



Shaping Light Dark Sectors

Speaker: **Xucheng Gan**

About Me



Xucheng Gan

Front row, first from left

DES Y Theory Group (Cosmology)

PhD Institute

New York University

PhD Advisor

Joshua T. Ruderman

Research Area

BSM Physics Model Building

Cosmology Astroparticle

DM Detection Gravitational Wave

Other Interests

Movie Museum Good Food

Traveling Jogging

About Me



Xucheng Gan

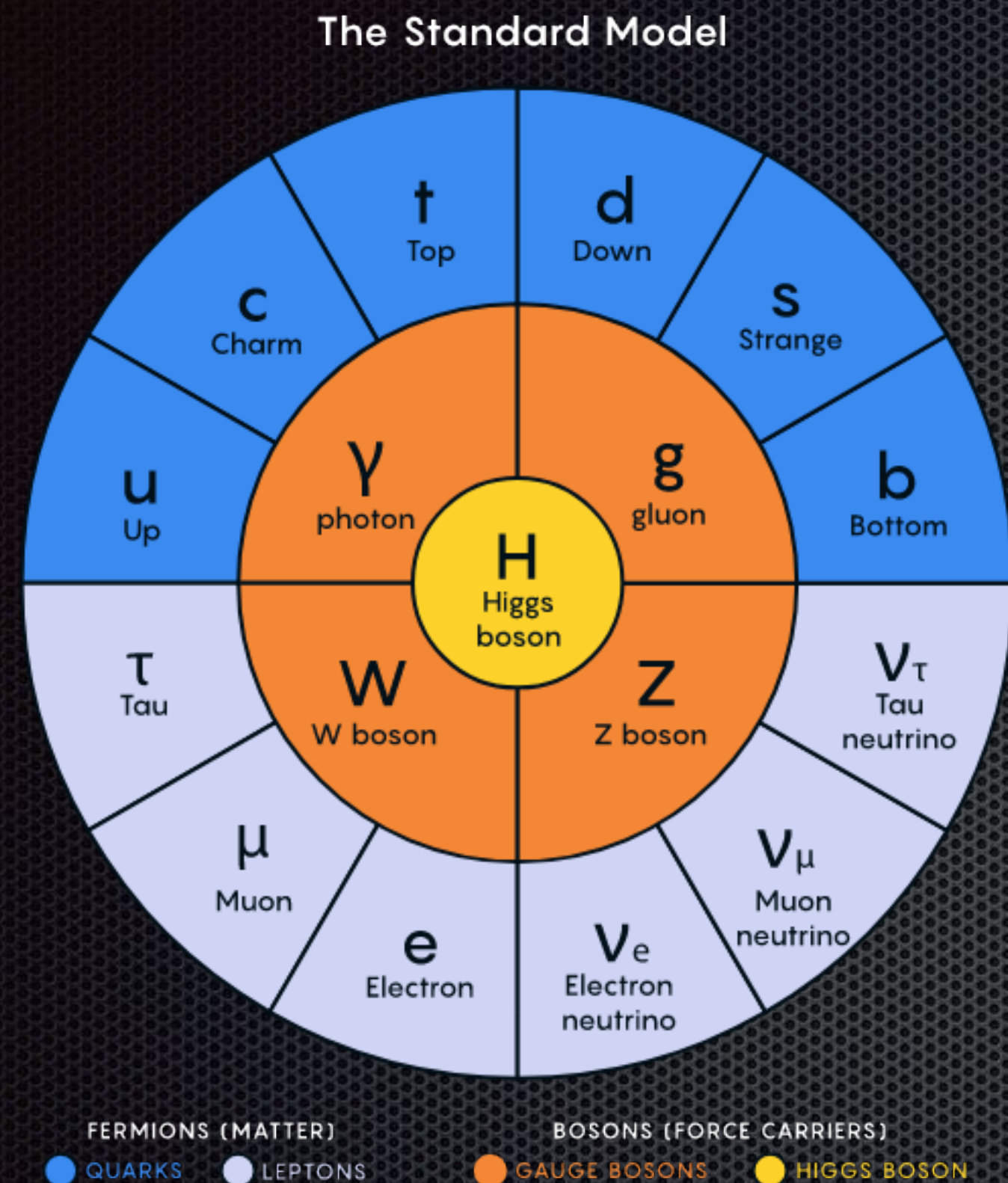
Front row, first from left



Hometown

Zhoushan Archipelago, China

Standard Model



