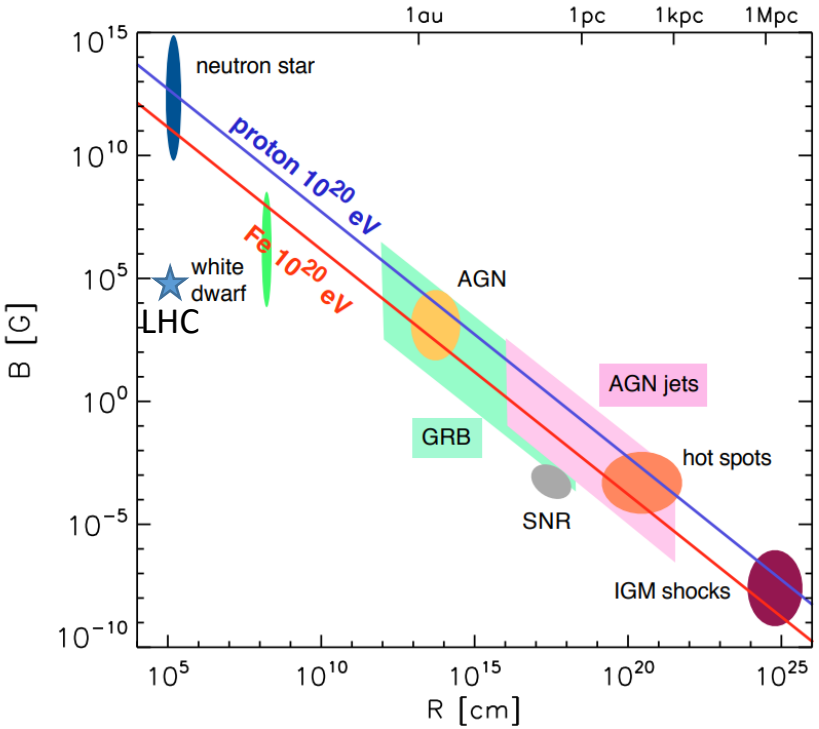
Particle Physics Beyond-the-Standard -Model with Cosmic Accelerators

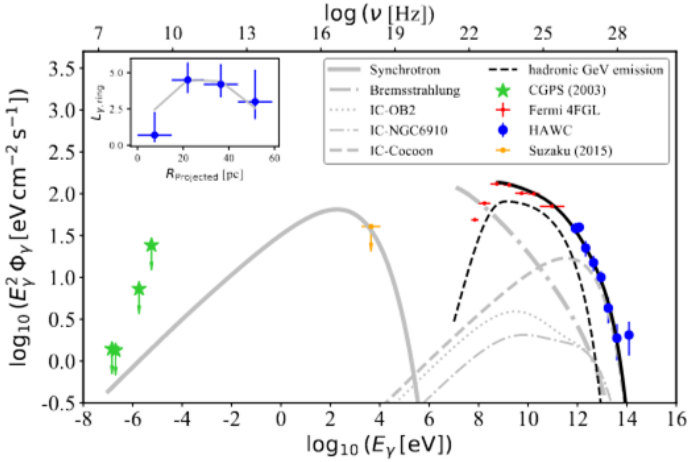
Pat Harding – Los Alamos National Lab

Captions

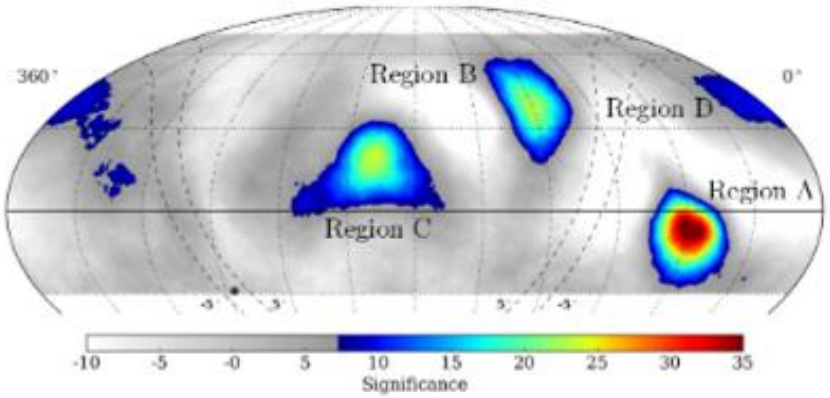


Kotera and Olinto, Annual Review of Astronomy and Astrophysics 49, 1 (2011)

HAWC observations of the acceleration of very-high-energy cosmic rays in the Cygnus Cocoon
Abeysekara+, Nature Astronomy 5 (2021)

