THE BERYLLIUM ANOMALY AND DARK COMPTON SCATTERING

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OUTLINE

A. J. Krasznhorkay *et al.*, “Observation of Anomalous Internal Pair Creation in ^{8}Be: A Possible Indication of a Light, Neutral Boson,” 1504.01527 [nucl-ex], PRL 116, 042501 (2016)

J. Feng *et al.*, “Protophobic Fifth Force Interpretation of the Observed Anomaly in ^{8}Be Nuclear Transitions,” 1604.07411 [hep-ph], PRL 117, 071803 (2016)

J. Feng *et al.*, “Particle Physics Models for the 17 MeV Anomaly in Beryllium Nuclear Decays,” 1608.03591 [hep-ph]

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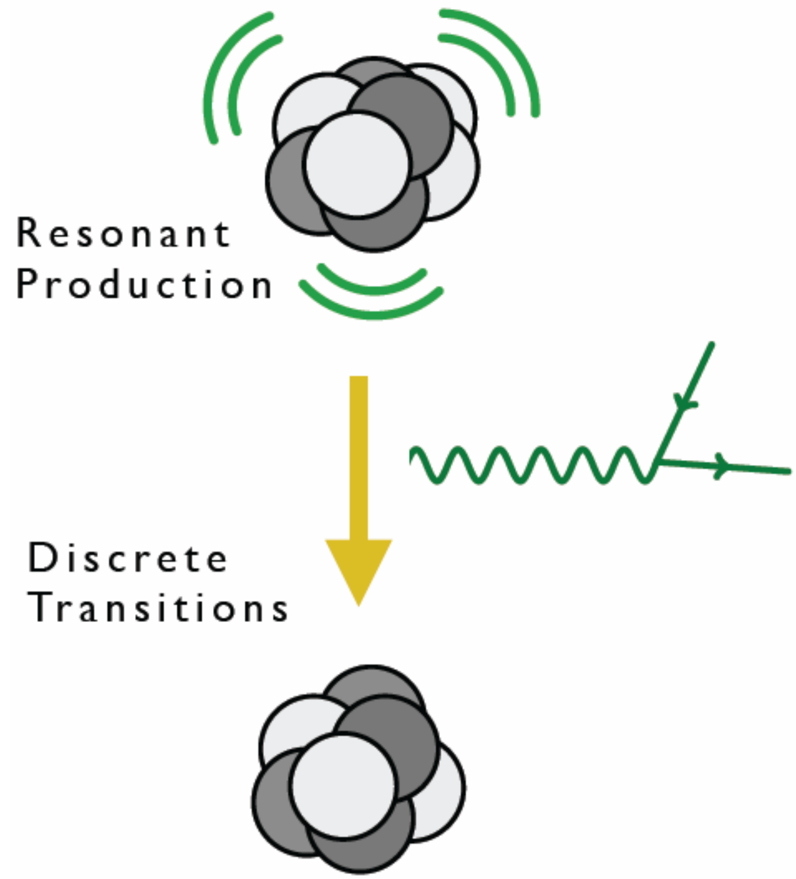
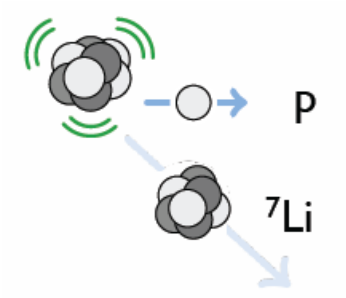
^{8}BE AS A NEW PHYSICS LAB

- ^{8}Be is composed of 4 protons and 4 neutrons
- Excited states can be produced in large numbers through p + ^{7}Li → high statistics "intensity" frontier
- Excited states decay to ground state with relatively large energies (~20 MeV)
- ^{8}Be nuclear transitions then provide interesting probes of light, weakly-coupled particles