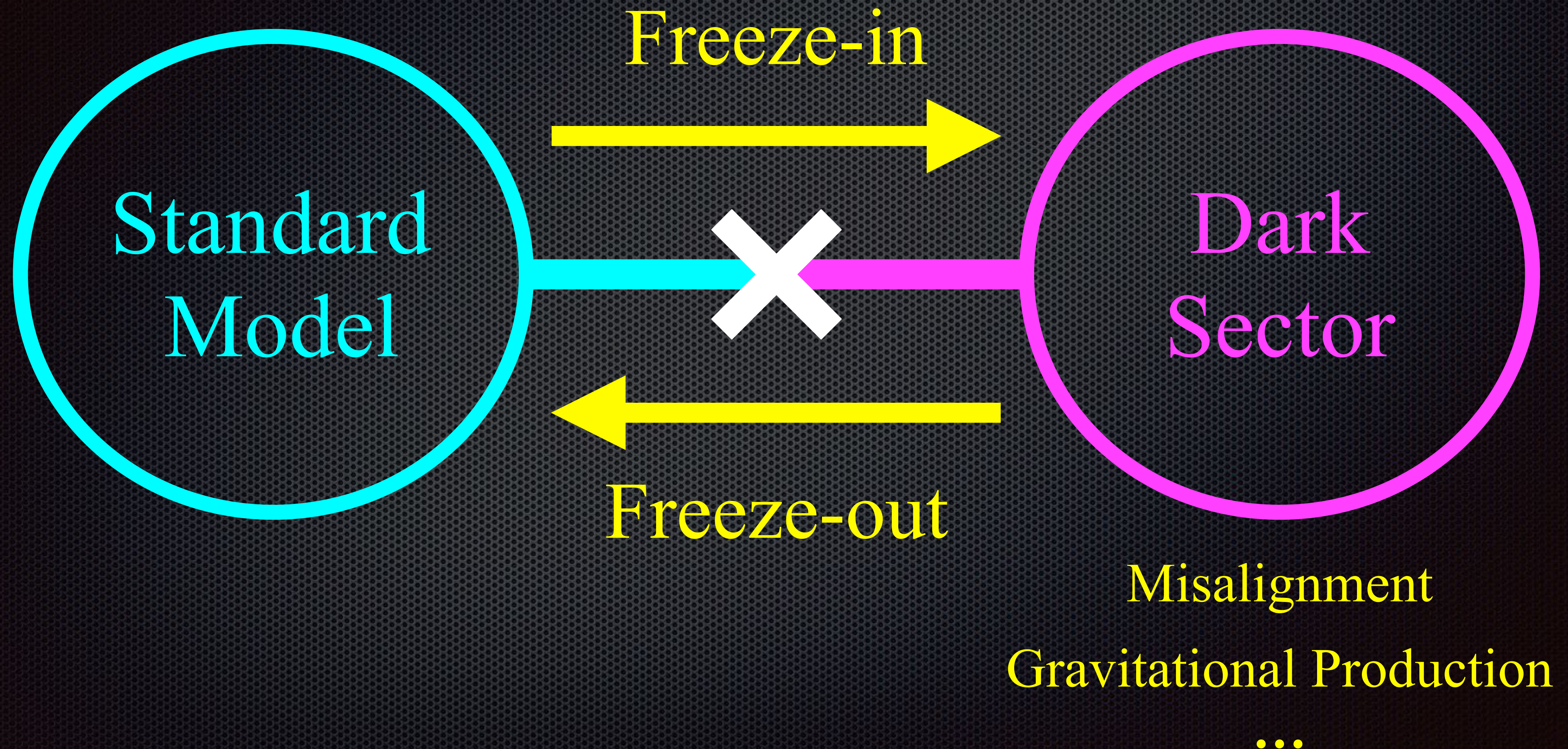
Dark Matter

Dark Energy

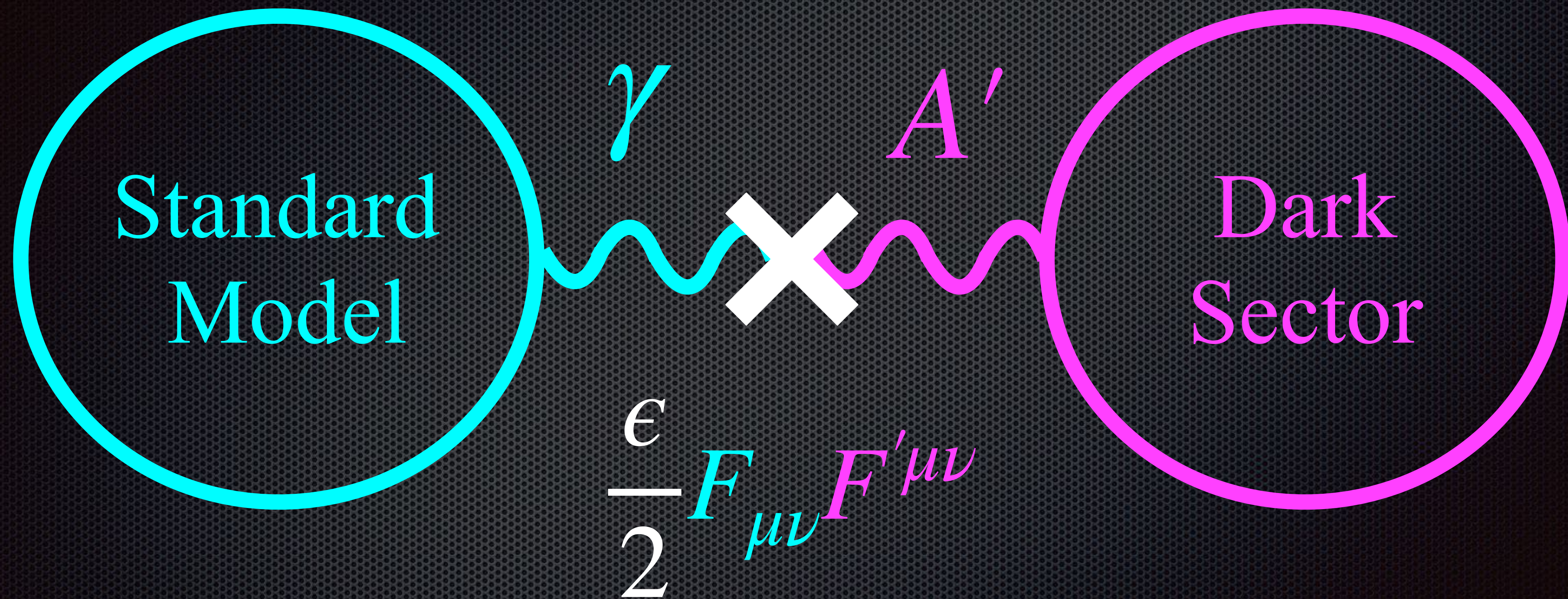
Higgs Naturalness

Strong CP

Dark Matter Production

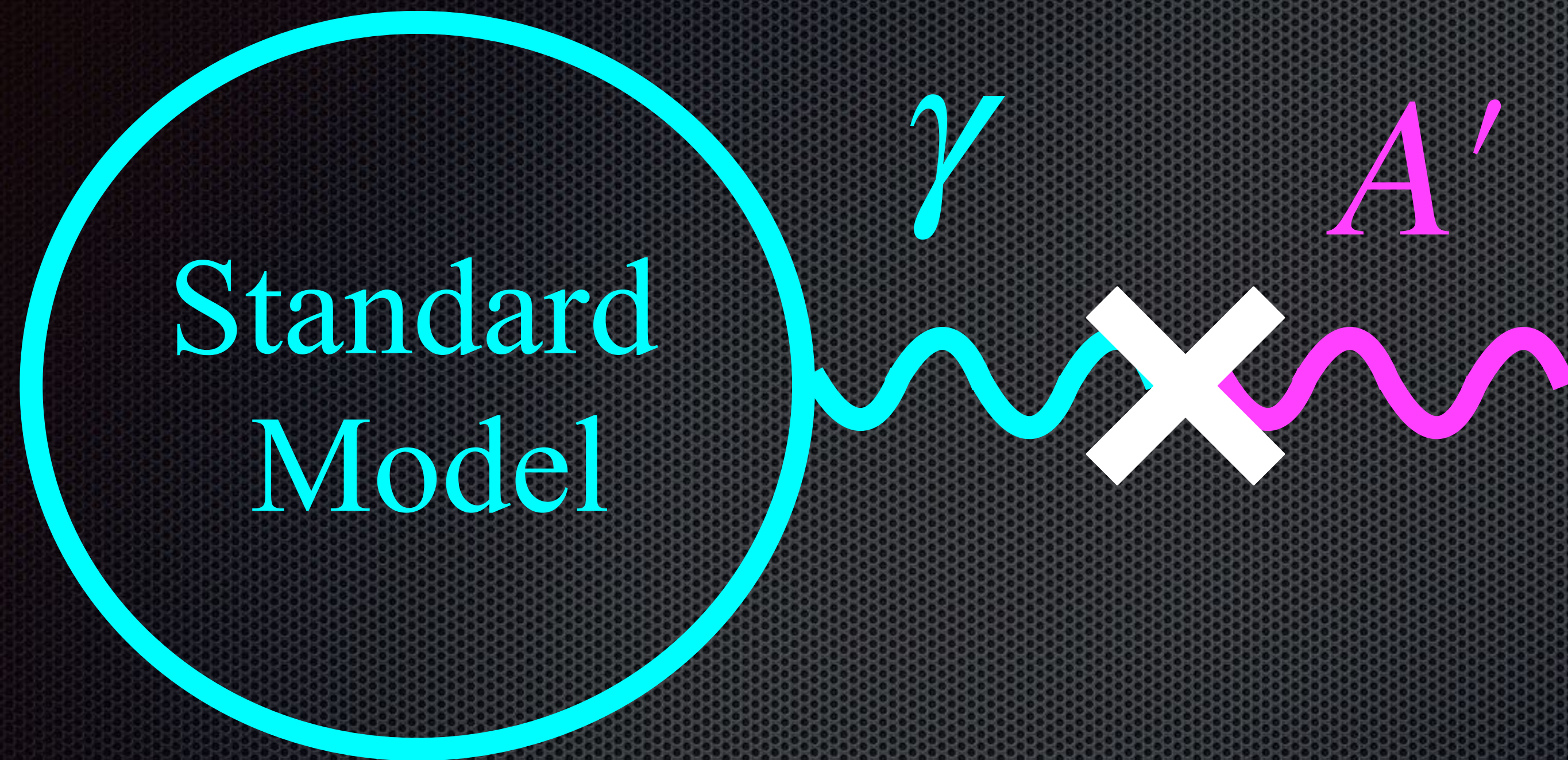


Kinetic Mixing Portal



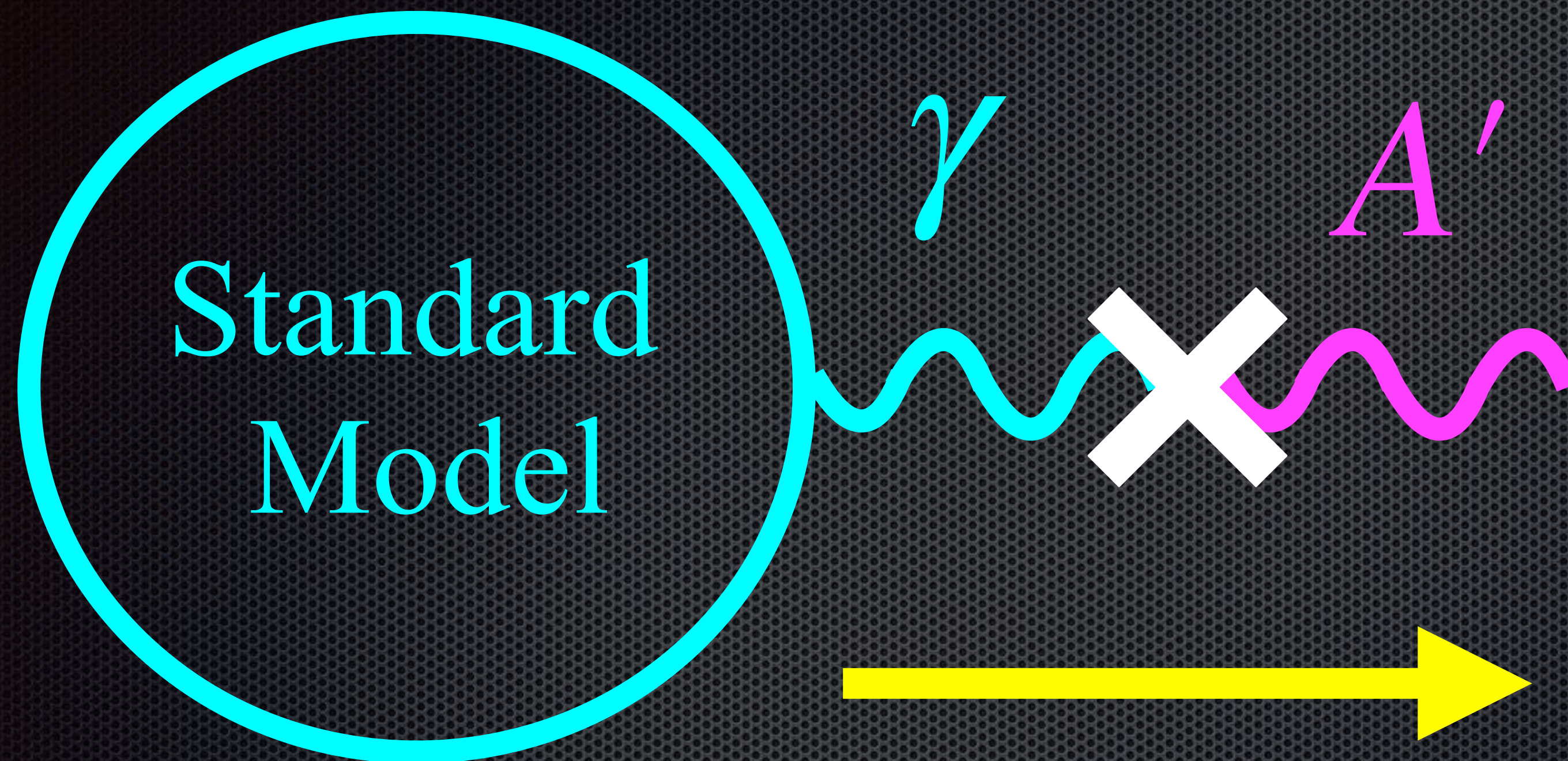
