Chacko. *et al* arXiv:1505.04192 [PRD]

$$N_R N_R \rightarrow \nu_R \nu_R$$

$$\Delta N_{\rm eff} \sim 0.2$$

 $k_{lpha}N_{Rlpha}^{c}N_{Rlpha}S^{*}$

$$g' Z'_{\mu} \sum_{F} q_{F} \overline{F} \gamma^{\mu} F$$

Dark Scalar Portal