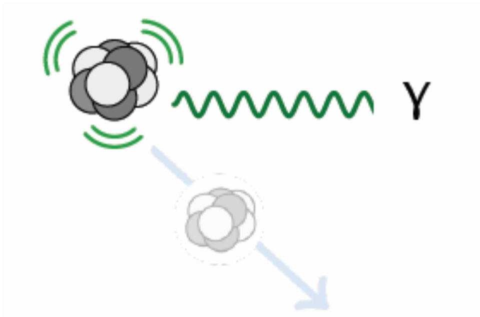


^{8}BE* DECAY

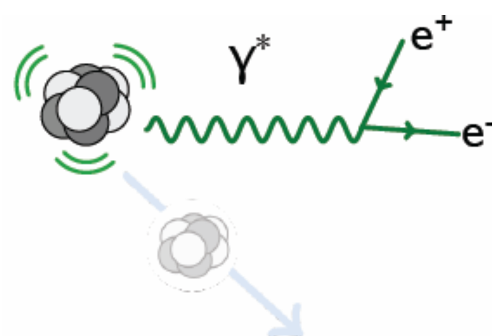
- Hadronic
  B(p ^{7}Li) ≈ 100%



- Electromagnetic
  B(^{8}Be γ) ≈ 1.5 x 10^{-5}

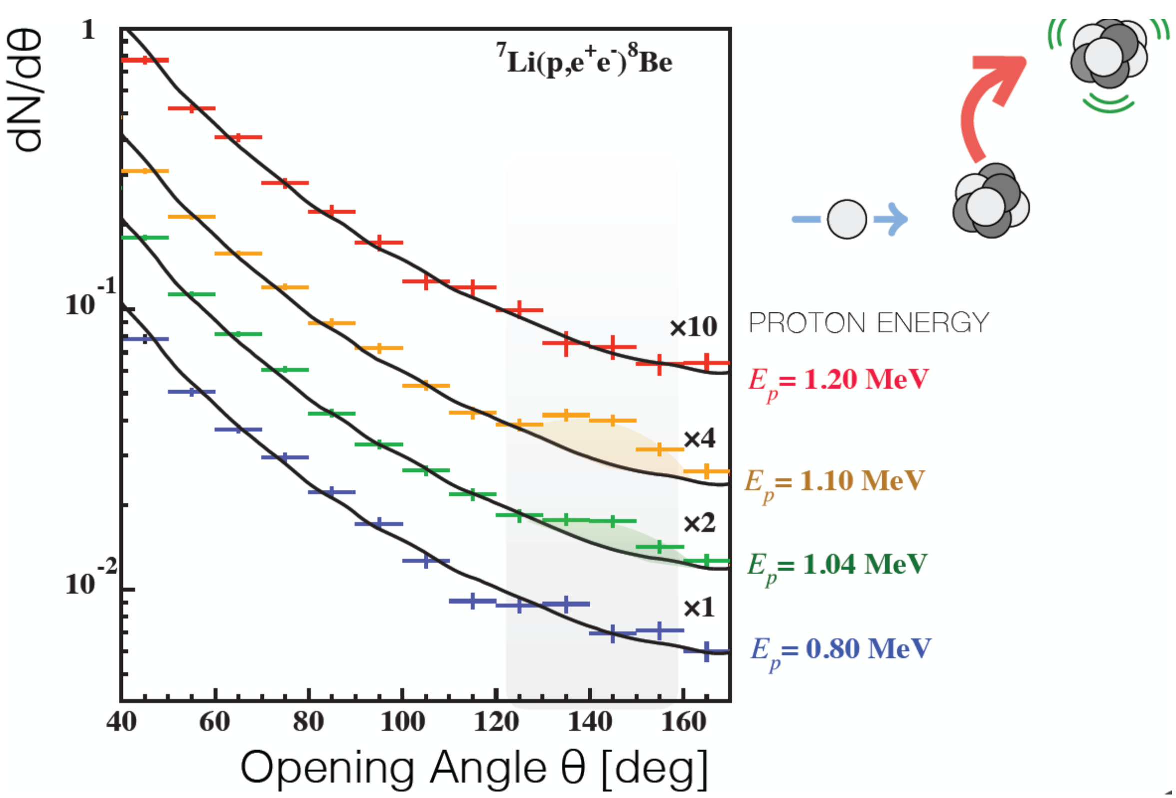


- Internal Pair Creation
  B(^{8}Be e^{+} e^{-}) ≈ 5.5 x 10^{-8}



THE ATOMKI ANOMALY

- A bump at ~140 degrees is observed as one passes through the ^{8}Be* resonance
- Background fluctuation probability: 5.6 x 10^{-12} (6.8σ)



