

# SUSY Hidden Dark Photon

- SUSY:  $m_{A'} \sim \min \{ \sqrt{\epsilon} m_Z, \epsilon m_{MSSM} \}$   
[Arkani-Hamed+Weiner 2008; Cheung et al. 2009; DM, Poland, Zurek 2009; ...]
- Hidden Higgs fields spontaneously break the U(1)'.

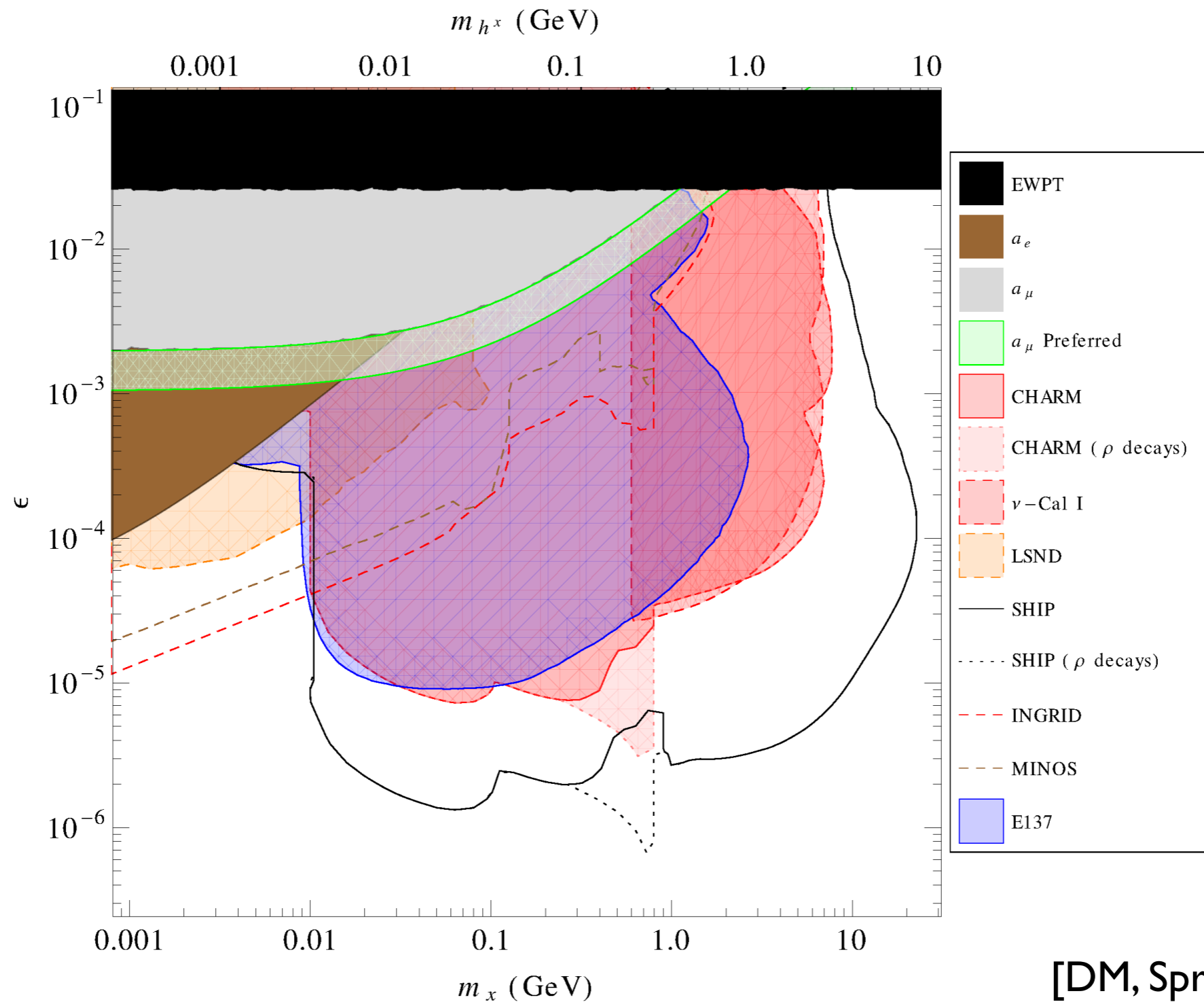
$$\mathcal{L} \supset \int d^2\theta \left( \underbrace{\frac{\epsilon}{2c_w} B^\alpha X_\alpha}_{\text{vector portal}} + \underbrace{\mu' H H'}_{\text{hidden Higgs fields}} \right) + (h.c.)$$

- Physical states:
  - 1  $A'$  massive hidden photon
  - 3  $\chi_{1,2,3}^x$  hidden fermion “neutralinos” (lightest is stable)
  - 2  $h_{1,2}^x$  hidden scalar Higgs bosons
  - 1  $a^x$  hidden pseudoscalar Higgs boson