Bob Holdom 1985

Kinetic Mixing Portal



Kinetic Mixing Portal

CMB Spectral Distortion



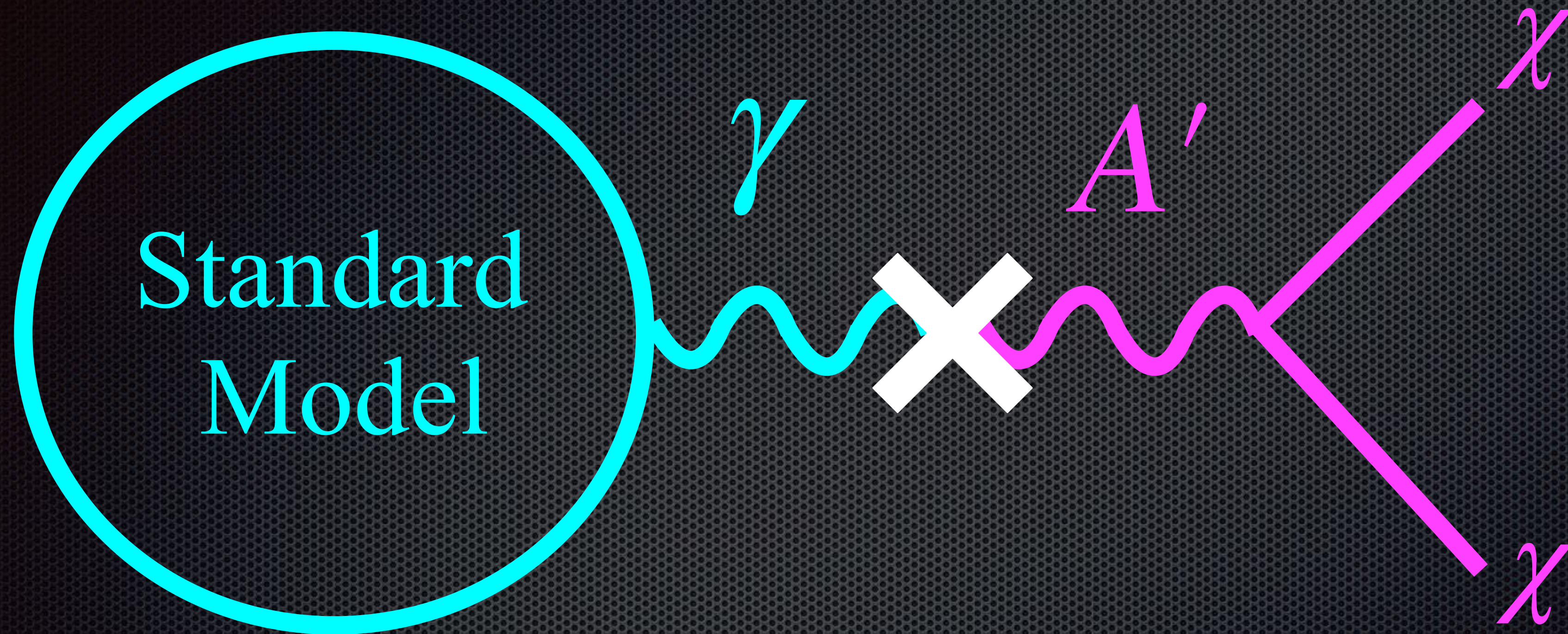
Mirrzi, Redondo, Sigl 2009

McDermott, Witte 2019

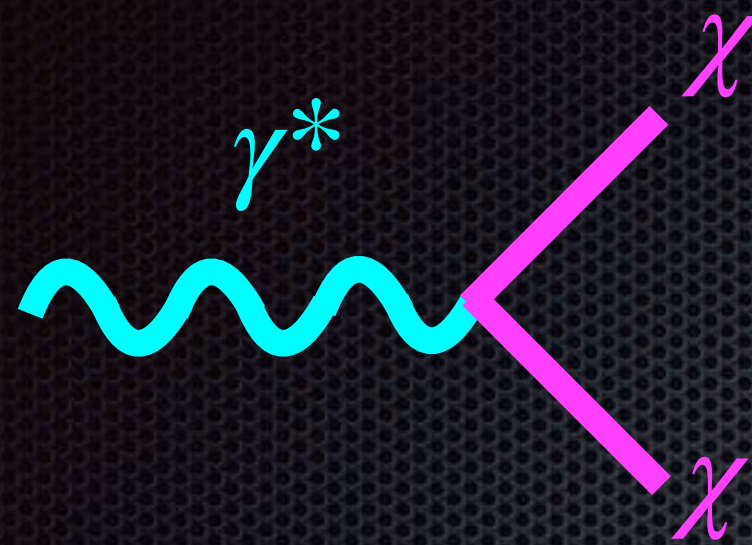
Caputo, Liu, Mishra-Sharma,
Ruderman 2020