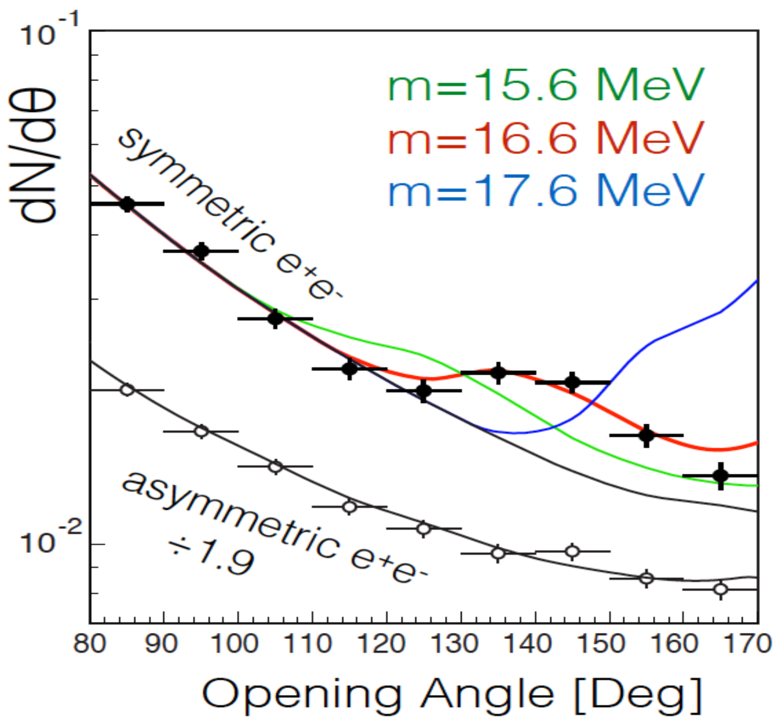
Krasznahorkay et al. (2015)

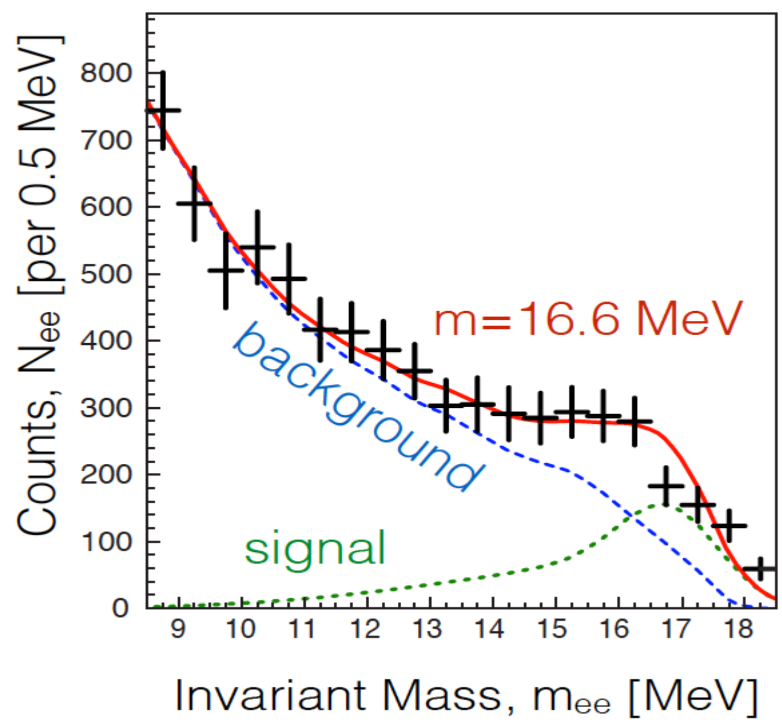
THE ATOMKI ANOMALY

- The e^+e^- opening angle θ (and invariant mass) distributions are well fit to a new particle: $\chi^2/\text{dof} = 1.07$

  m = 16.7 ± 0.35 (stat) ± 0.5 (sys) MeV

  $B(^8Be^* \rightarrow {}^8Be\ X) / B(^8Be^* \rightarrow {}^8Be\ \gamma) = 5.6 \times 10^{-6}$



