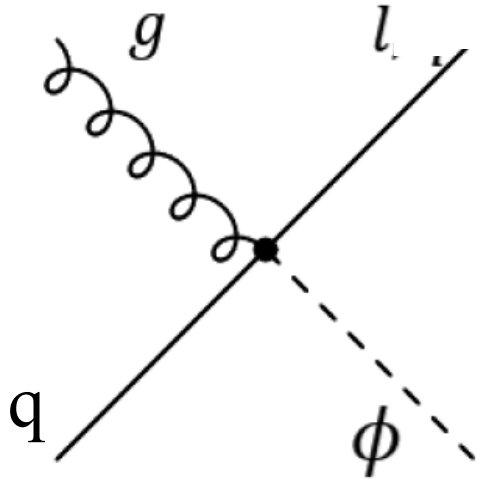


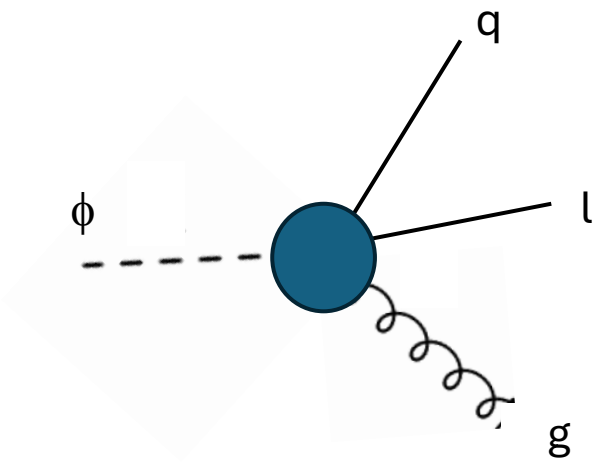
SU(3) Tensor Product Rule

$$8 \otimes 3 = 15 \oplus \overline{6} \oplus 3$$

15-Plets and Sextets Accessible
Some SU(2) Adjoints and Doublets
Unusual electric charges

