

# Theory Retreat

## Les Houches

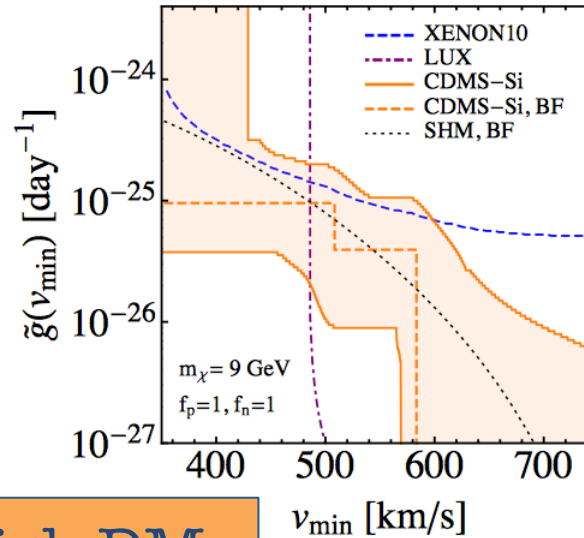
Matthew McCullough

My world-line: Belfast → Oxford → MIT → CERN

# Dark Matter Models and Methods:

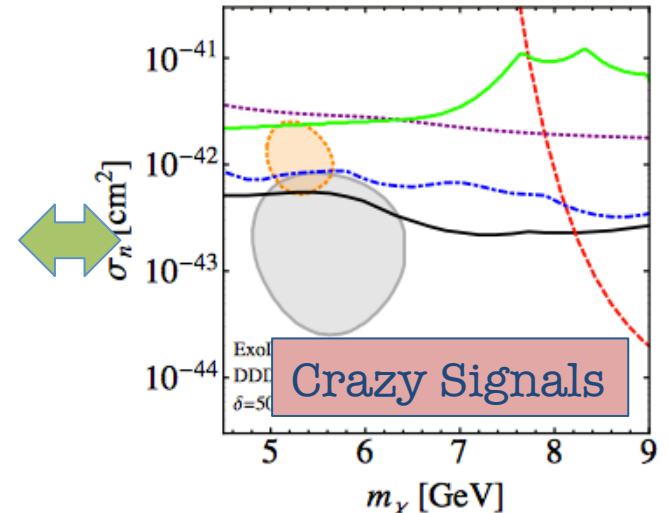
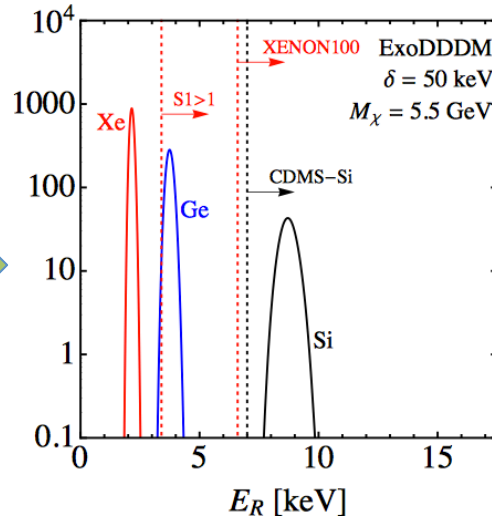
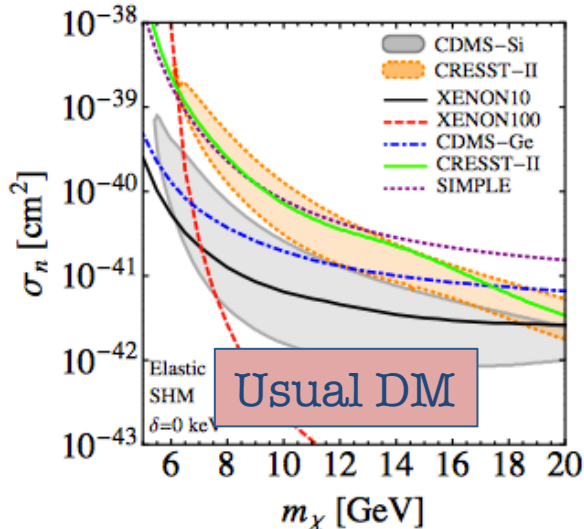
## Direct Detection

Halo-Independent Analysis Strategies:



With Fox, Kahn.  
JCAP and ongoing.

