LHC dijet limits on $0\nu\beta\beta$

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Based on:

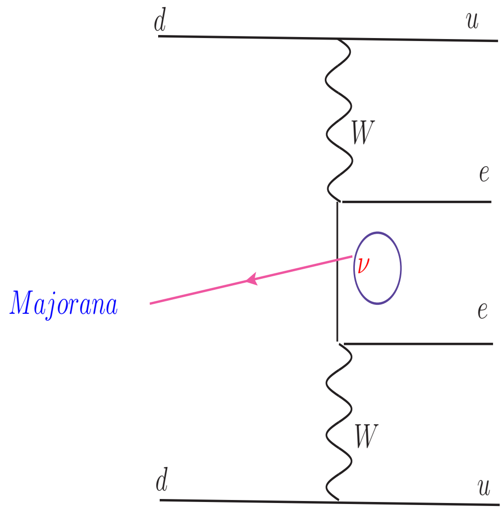
J.C. Helo, M. Hirsch, Phys.Rev. D92, 7, 073017.

Contents

- Lepton number violation

$$(A, Z) \rightarrow (A, Z+2) + 2e^-$$

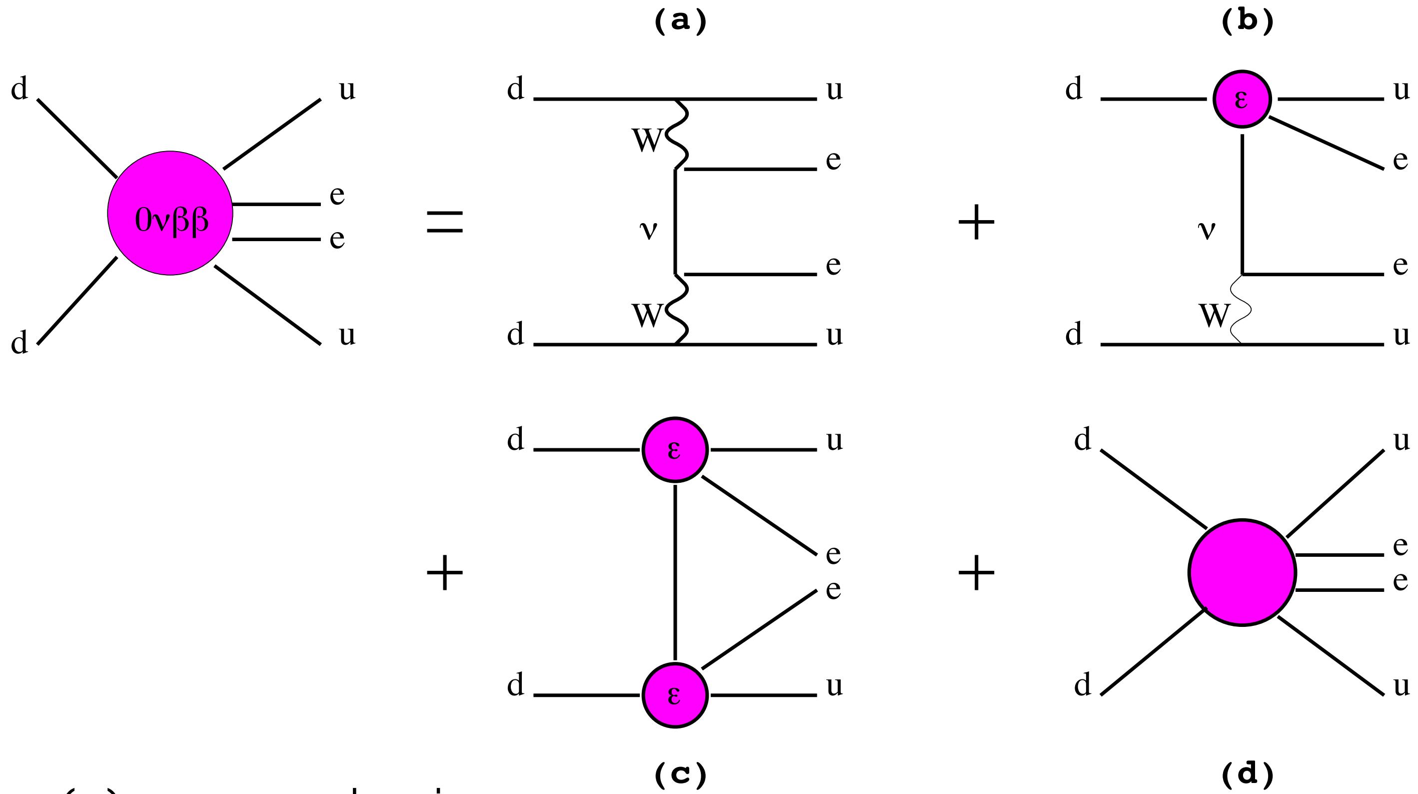
- Neutrino Mass Mechanism



- Sensitive to extensions of SM:
  Left-Right, SUSY RPV, LQ, Sterile neutrinos, Color sextet diquarks, ..etc.
  For a review: Deppish et al . Arxiv: 1208.0727