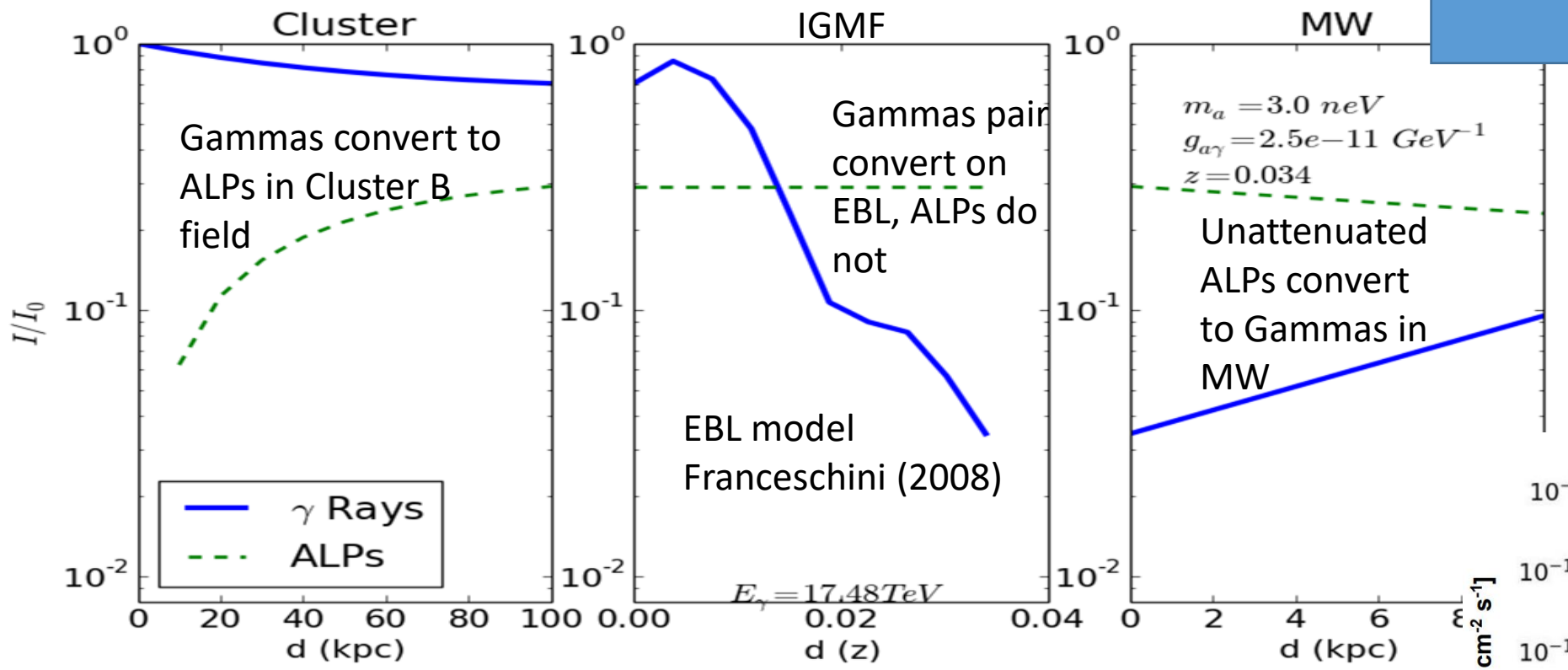


Observation of Anisotropy of TeV Cosmic Rays with Two Years of HAWC
Abeysekara+, ApJ 865, 1 (2018)