Exothermic Double-Disk DM

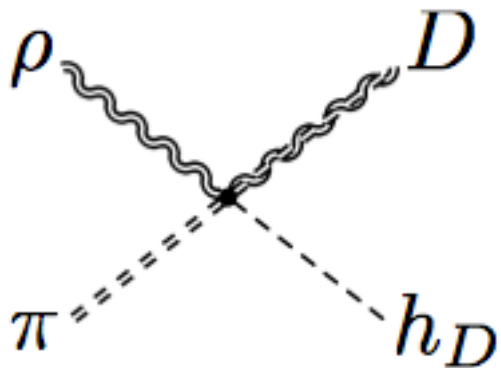


With Randall. JCAP.

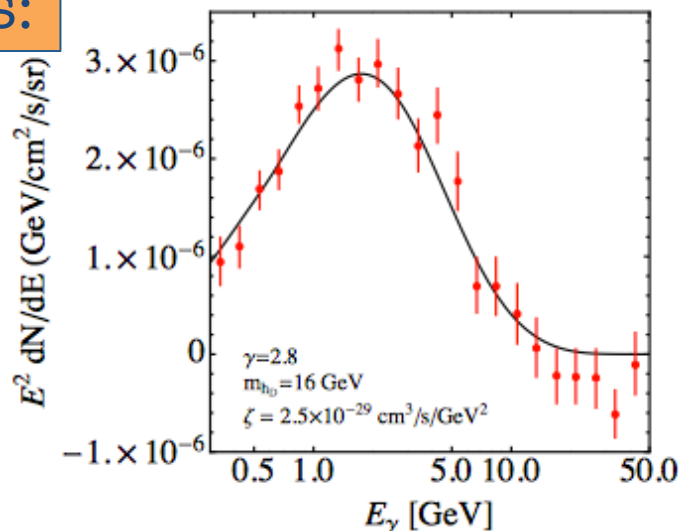
# Dark Matter Models: Indirect Detection

## Dark Nuclear Physics:

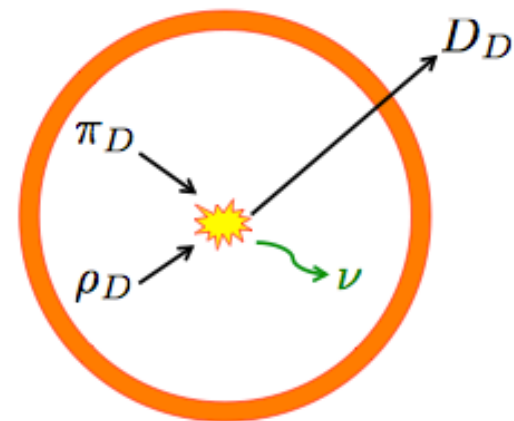
With Detmold, Pochinsky



Dark Nucleosynthesis



Ambulance Friendly

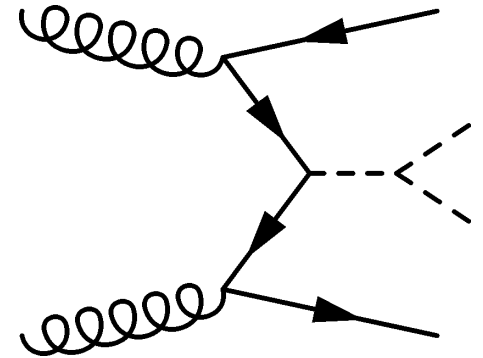
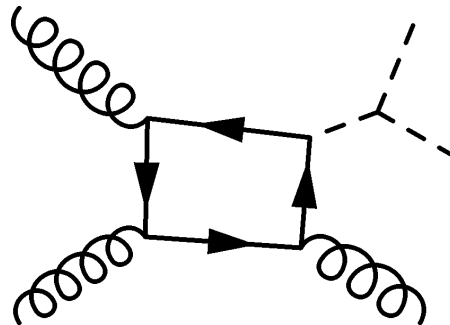
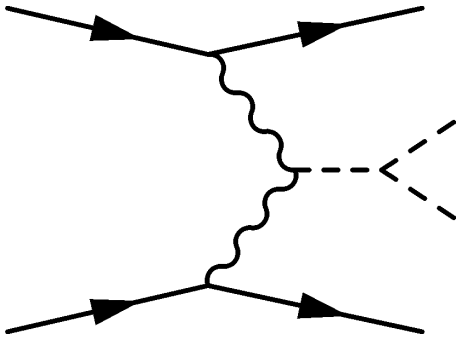


Crazy Signals

# Dark Matter Models: Collider Detection

Off-shell Higgs Portal.