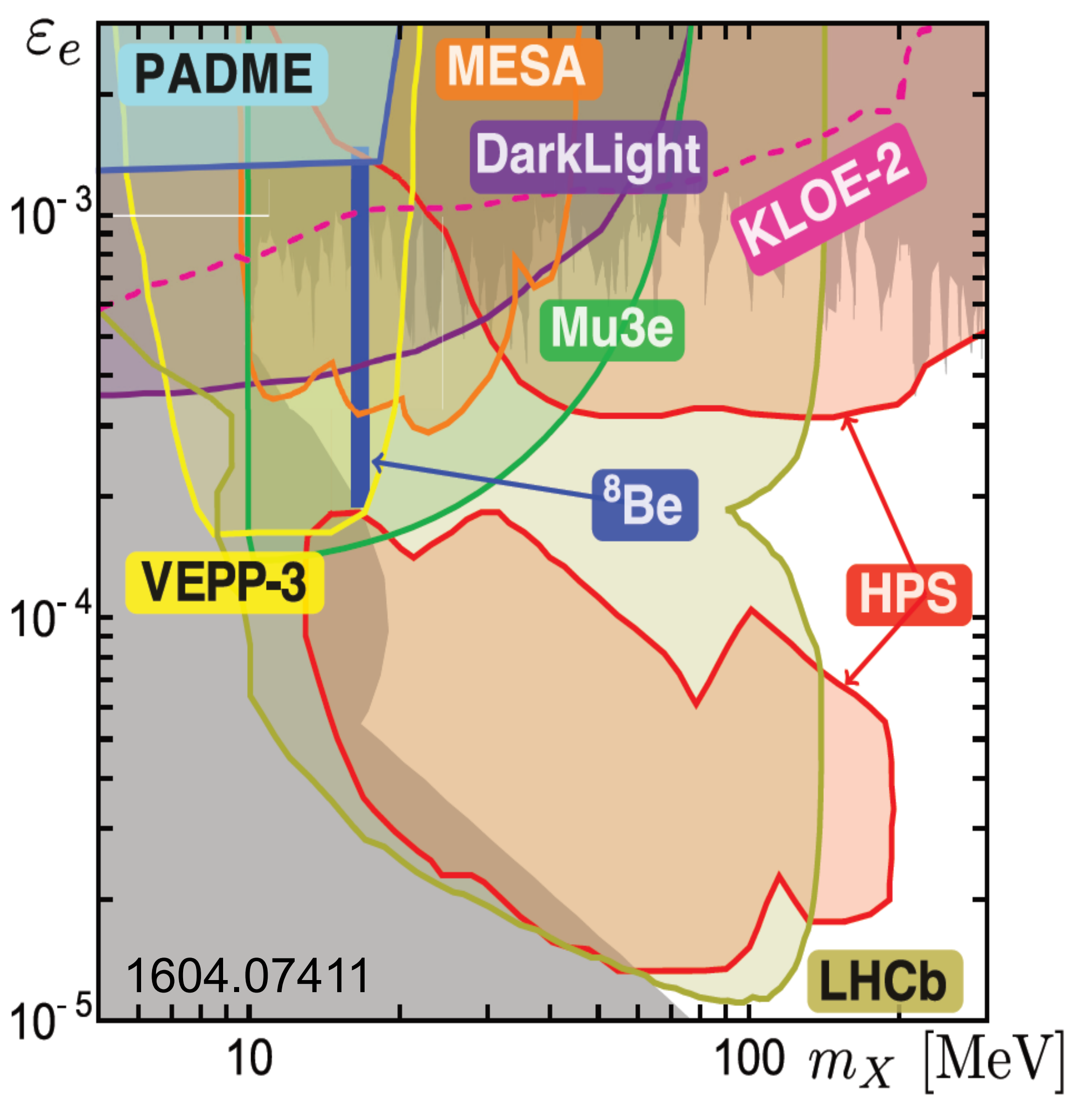


Krasznahorkay et al. (2015)