- Schether-Valle Theorem: Observation of $0\nu\beta\beta$ implies neutrinos are Majorana Phys. Rev. D. 25 2951 (1982). However it won't be easily interpreted as evidence for any specific model.

Lorentz-invariant description

Graphically:



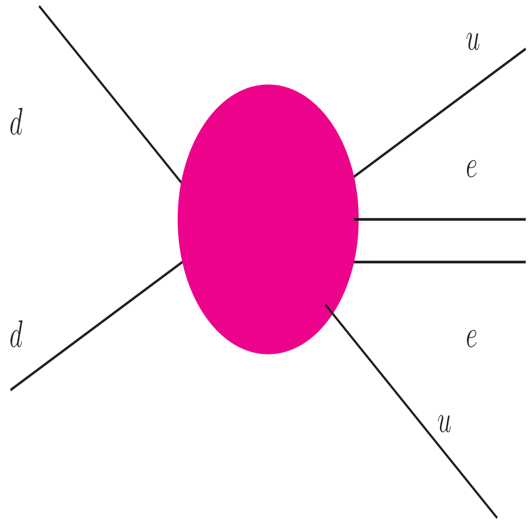
⇒ (a) mass mechanism

⇒ (b) long-range part: H. Päs et al. PLB453 (1999)

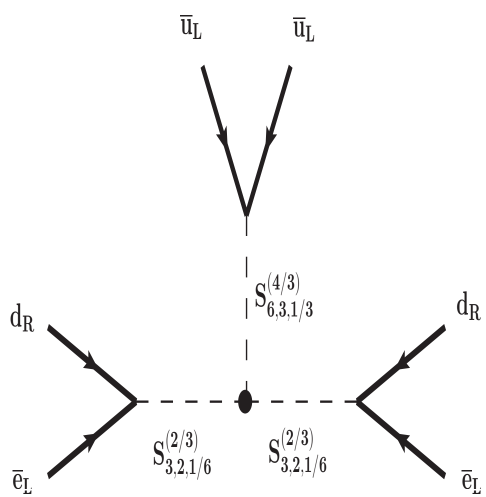
⇒ (d) short-range part: H. Päs et al. PLB498 (2001)