# Experimental Signals of the Theory

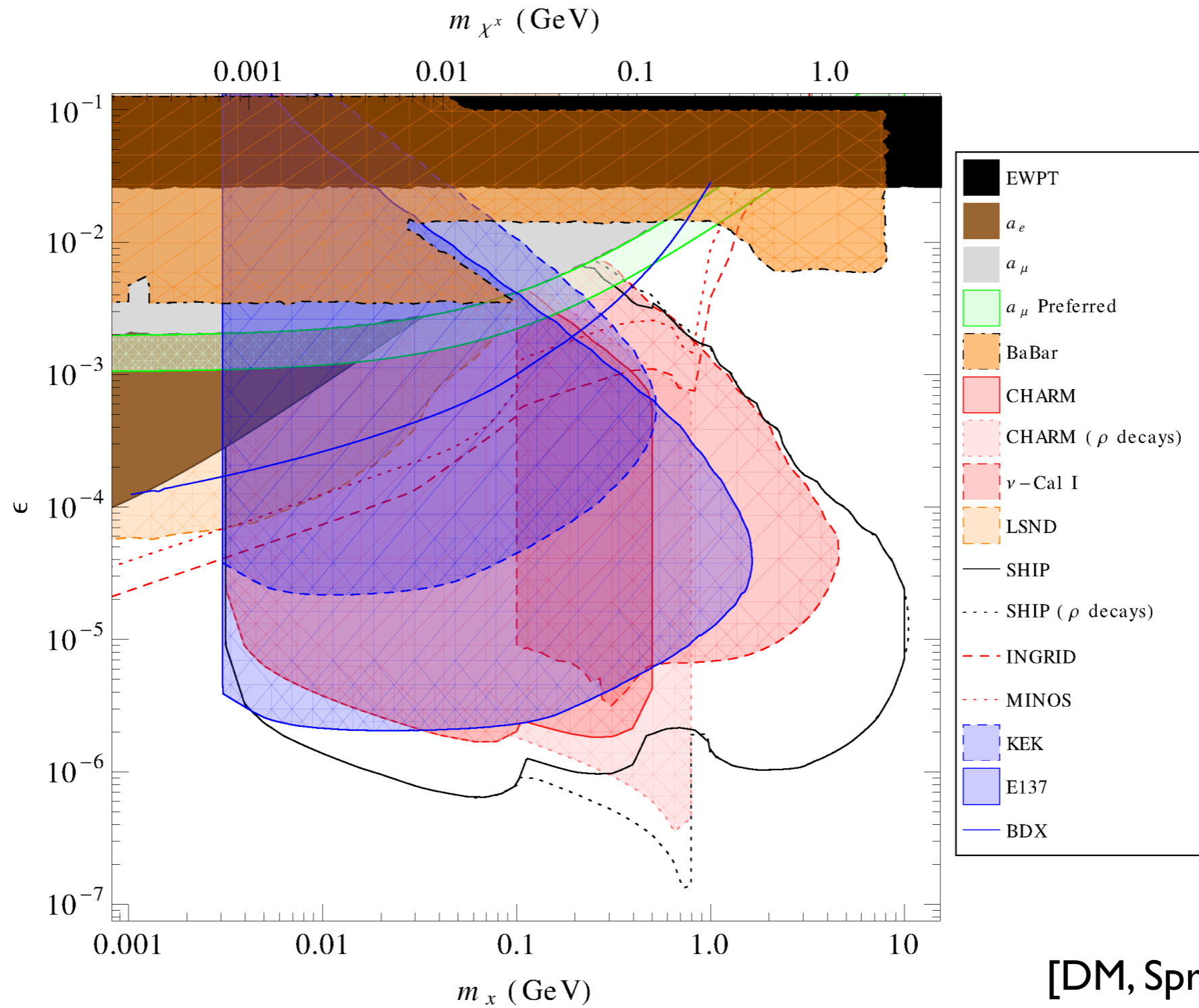
- Depend mainly on how the hidden photon decays. This is determined mostly by the mass spectrum.
- Four main cases:
  - A:  $A' \rightarrow SM + SM$ , similar to visible vector portal
  - B:  $A' \rightarrow \chi_1^x + \chi_1^x$ , similar to dark vector portal
  - C:  $A' \rightarrow h_1^x + a^x$ , not much attention [Schuster, Toro, Yavin 2009]
  - D:  $A' \rightarrow \chi_1^x + \chi_2^x$ , new!
- Focus on cases C and D. [DM, Spray 2014]  
 $h_1^x, a_x, \chi_2^x$  are typically long-lived.