**Arsenadze, Caputo, Gan,
Liu, Ruderman 2024**

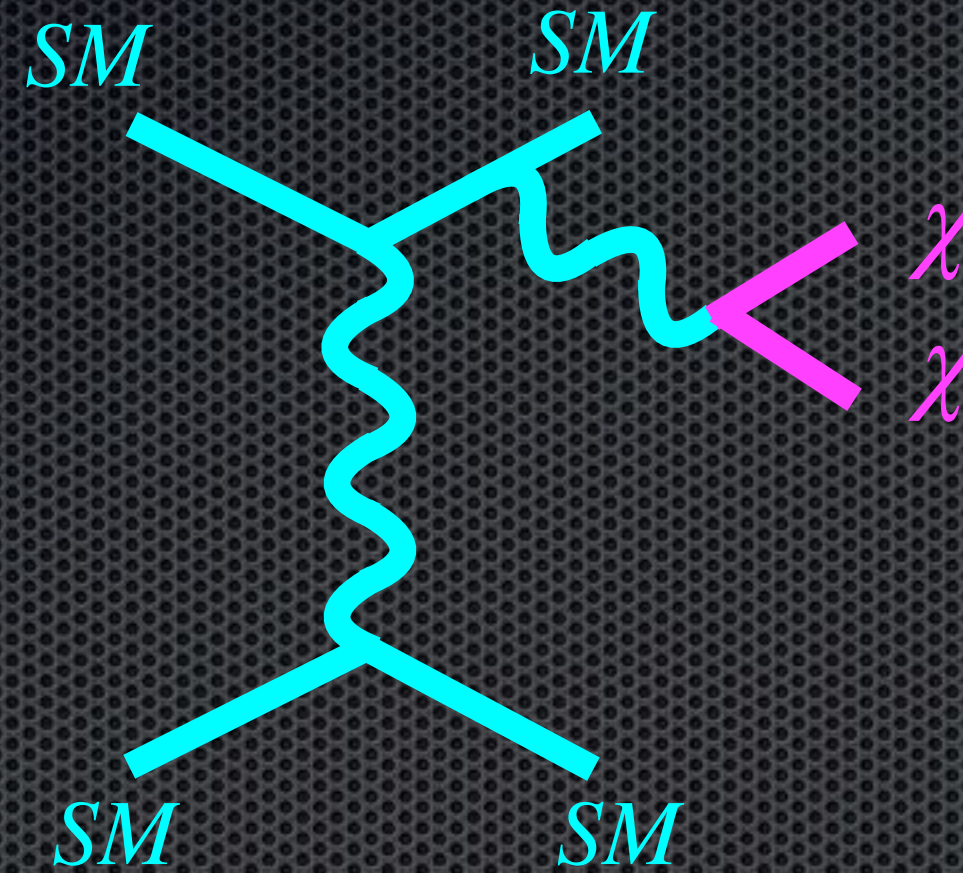
Millicharged Particle



Millicharged Particle Detections



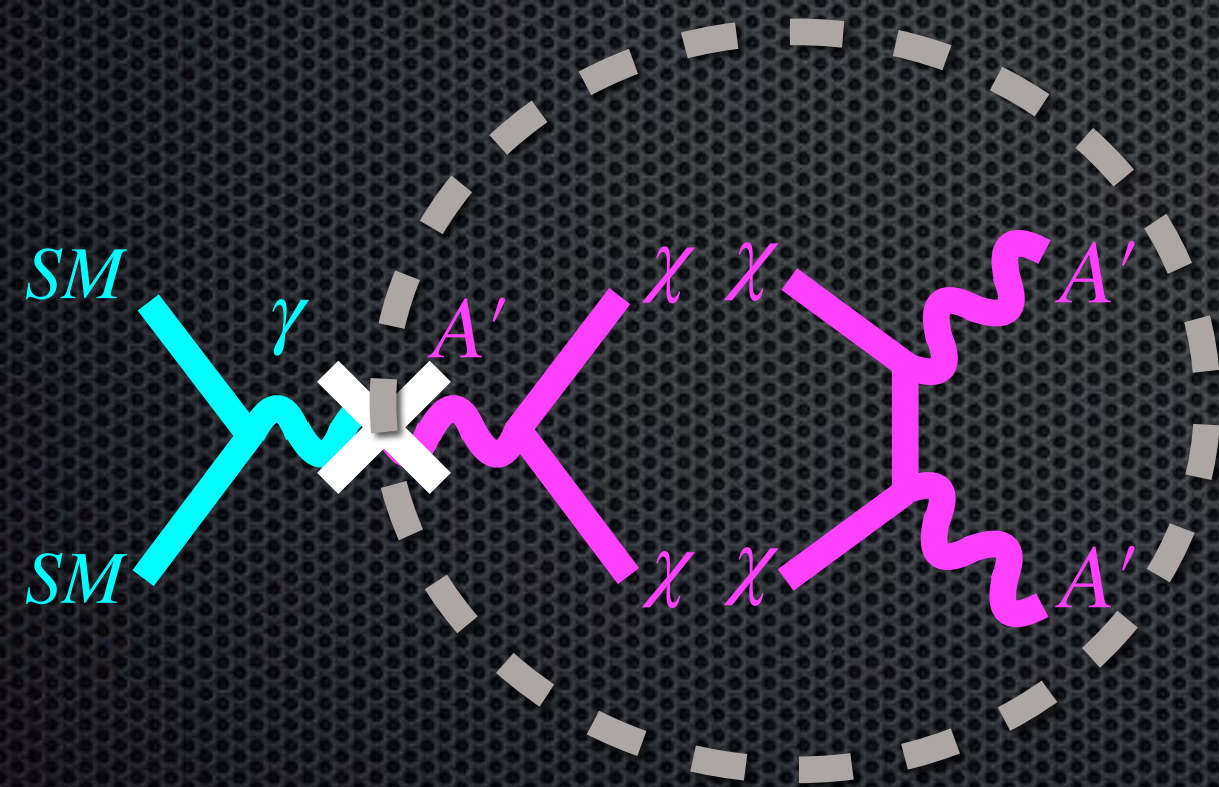
Stellar Energy Loss



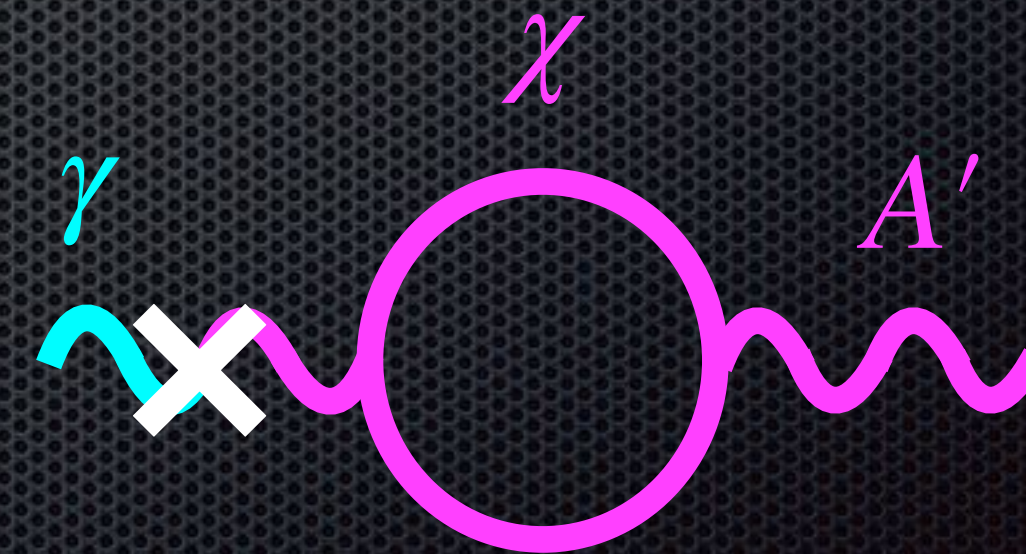
Missing Momentum



Direct Detection/CMB/Beam Dump



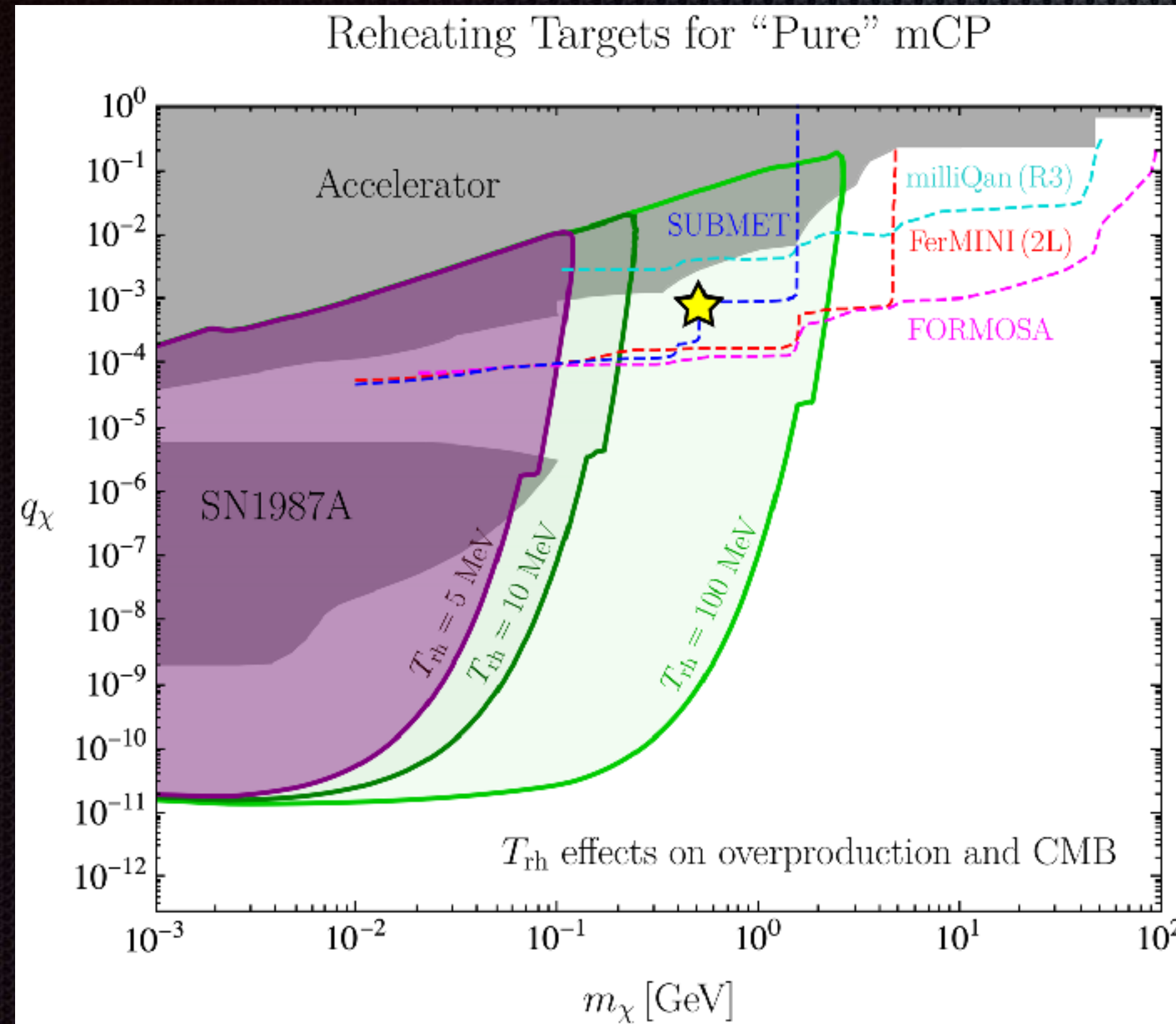