Lepton-Associated Single Production

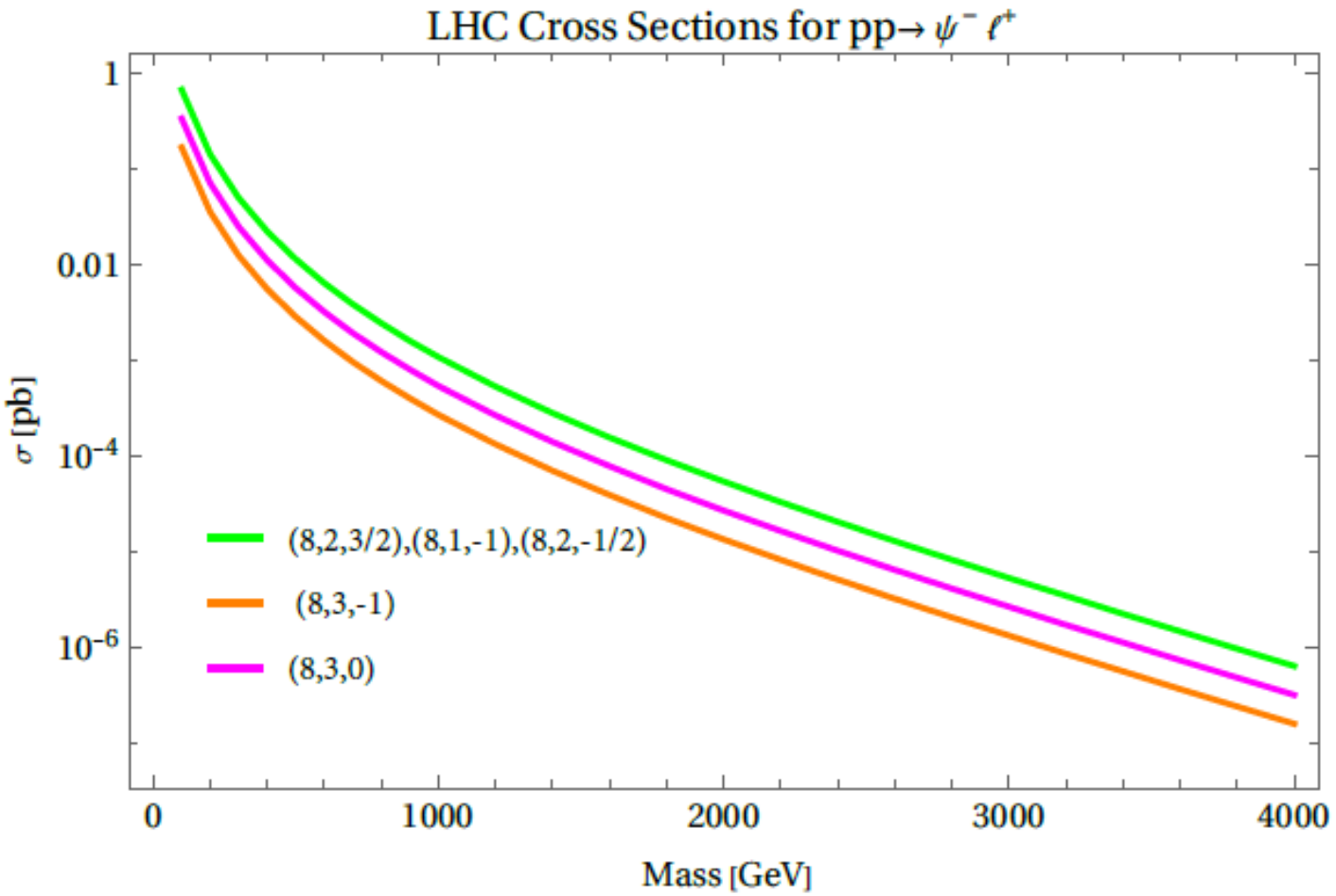


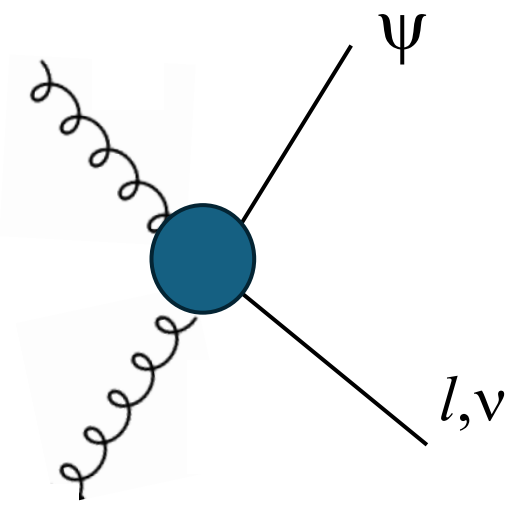


Three body Decay to 2j+l

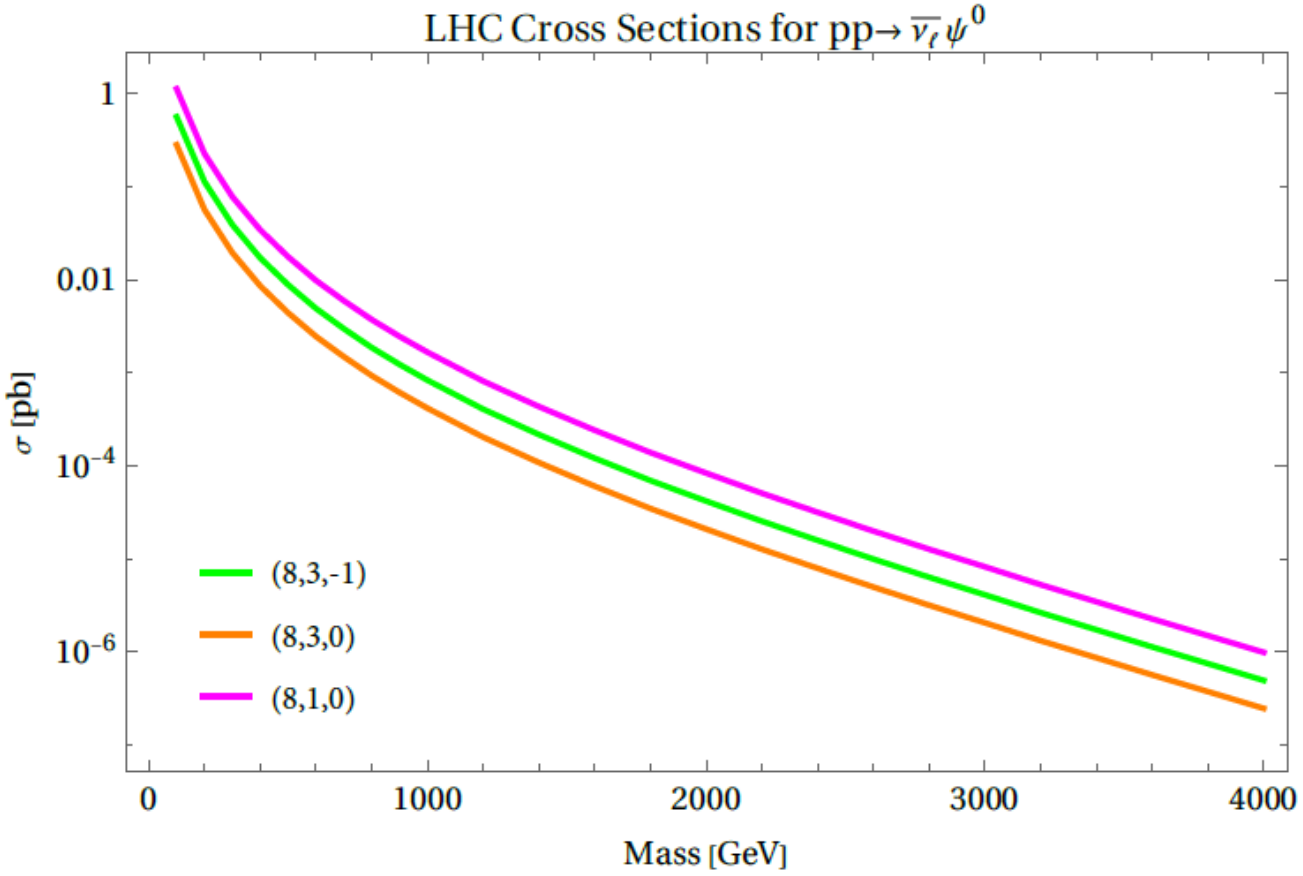
Some Exotic Fermionic Octets

		B	L	
$G_{\mu\nu}\overline{\ell}\sigma^{\mu\nu}\psi^i H_i$	$(8,2,3/2)$	0	1	FermionicDoublets
$G_{\mu\nu}\overline{\ell}\sigma^{\mu\nu}\psi_i H^{\dagger i}$	$(8,2,-1/2)$	0	1	
$G_{\mu\nu}\overline{L}^i\sigma^{\mu\nu}\psi_i^j H_j$	$(8,3,-1)$	0	1	FermionicBi-Adjoint
$G_{\mu\nu}\overline{L}^i\sigma^{\mu\nu}\psi H_i$	$(8,1,-1)$	0	1	Charged Fermionic Octet
$G_{\mu\nu}\overline{L}^i\sigma^{\mu\nu}\psi_{ij} H^{\dagger j}$	$(8,3,0)$	0	1	FermionicBi-Adjoint neutral
$G_{\mu\nu}\overline{L}^i\sigma^{\mu\nu}\psi H_i^\dagger$	$(8,1,0)$	0	1	Fermionic Pure Octet





Single Octet Production in Association with charged lepton



Single Octet Production in Association with neutrino

Producing More Extreme Exotics, Dimension 7

Fermionic Spin1/2 Exotics

$G_{\mu\nu}G^{\mu\nu}\bar{\ell}\psi$	$(1,1,-1),\ (8,1,-1),\ (10,1,-1),$ $(\overline{10},1,-1),\ (27,1,-1)$	0	1