Ongoing with Craig, Lou, and Thalapillil.



Modified detection strategies.

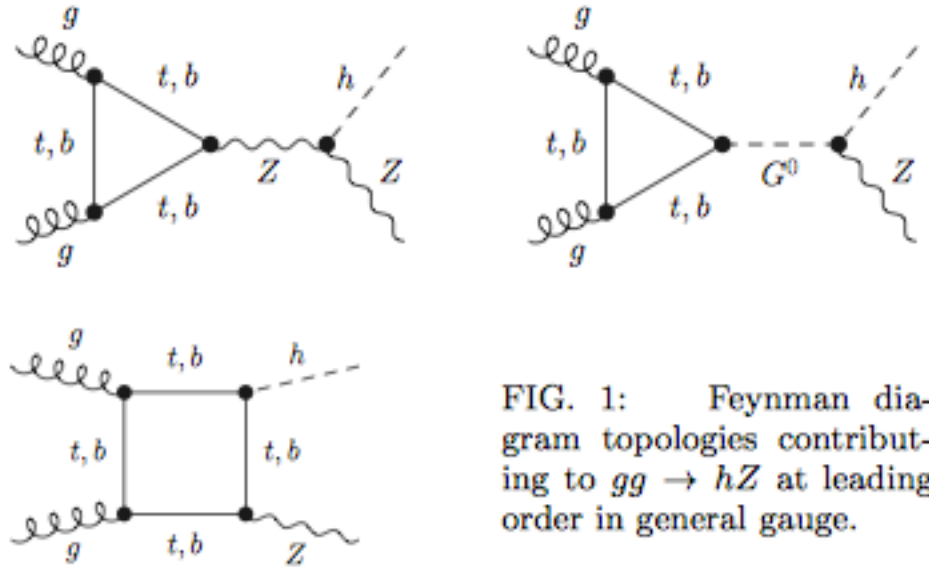
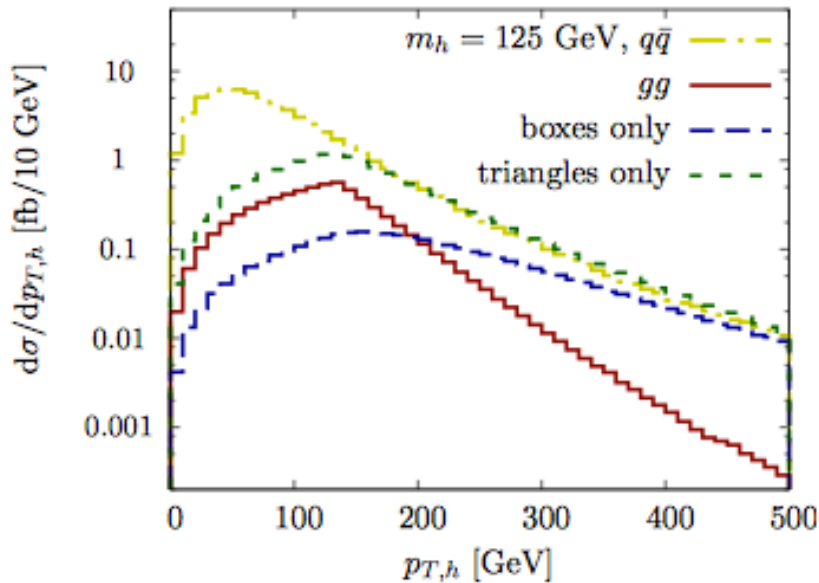
Ongoing with Barr.

Watch this space....