Dec. of dim-9 op. Bonnet et al. JHEP03 (2013) 055

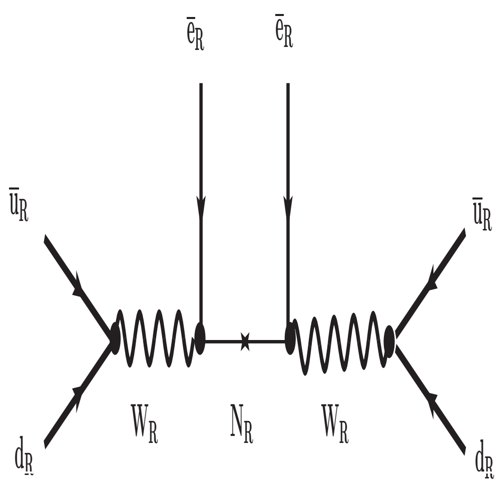
Short Range Examples



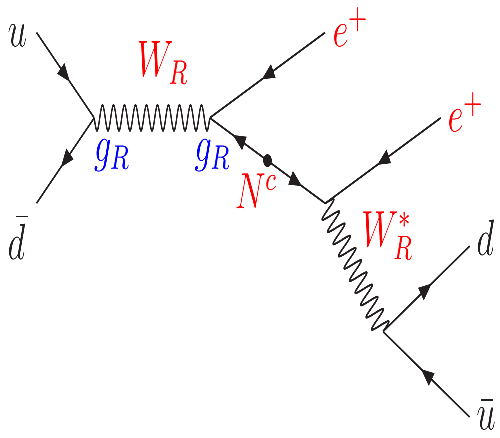
Diquark Model:
Bonnet et al. JHEP03 (2013) 055



LR symmetric model:
$SU(3)_c \times SU(2)_L \times SU(2)_R \times U(1)_{B-L}$



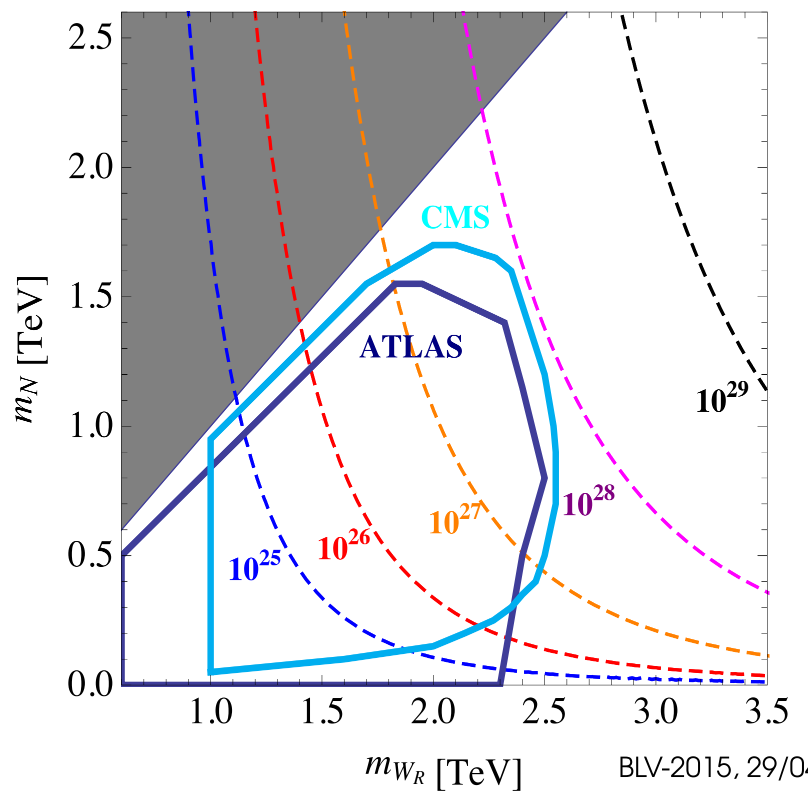
Example: W_R @ LHC



Keung & Senjanovic, 1983
Phys. Rev. Lett. 50, 1427

Signal:

di-lepton + jets, **no** $\not{E}_T$

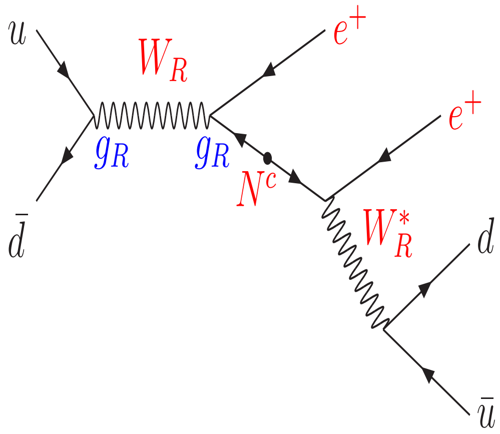


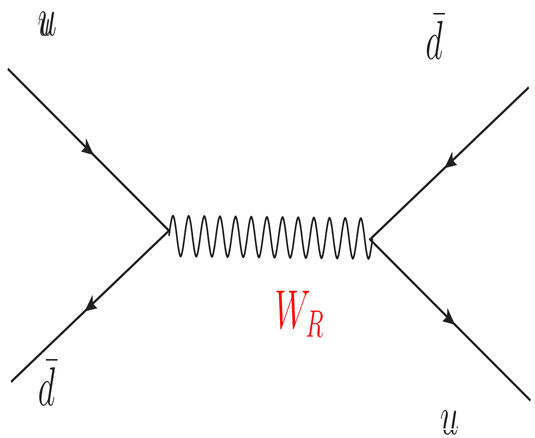
$0\nu\beta\beta : dd \to uue^-e^-$

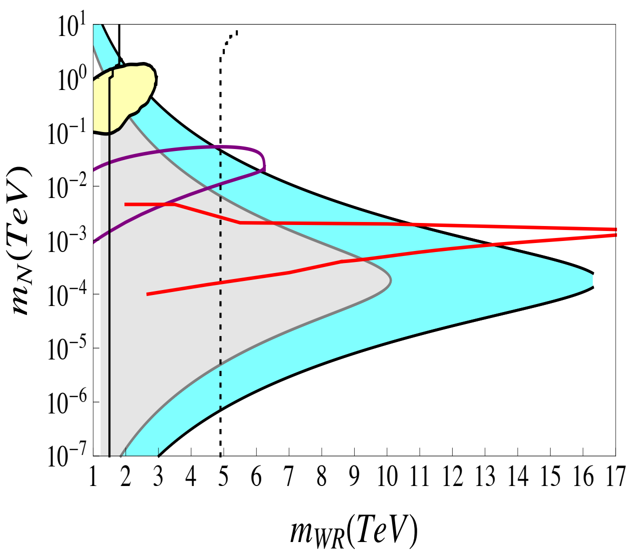
CMS (and ATLAS) with $\sqrt{s} = 8$ TeV:

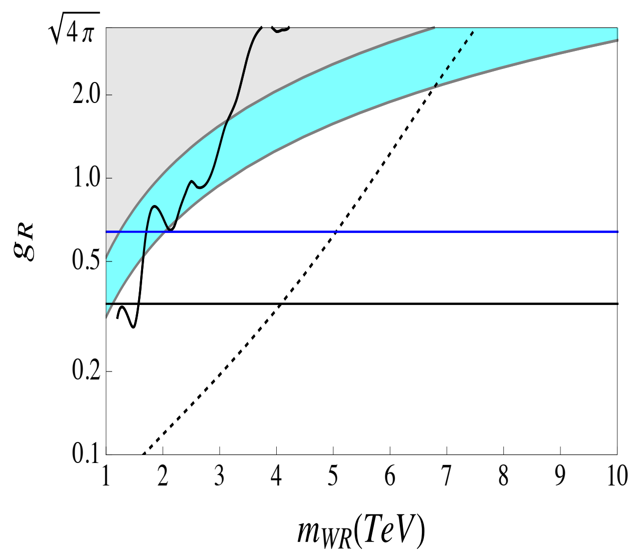
Non-observation gives stringent limits on short-range W_R diagrams for $0\nu\beta\beta$ decay.

