Global Analysis and Dark Photons

Nicholas Hunt-Smith

arXiv:2302.11126

Supervisors: Tony Thomas and Martin White
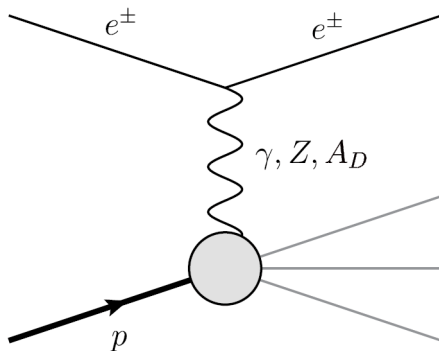
Collaborators: Wally Melnitchouk, Nobuo Sato and Xuan-Gong Wang

University of Adelaide

November 30, 2023

Dark Photon in DIS

$$\mathcal{L} \supset -\tfrac{1}{4}F'_{\mu\nu}F'^{\mu\nu} + \tfrac{m^2_{A'}}{2}A'_\mu A'^\mu + \tfrac{\epsilon}{2\cos\theta_W}F'_{\mu\nu}B^{\mu\nu}$$

Dark Photon in DIS

$$C_Z^v = (\cos \alpha - \epsilon_W \sin \alpha)\, \overline{C}_Z^v + \epsilon_W \sin \alpha \cot \theta_W\, C_\gamma^v,$$
$$C_Z^a = (\cos \alpha - \epsilon_W \sin \alpha)\, \overline{C}_Z^a,$$

$$C_{A_D}^v = -(\sin \alpha + \epsilon_W \cos \alpha)\, \overline{C}_Z^v + \epsilon_W \cos \alpha \cot \theta_W C_\gamma^v$$
$$C_{A_D}^a = -(\sin \alpha + \epsilon_W \cos \alpha)\, \overline{C}_Z^a$$

Modified couplings depend on two dark parameters, ϵ and m_{A_D}.