CMB/BBN ΔN_{eff}



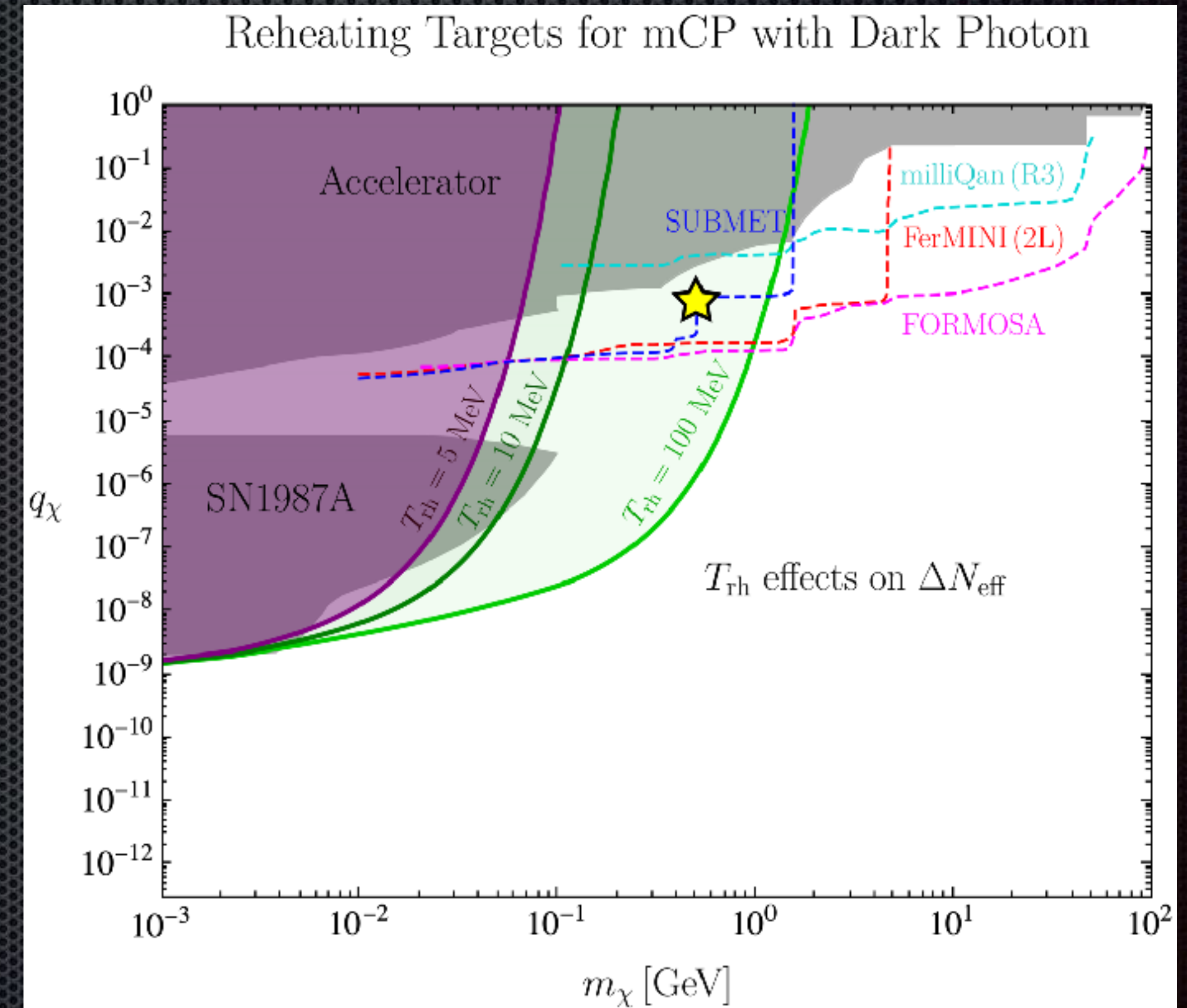
Dark Plasma Mass

**Berlin, Dror, Gan,
Ruderman, 2022**

Cosmic Millicharge Background



Pure mCPs



Kinetic Mixing mCPs

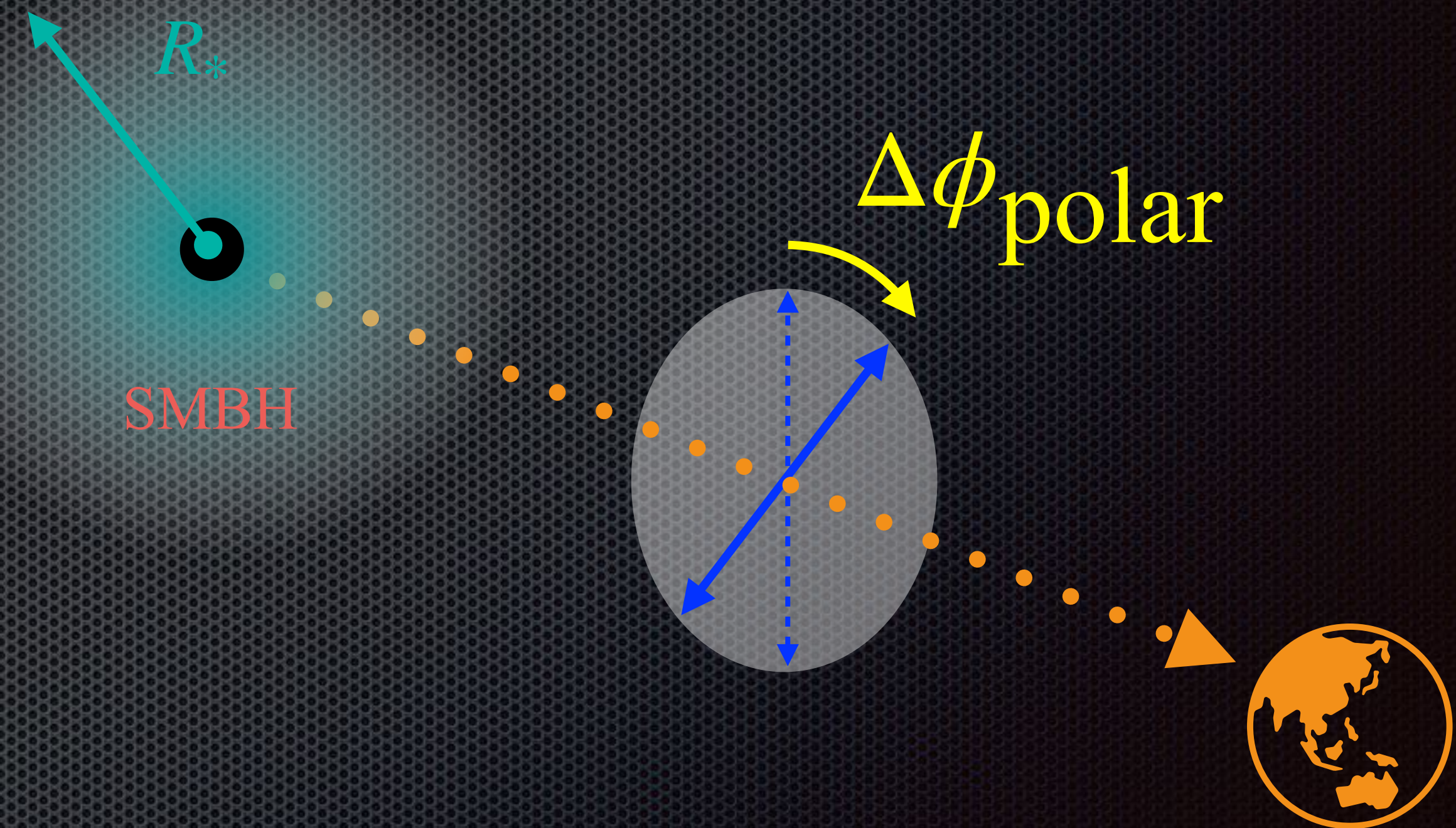
X. Gan, Tsai, 2023

Axion Dark Matter

Axion-Photon Interaction