# BSM (and SM) Higgs: LHC

## Distributions and sub-leading production $gg \rightarrow hZ$

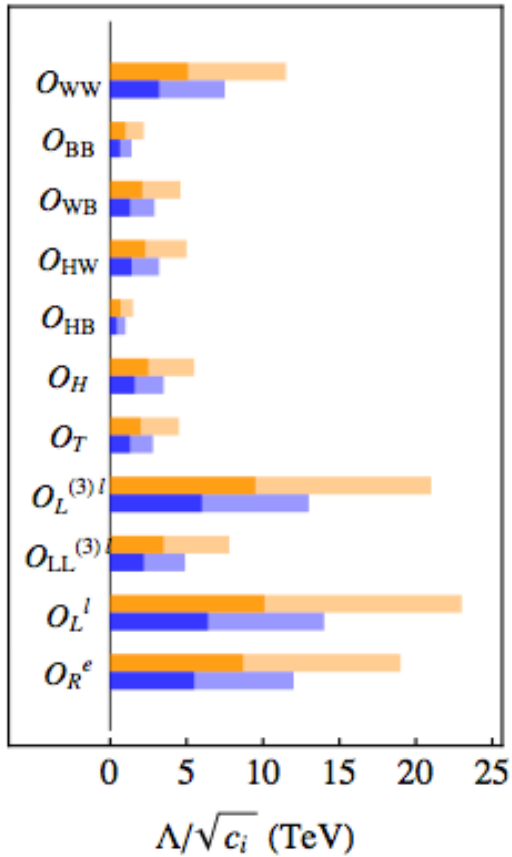
With Englert and Spannowsky (PRD)



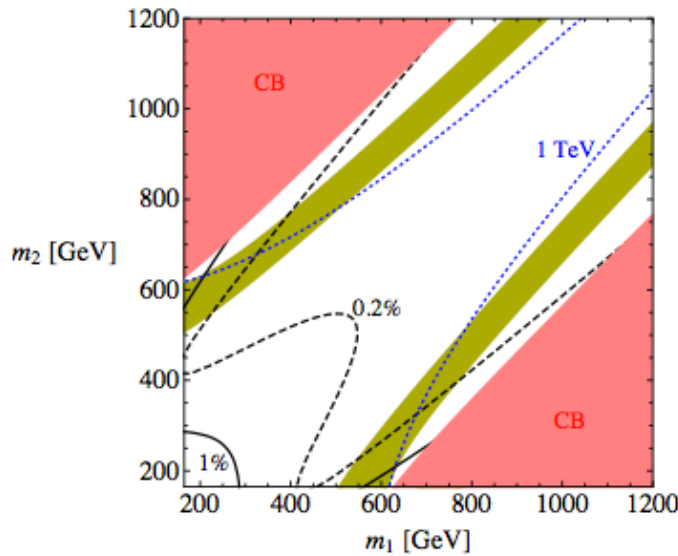
and continuing work...

# BSM Higgs: Future Colliders

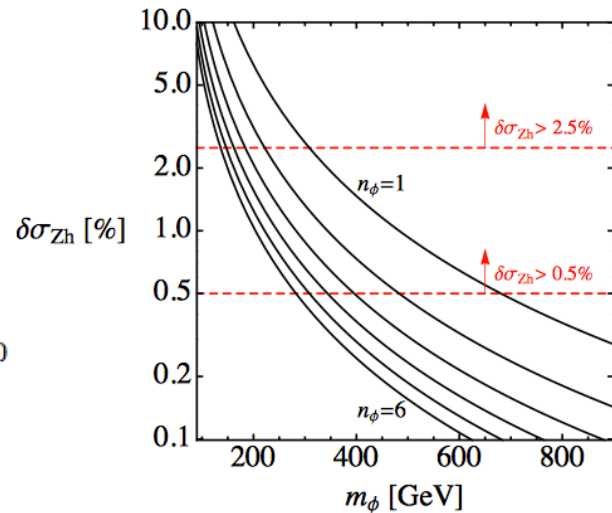
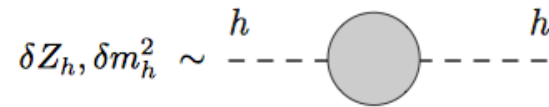
## Effective operators



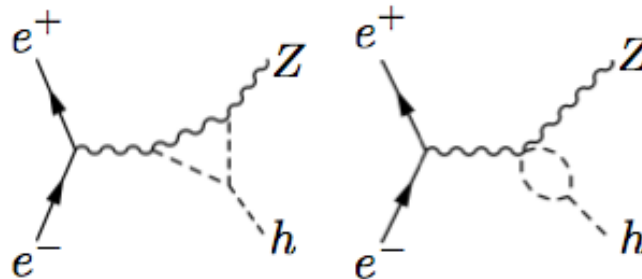
## Stops



## Neutral Naturalness



## Self-Coupling?



Variously with Craig, Englert, Farina, and Perelstein. PRD, JHEP, PRL.