Example: W_R @ LHC



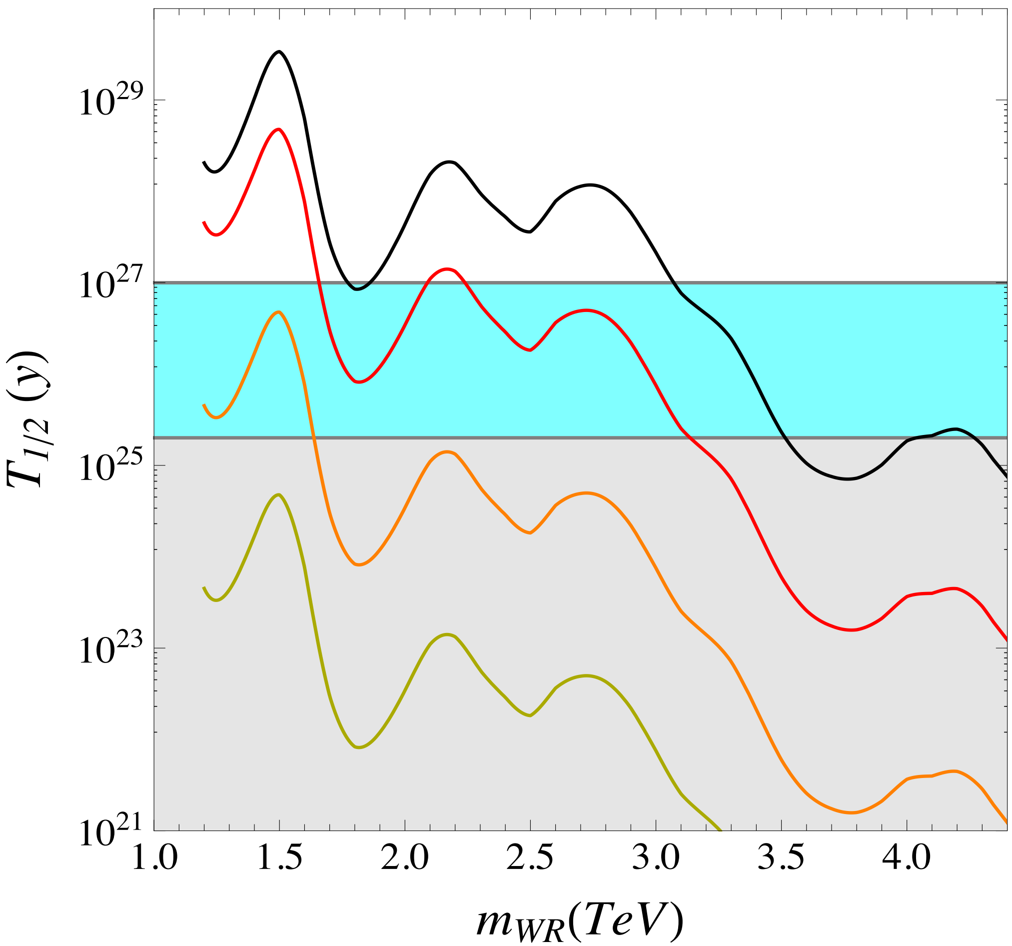






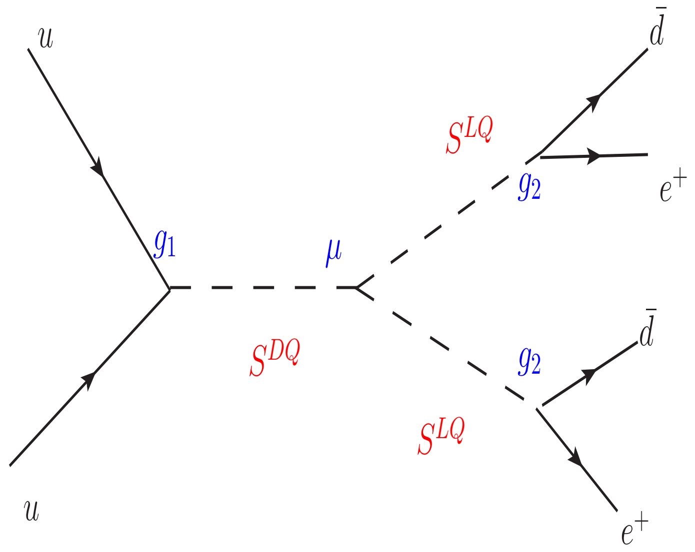
$m_N = 1TeV.$

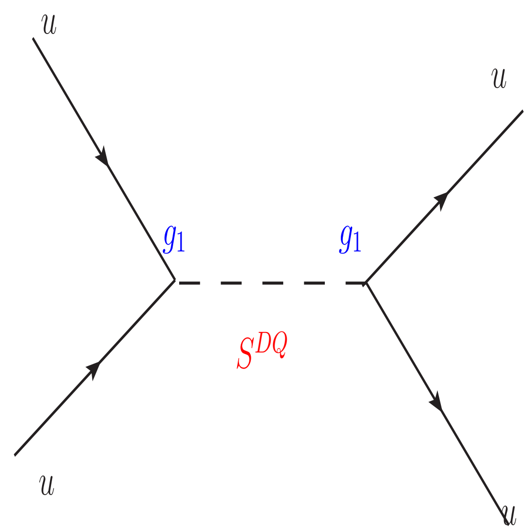
Example: W_R @ LHC



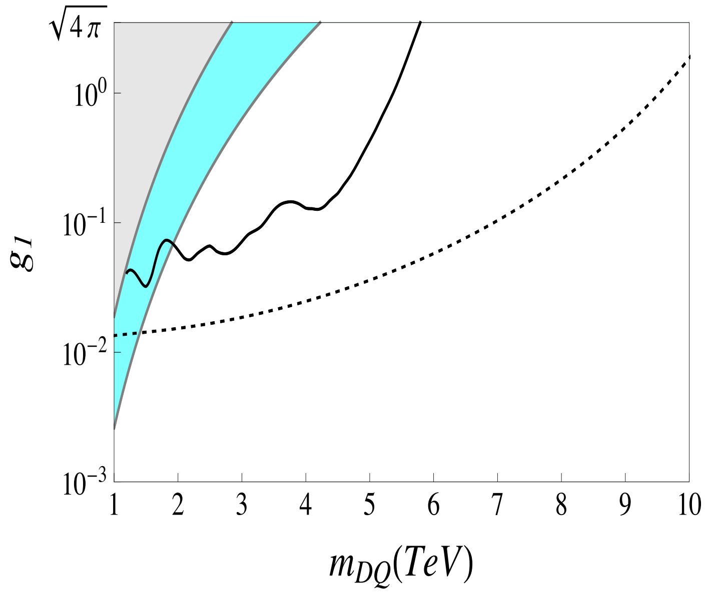
Example: S^{DQ} @ LHC

$0\nu\beta\beta : dd \to uue^- e^-$

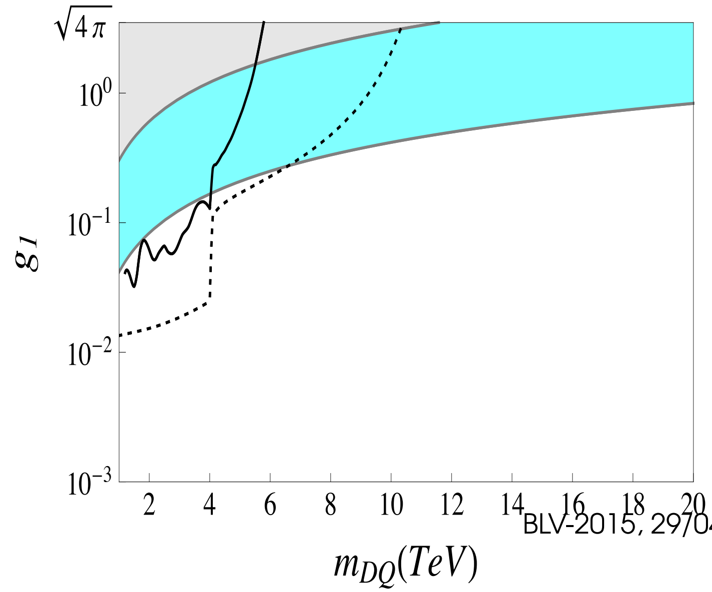




$\mu = m_{DQ}, g_2 = 1, m_{LQ} = m_{DQ}$



$\mu = m_{DQ}, g_2 = 1, m_{LQ} = 2TeV.$



Conclusions

⇒ We have discussed how upper limits on dijet cross sections, derived from LHC data, can be used to constrain the short-range part of the $0\nu\beta\beta$ decay amplitude.

⇒ We have concentrated on two example models: (a) minimal left-right symmetry and (b) a diquark model with LNV. For both setups, the LHC dijet data provides constraints complementary to those derived from the LNV searches.

⇒ We have also estimated the impact of future LHC data. Current dijet limits provide already interesting constraints on $0\nu\beta\beta$ decay, future limits will rule out measurably half-lives of double beta decay ($T^{1/2} \lesssim 10^{27} yr$), except in some well-defined regions of parameter space

⇒ We note that, while we have concentrated on two particular example models, similar constraints will apply to any short-range contribution to $0\nu\beta\beta$ decay in which a state coupling to a pair of quarks appars.