Constraining contributions from Kr-85 in DEAP-3600

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DEAP-3600 Detector
- Dark matter experiment using argon pulse-shape discrimination, containing 3300 kg of liquid argon
- Single phase, liquid argon scintillation light detector
- Particle interactions in the argon induce scintillation light
- Photomultiplier tubes (PMTs) detect light from interactions inside the detector

Ar-39 Spectrum Investigation
- Deviations from the Ar-39 spectral shape can lead to implications for searches related to:
  - Radiative neutrinoless double electron capture of Ar-36
  - Weak magnetism in Ar-39
  - Sterile neutrino searches
- This work also directly informs on the energy response of the detector
- Several efforts are underway to study the Ar-39 spectrum in DEAP-3600, including Ar-39 activity, half-life, and spectral shape
- All of these studies require an extensive understanding of backgrounds to the Ar-39 spectrum
- One possible background is Kr-85, which is a radioactive isotope that can potentially bypass the purification methods used to fill the detector with argon

Constraining background from Kr-85 on Ar-39 activity and spectral shape measurements
- Possible contribution from Kr-85 in the Ar-39 spectrum
  - Kr-85 Q-value above Ar-39, $Q_{Kr-85} = 687$ keV while $Q_{Ar-39} = 565$ keV
- Full fit to Ar-39 data was completed, including electron recoil (ER) background
- Kr-85 spectrum is added to the Ar-39 spectrum in small, varied amounts
- Region above the endpoint of Ar-39 is the best place to search for signs of Kr-85 activity in DEAP-3600
- By varying the amount of Kr-85 included in the fit, we can observe the effect on the shape of the spectrum and compare it to data

Preliminary fit to data including electromagnetic recoil background spectrum. This fit includes 0.1% Kr-85 counts relative to the Ar-39 counts.

Any contribution from Kr-85 must be small
- Preliminary best fit shown here is at 0% additional krypton
- Still possible that there is some contribution from krypton given the uncertainties in this measurement
- Systematics including Ar-39 endpoint uncertainty and updated theoretical model are being evaluated
- Results from this study will have potential impacts on measurements of the Ar-39 specific activity, spectral shape, and half-life in DEAP-3600

Four fits with varying amounts of Kr-85 relative to Ar-39. The fit is completed on the full spectrum, with a small region shown here. These plots focus on the endpoint of the Ar-39 beta spectrum, which is fixed at 565 keV here. The endpoint of the Kr-85 beta spectrum is slightly higher, at 687 keV.

References

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