# Case C - Limits



[DM, Spray 2014]

# Case D - Limits



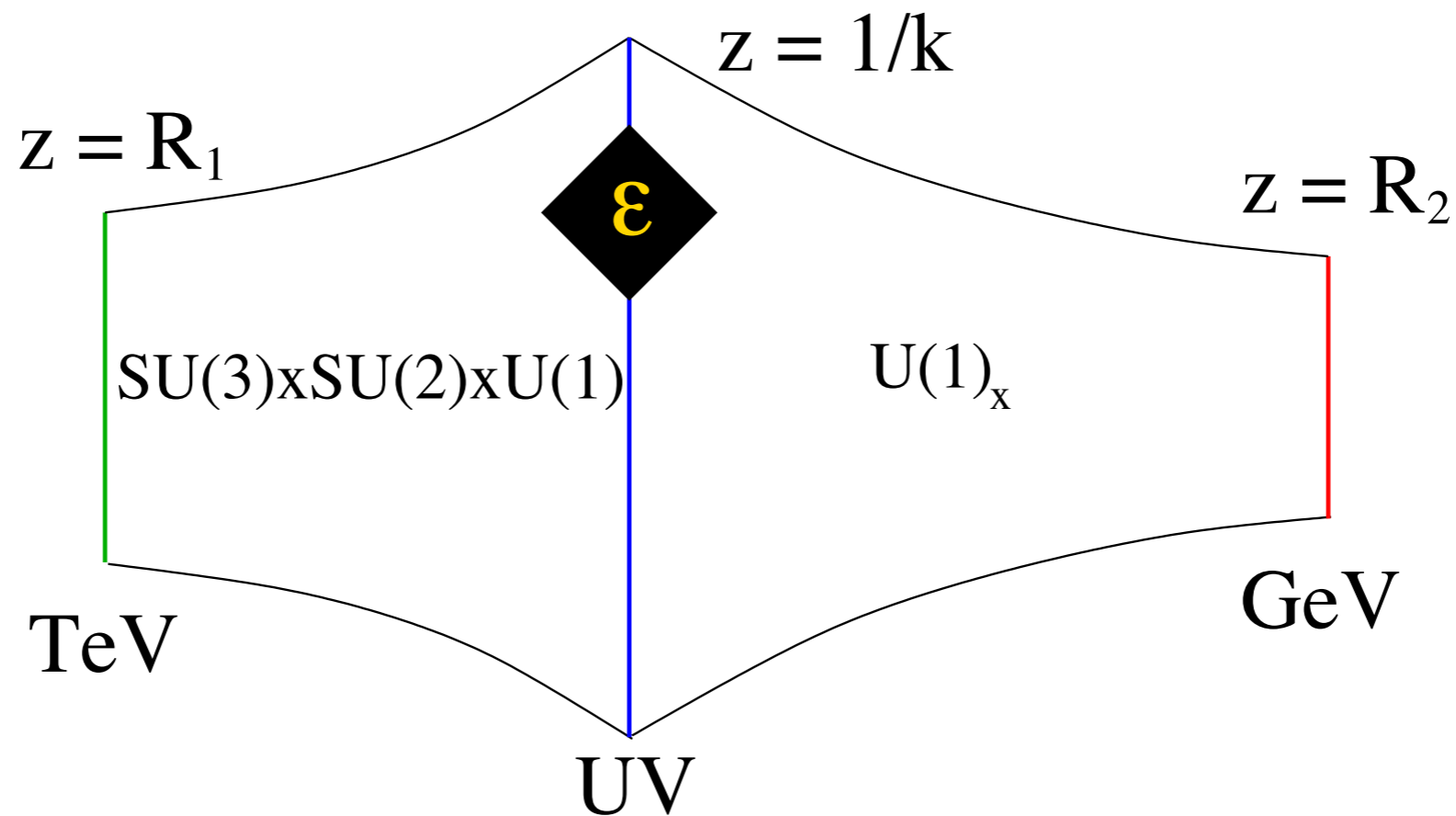
[DM, Spray 2014]

# Warped Dark Photon

- Warping (compositeness) can also produce a light  $A'$ .

[McDonald, DM 2010]

- Setup:



- Dark photon Kaluza-Klein partners,  $n = 1, 2, 3, \dots$

$$m_n \sim n m_x / \sqrt{\ln(M_{\text{Pl}}/m_x)}, \quad \epsilon_n \sim \epsilon / \sqrt{n \ln(M_{\text{Pl}}/m_x)}$$

# Warped Dark Photon

- Other dark states: [McDonald, DM 2011]
  - dark IR brane Higgs
  - dark bulk radion + KK modes
  - dark-localized graviton KK modes
- Higher KK modes cascade down giving multi-body signals.  
e.g.