$G_{\mu\nu}G^{\mu\nu}\overline{L^i}\psi_i$	$(1,2,-1/2),\ (8,2,-1/2),\ (10,2,-1/2),$ $(\overline{10},2,-1/2)(27,2,-1/2)$	0	1
$W^i_{\mu\nu j}G^{\mu\nu}\bar{\ell}\psi^j_i$	$(8,3,-1)$	0	1
$W^{ij}_{\mu\nu}G^{\mu\nu}\overline{L^k}\psi_{ijk}$	$(8,4,-1)$	0	1
$W^i_{\mu\nu j}G^{\mu\nu}\overline{L^j}\psi_i$	$(8,2,-1)$	0	1
$B_{\mu\nu}G^{\mu\nu}\bar{\ell}\psi$	$(8,1,-1)$	0	1
$B_{\mu\nu}G^{\mu\nu}\overline{L^i}\psi_i$	$(8,2,-1/2)$	0	1

$$8 \otimes 8 = 1 \oplus 8 \oplus 8 \oplus 10 \oplus \overline{10} \oplus 27$$

Can access 10 and 27 of SU(3)
Can access SU(2) quadruplet color octet
Can Access Unusual Fermionic Singlets

Conclusions

We don’t know what Nature Ordered but simply asking what states are hypothetically accessible provides large and unusual collection of possible exotics with strange collider signatures

Collider phenomenology becomes open to many more possibilities

We can open up new pockets in the theoretical landscape for further exploration making room for new paradigms