# SUSY Model Building

## R-Symmetric Models

Field	Gauge rep.	$R$ -charge	$Z_2$ -parity
$Q$	$(\mathbf{3}, \mathbf{2}, \frac{1}{6})$	1	1
$U^c$	$(\bar{\mathbf{3}}, \mathbf{1}, -\frac{2}{3})$	1	1
$D^c$	$(\bar{\mathbf{3}}, \mathbf{1}, \frac{1}{3})$	1	-1
$L$	$(\mathbf{1}, \mathbf{2}, -\frac{1}{2})$	1	1
$E^c$	$(\mathbf{1}, \mathbf{1}, \mathbf{1})$	1	-1
$H$	$(\mathbf{1}, \mathbf{2}, \frac{1}{2})$	0	1
$\eta$	$(\mathbf{1}, \mathbf{2}, -\frac{1}{2})$	2	-1
$O$	$(\mathbf{8}, \mathbf{1}, 0)$	0	1
$T$	$(\mathbf{1}, \mathbf{3}, 0)$	0	1
$X$	$(\mathbf{1}, \mathbf{1}, 0)$	2	-1
$W'$	$(\mathbf{1}, \mathbf{1}, 0)$	1	1

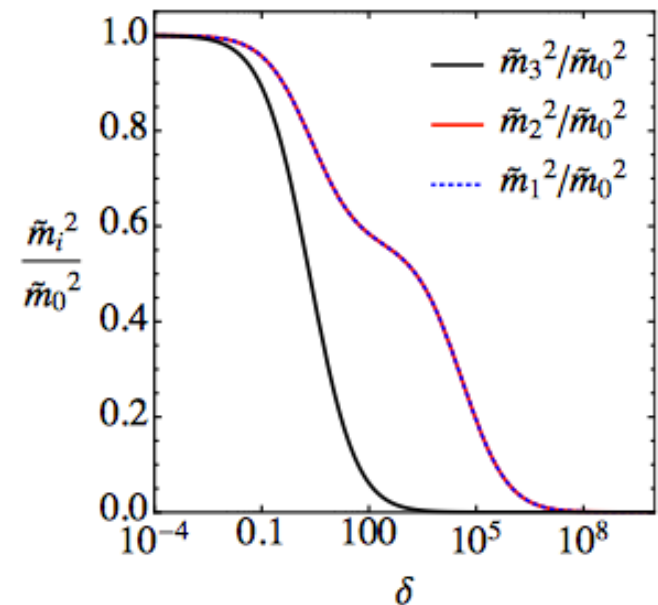
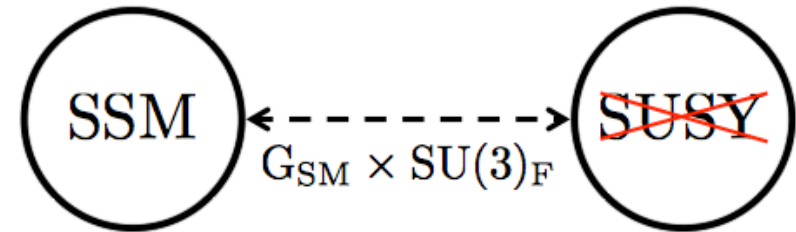
Table 1. The chiral superfield matter content of the SOHDM. Gauge superfields are even under the  $Z_2$ -parity and are not shown. The fields  $X$  and  $W'$  are the spurion superfields parametrisising SUSY breaking.

With Davies, March-Russell. JHEP.

## Dirac Gauginos “Goldstone Gauginos”

In prep with Alves, Galloway, Weiner.

## Natural SUSY “Flavor Mediation”



Variously with Craig, Kahn, Thaler. JHEP.

# On behalf of Fellows...

Thanks to Michelangelo and everyone else involved putting together a great few days!