Shining Dark Matter at Xenon1T

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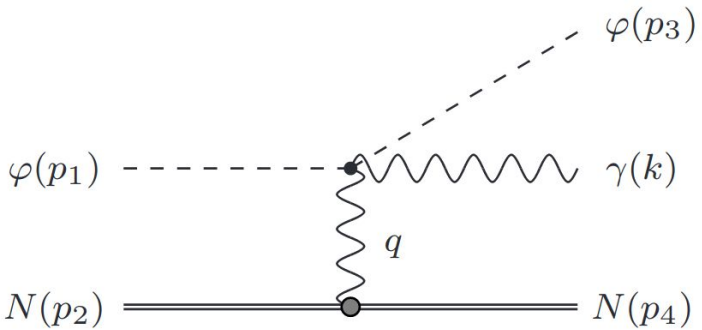
2006.12462 with Gil Paz, Alexey Petrov and Jure Zupan

June 29th, 2020

Rayleigh operators

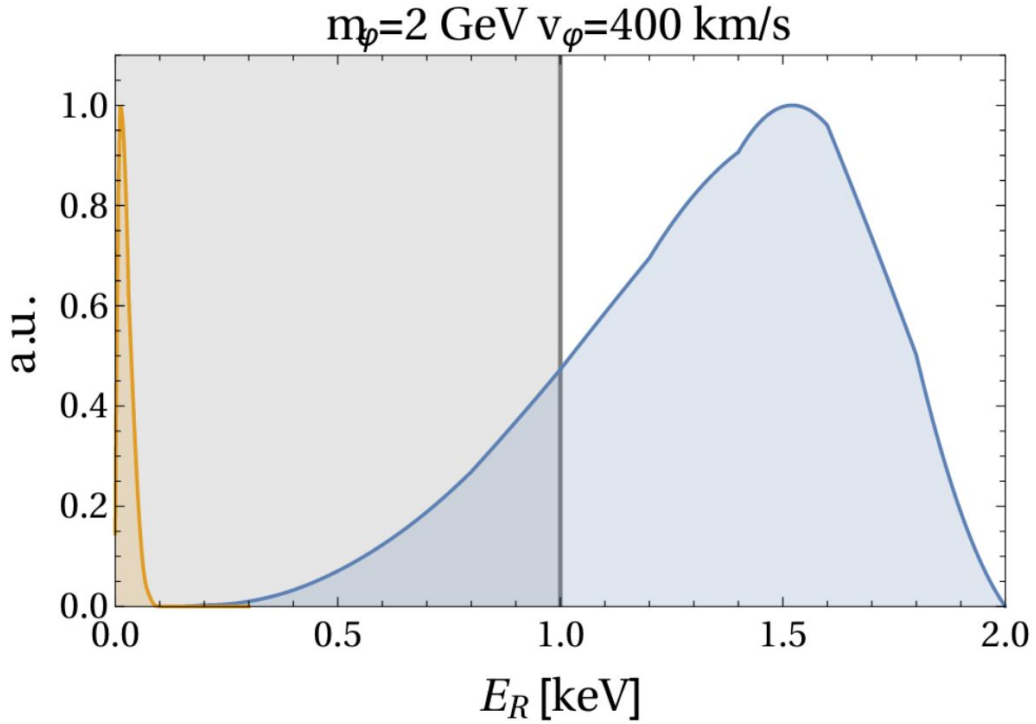
O(2 GeV) Non-Relativistic DM scattering on Xenon nuclei

$$\mathcal{L}_{\rm int} = \frac{\alpha}{12\pi}\frac{1}{\Lambda^2}\left\{C_\gamma(\varphi\varphi)F_{\mu\nu}F^{\mu\nu} + \widetilde{C}_\gamma(\varphi\varphi)F_{\mu\nu}\widetilde{F}^{\mu\nu}\right\}$$