$$\mathcal{L} \supset \frac{1}{4} g_{a\gamma\gamma} a F \widetilde{F}$$

$$\Delta\phi_{\text{polar}} = \frac{g_{a\gamma\gamma}}{2} (a_{\text{earth}} - a_{\text{source}})$$



X. Gan, L-T. Wang, H. Xiao, 2023

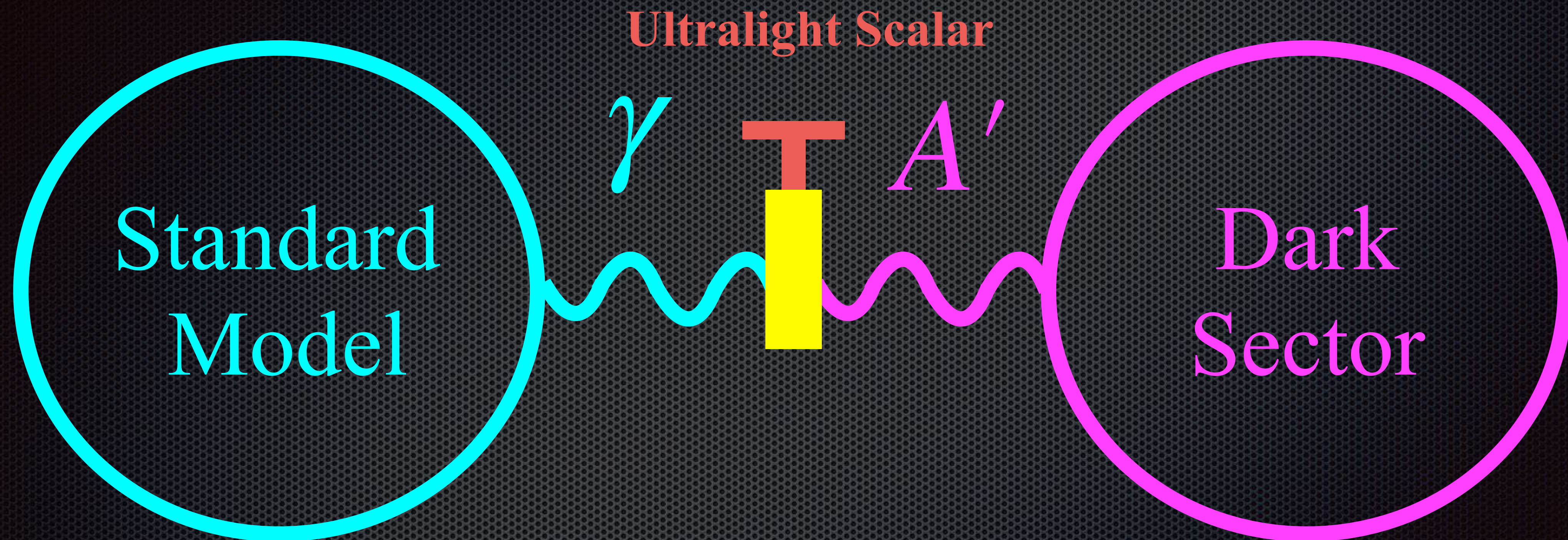
Higher Dimension Portals

$$\mathcal{L} = \mathcal{L}_{SM} + F_{\mu\nu} F'^{\mu\nu} + \frac{1}{\Lambda} \mathcal{O}_5 + \dots$$

	Only Photon	Photon + Dark Photon
CP-odd scalar	$a F \widetilde{F}$	$a F \widetilde{F}'$
CP-even scalar	ϕF^2	$\phi F F'$

Cosmologically Varying Kinetic Mixing
Xucheng Gan and Di Liu 2023

Cosmologically Varying Kinetic Mixing



Viable Dark Photon Dark Matter Model

Varying α_{em} + Fifth Force

My Future Plan