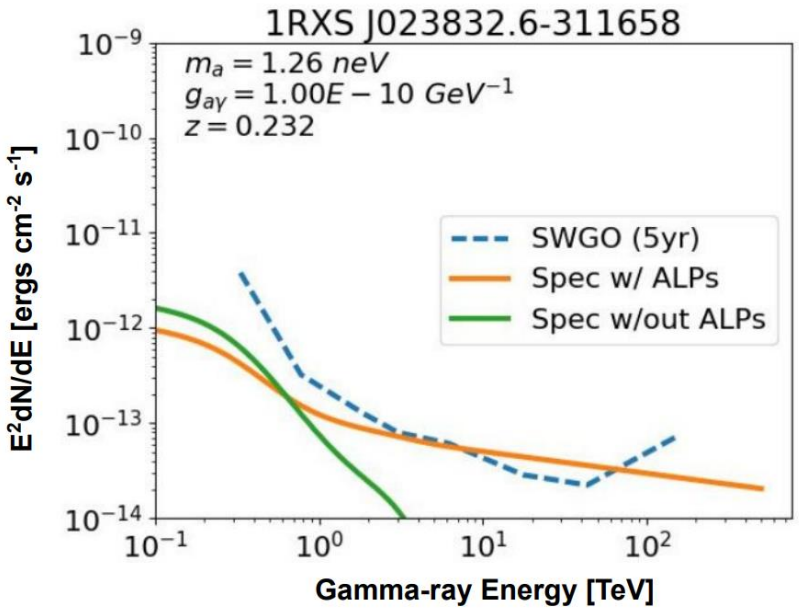


Searches for Axions and Axion-like Particles

Captions



A. Albert, Snowmass LOI



Violations of Lorentz Invariance

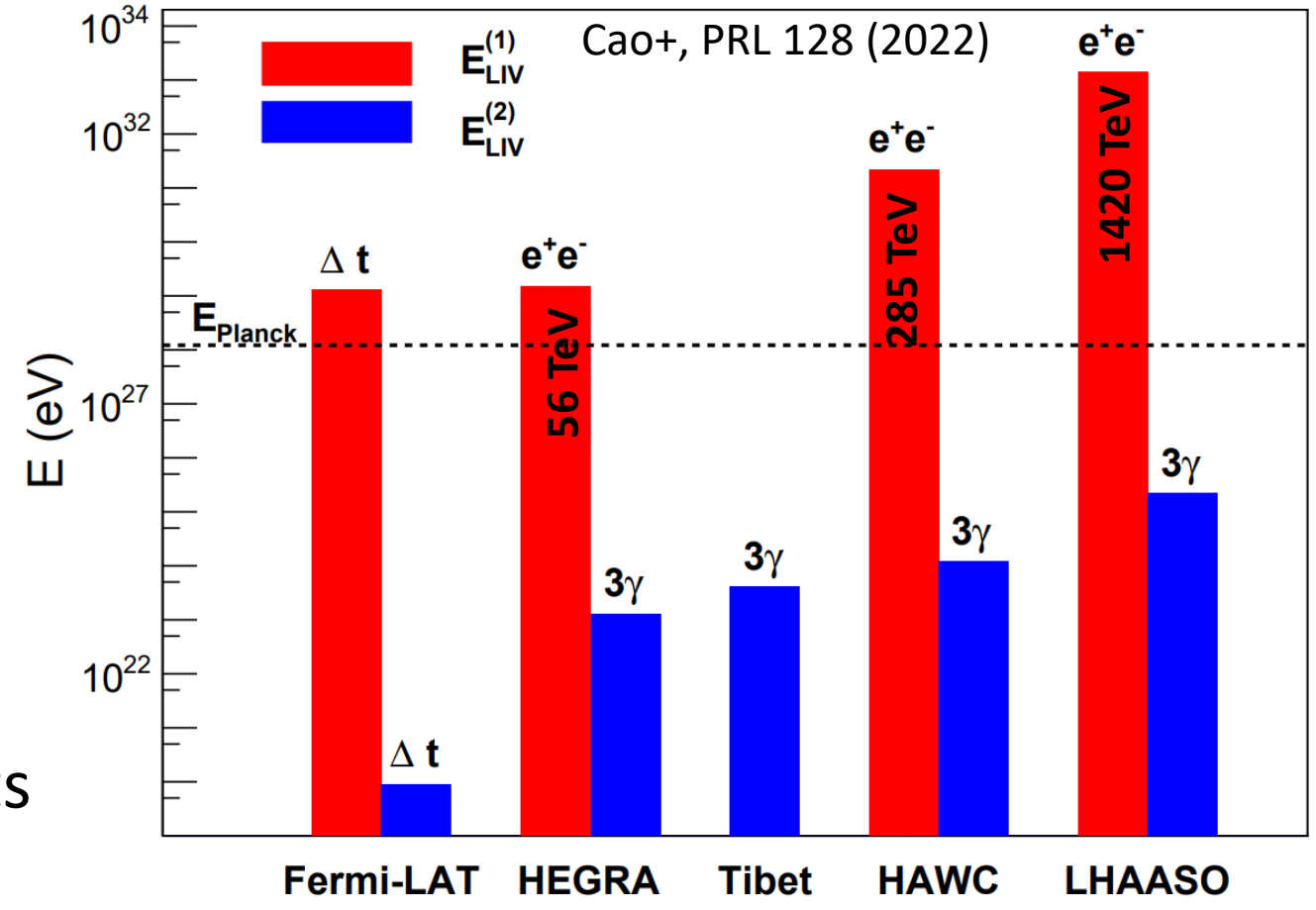
Captions

- At sufficiently high energies, and with sufficiently long free paths, photons will decay if GUT theories break Lorentz Invariance
  - No photons will survive above an energy of E_γ for a GUT scale of $E_{LIV}^{(n)}$

$$E_{\rm LIV}^{(1)} \gtrsim 9.57 \times 10^{23}{\rm eV} \left(\frac{E_\gamma}{\rm TeV}\right)^3$$

$$E_{\rm LIV}^{(2)} \gtrsim 9.78 \times 10^{17}{\rm eV} \left(\frac{E_\gamma}{\rm TeV}\right)^2$$

  - n=1 if GUT violates CPT
  - n=2 if GUT conserves CPT
- Also produces energy-dependent time lag on photons from transients



For more, see Albert+, PRL 124, 131101 (2020)