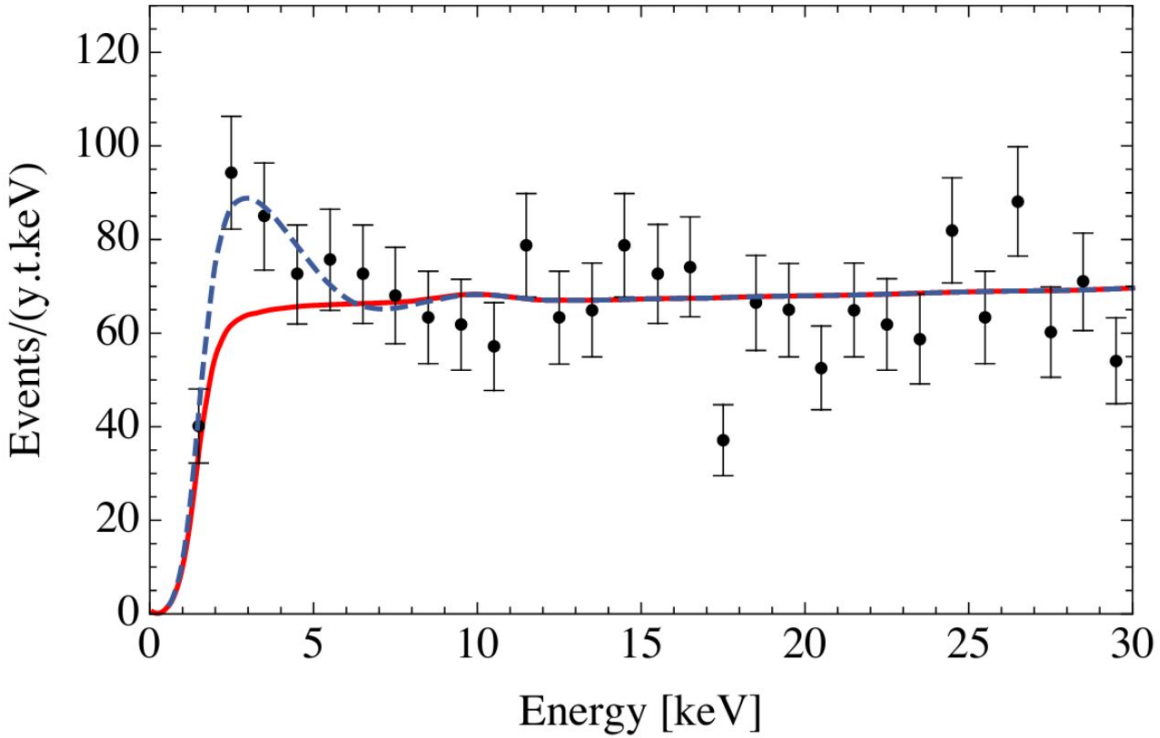
Photons = Electrons at Xenon1T

Xenon1T detects the emitted photon



Event simulation with FeynRules and MadGraph

Xenon1T detects the emitted photon



Best fit point:

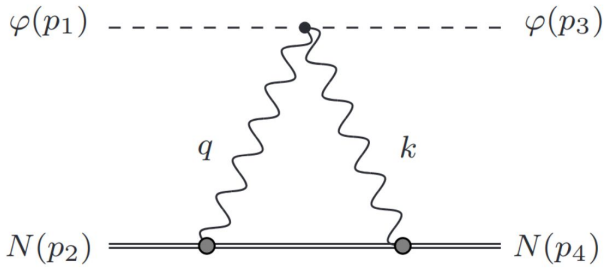
$$m_\varphi = 1.9 \text{ GeV}$$

$$\Lambda/\sqrt{C_\gamma} = 50 \text{ MeV}$$

Significance over BG only:

$$3.3\ \sigma$$

Spin-Independent scattering at 1 loop



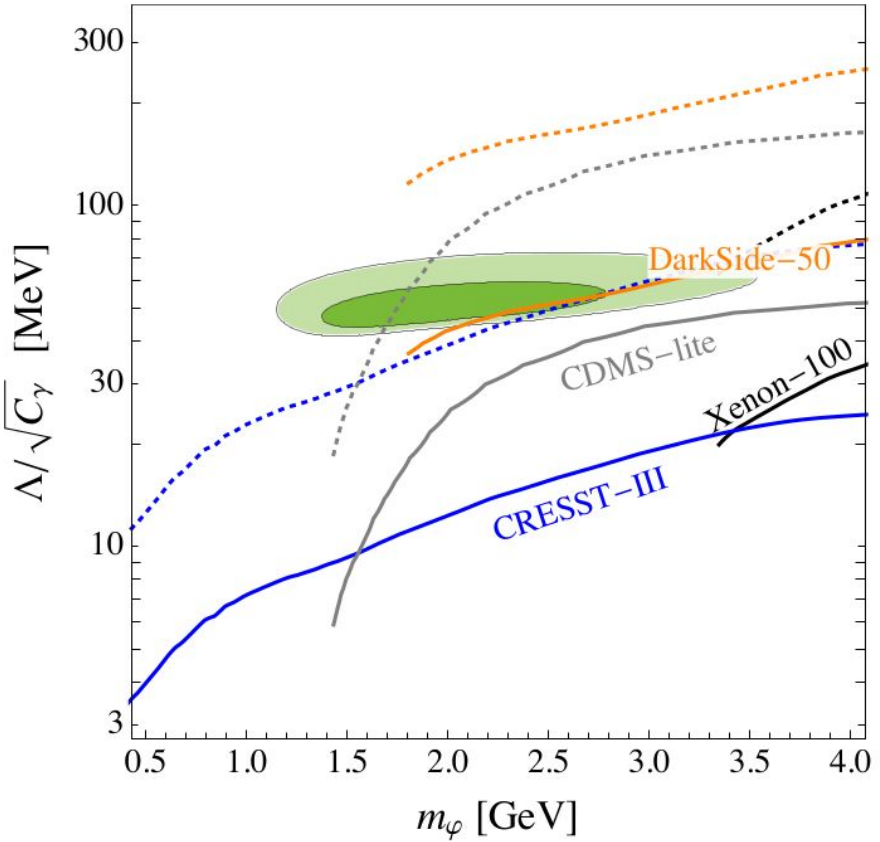
Non-perturbative matrix element

$$\langle f|(\varphi\varphi)F_{\mu\nu}F^{\mu\nu}|i\rangle = \frac{\alpha Z^2}{4\pi}\tilde{Q}_0\langle f|(\varphi\varphi)\bar{u}_A u_A|i\rangle$$