FUTURE TESTS: “DARK PHOTON” EXPTS

- Also SHiP, SeaQuest, … There are a host of experiments that have long been planned for dark photon searches, and may now be sensitive to the 17 MeV range.

- See “Advances in Dark Matter and Particle Physics 2016,” Messina, Italy, October 2016



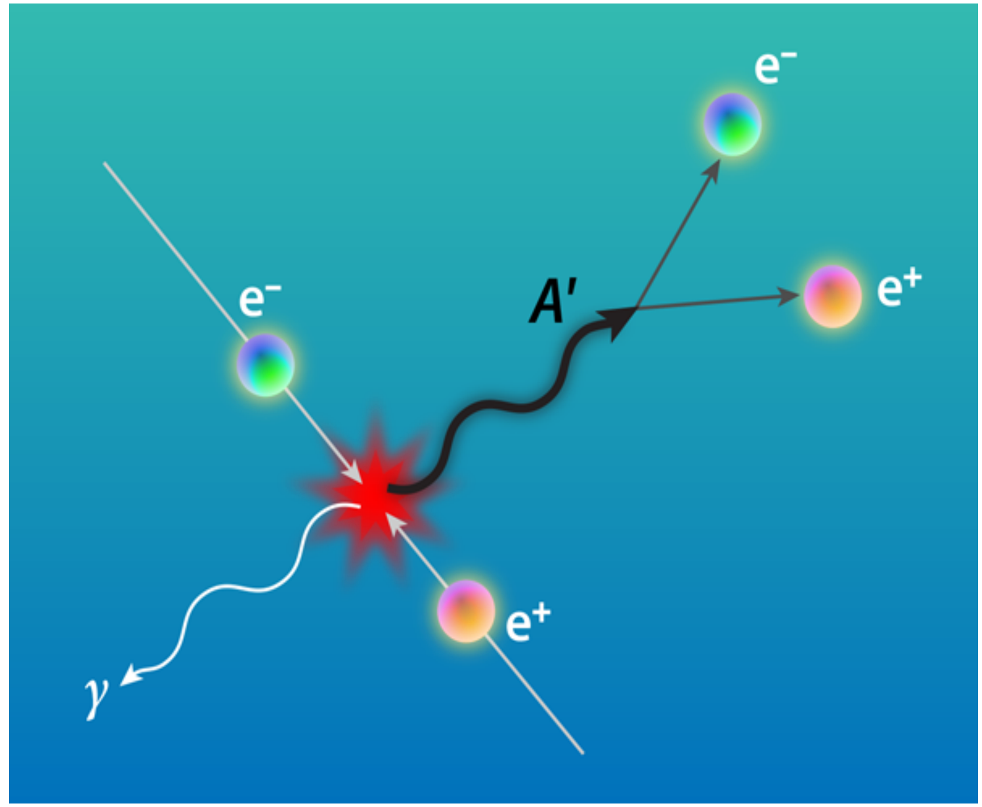
DARK COMPTON SCATTERING?

- A leading test is looking for X / A' production in e^- e^+ pair annihilation:

  $e^- e^+ \rightarrow \gamma A' \rightarrow \gamma e^- e^+$

- Alternatively, can reverse the e^+ line, look for X / A' production in Compton scattering:

  $\gamma e^- \rightarrow e^- A' \rightarrow e^- e^- e^+$



- Need photons with energy above $m_X \sim 20$ MeV, cross section is $\sim 10^{-6}\, \alpha^2 / m_X^2 \sim 0.1$ nb