JAM framework

- We used the JAM global analysis framework at NLO.
- DIS data taken from SLAC, BCDMS, NMC and HERA.
- Q^2 cut of 1.69 GeV^2 and a W^2 cut of 10 GeV^2 for the DIS data.
- Drell-Yan, Z-rapidity, W-asymmetry and jet production also included.
- Agreement between theory predictions and data is assessed through the χ^2.
- Extra χ^2 contribution from $g - 2$ of the muon.
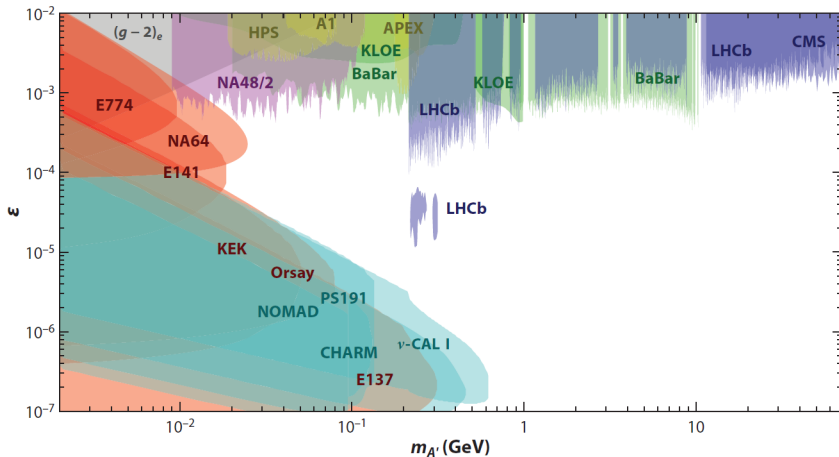
Excluded parameter space
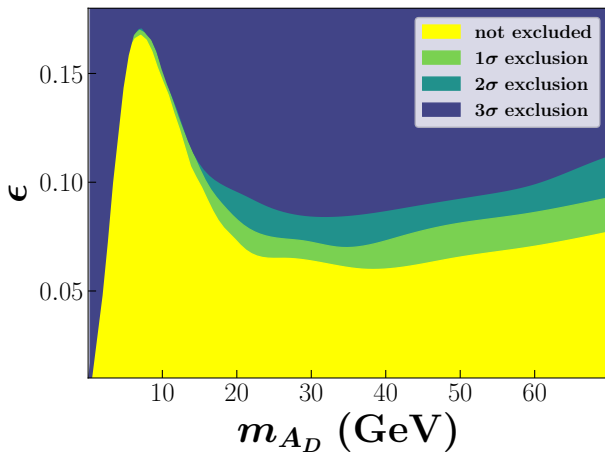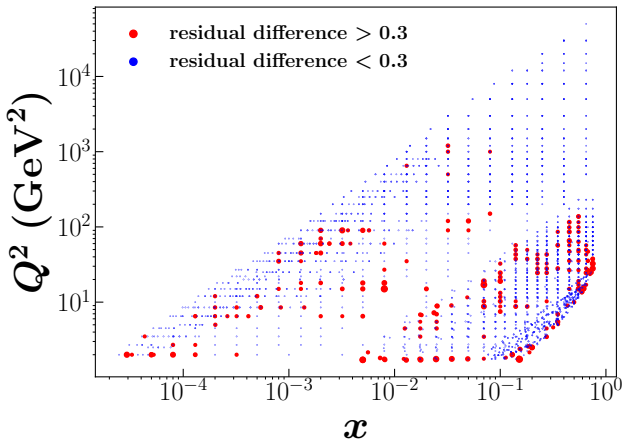
Potential dark photon signal?
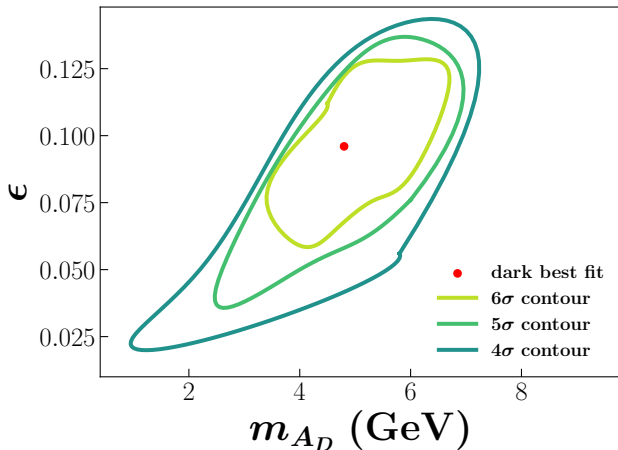
Difference in anomalous magnetic moment of $g - 2$ reduced from 4.2σ to 1.5σ for these parameter values.
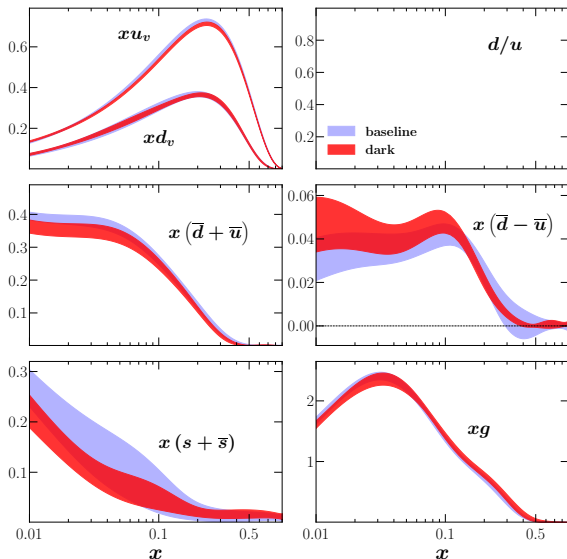
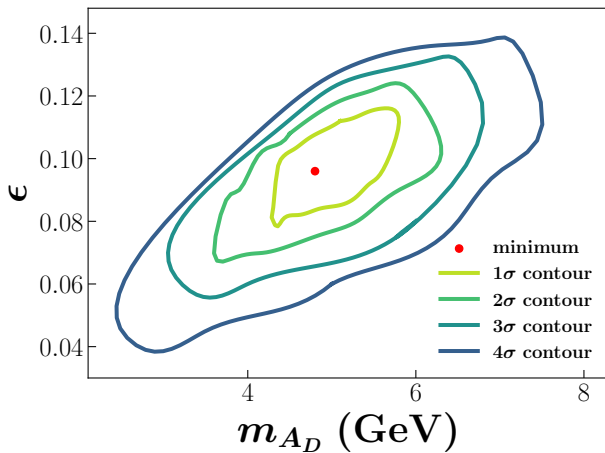# Potential dark photon signal?

Potential dark photon signal?

PDFs are stable

Cultural snippet

Profile Likelihood

χ^2 table

reaction	$\chi^2_{\mathrm{dof}}(\mathrm{dark})$	$\chi^2_{\mathrm{dof}}(\mathrm{base})$	N_{dof}
fixed target DIS	1.01	1.05	1495
HERA NC	1.02	1.03	1104
HERA CC	1.13	1.18	81
Drell-Yan	1.18	1.16	205
Z rapidity	1.08	1.05	56
W asymmetry	1.04	1.07	97
jets	1.16	1.15	200
total	1.03	1.05	3283