$$\tilde{Q}_0 \sim \frac{\kappa}{\sqrt{\langle r^2\rangle}}$$

Dashed $\kappa = 0.5$

Solid $\kappa = 0.05$

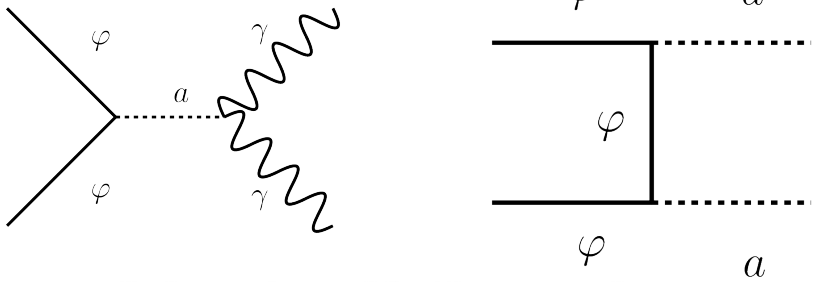


An example: Secluded DM

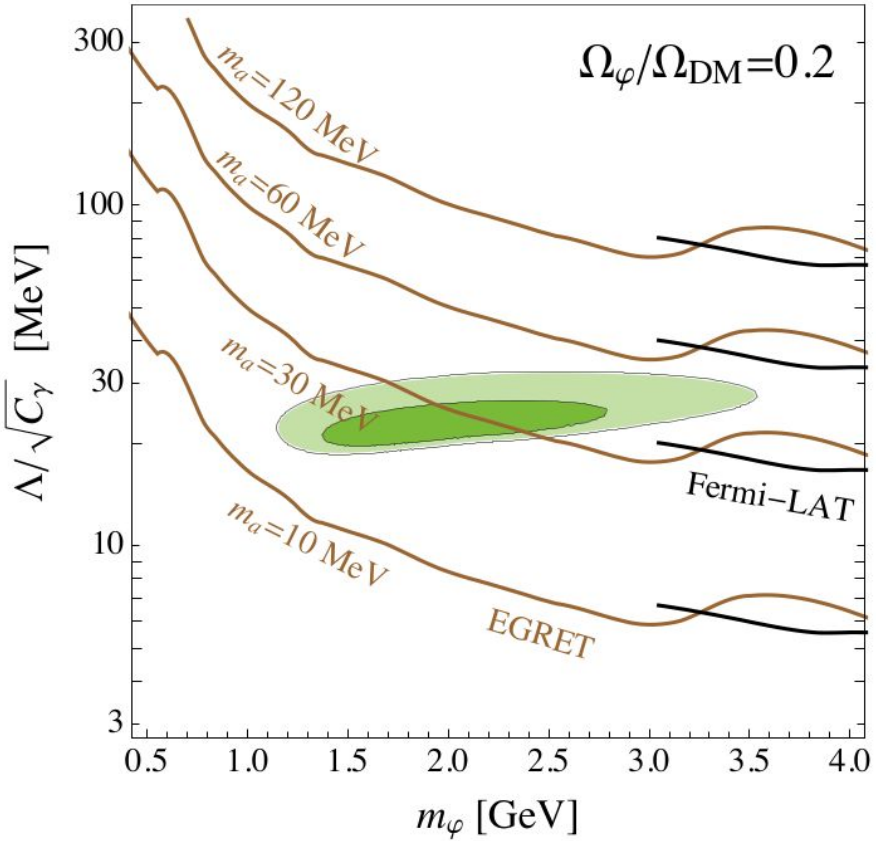
$$\mathcal{L}_a \supset \mu_\varphi(\varphi\varphi)a + \frac{\alpha}{12\pi}\frac{C_{a\gamma}}{\Lambda_{\rm UV}}aF_{\mu\nu}F^{\mu\nu}$$

At low momenta $$\frac{C_\gamma}{\Lambda^2} = \frac{C_{a\gamma}}{\Lambda_{\rm UV}}\frac{\mu_\varphi}{m_a^2}$$

Indirect detection from DM annihilation



$\varphi\varphi \to 2a$ bounds avoided by assuming dominant decay of a to neutrino or invisible



Conclusions

- Non-Relativistic DM + Rayleigh operators can explain the Xenon1T excess
- Direct Detection can already probe it (given better predictions)
- Light (pseudo)scalar mediators are viable models