BSM Neutrino-Nucleus Interactions and the MiniBooNE Anomaly

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Neutrino–Nucleus Interactions in the Standard Model and Beyond

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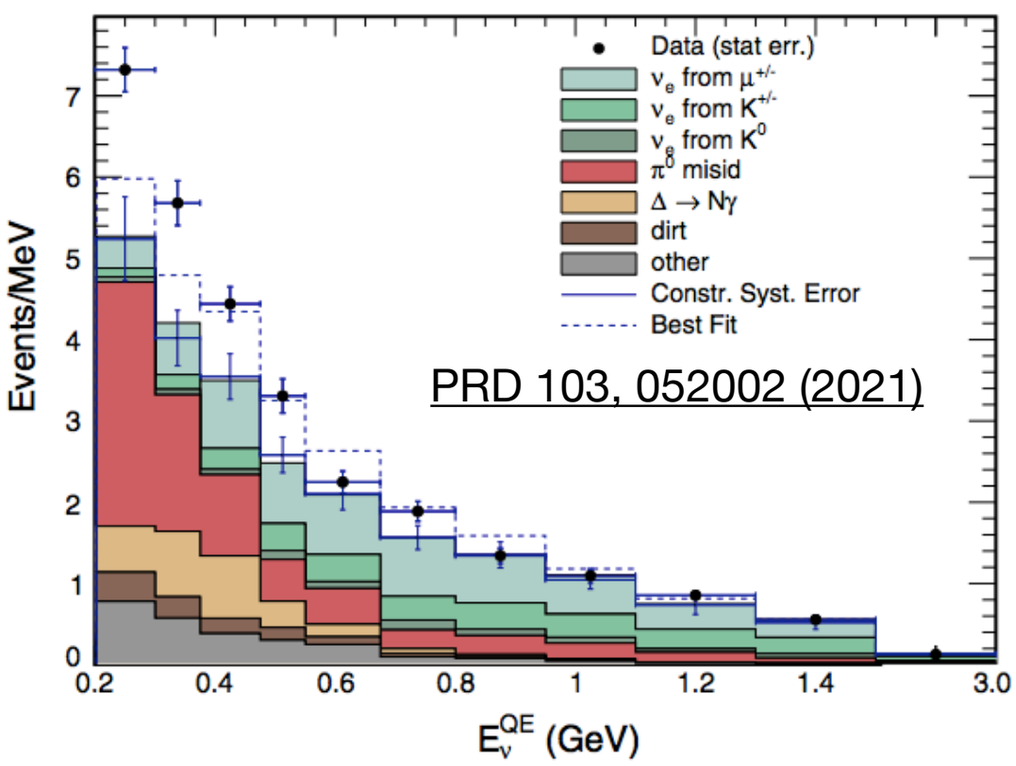
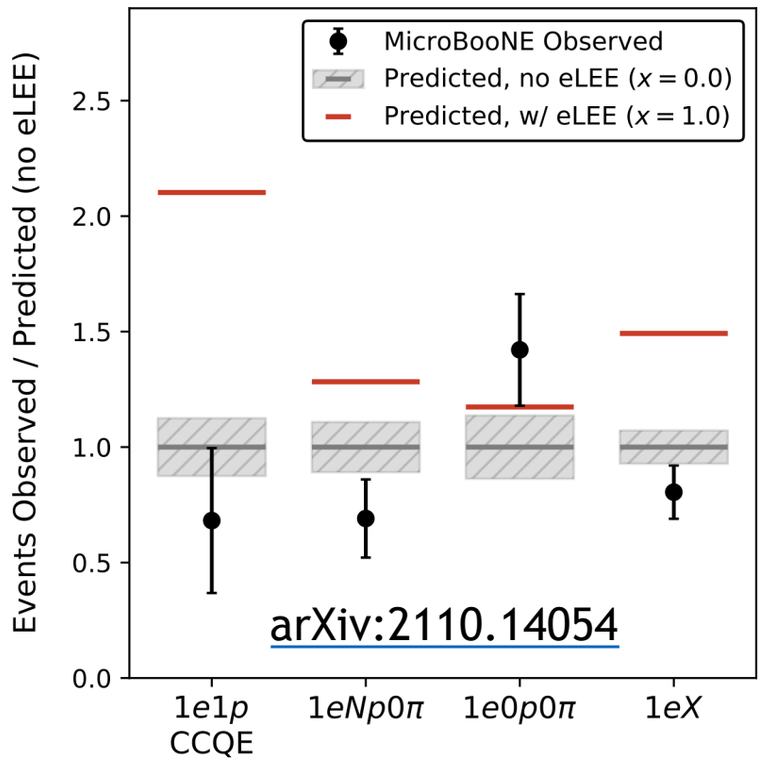
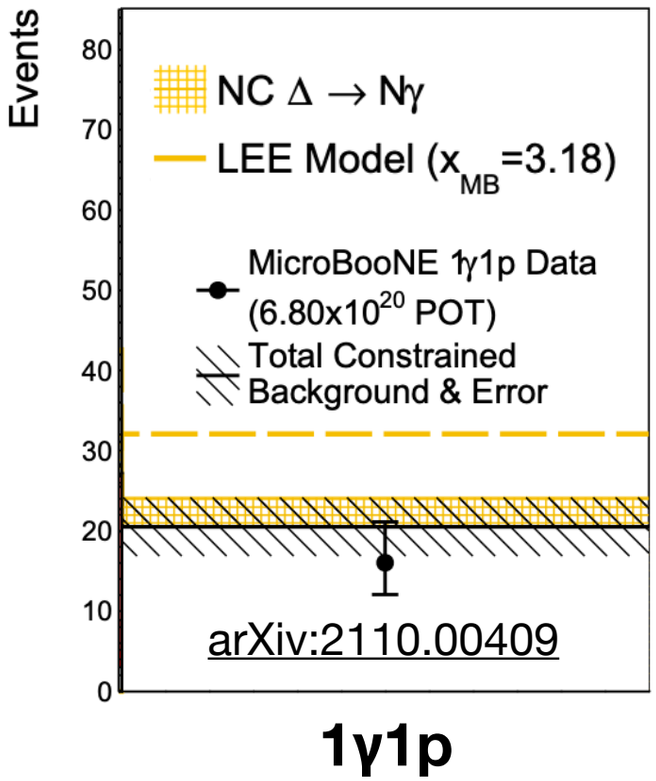
MiniBooNE & MicroBooNE

- Recent MicroBooNE results disfavor both electron neutrinos and NC $\Delta \rightarrow N\gamma$ events comprising the entirety of the MiniBooNE excess
  - Look for oscillation analyses and generic single photon search results in the near future!
- What other models could explain the anomaly?







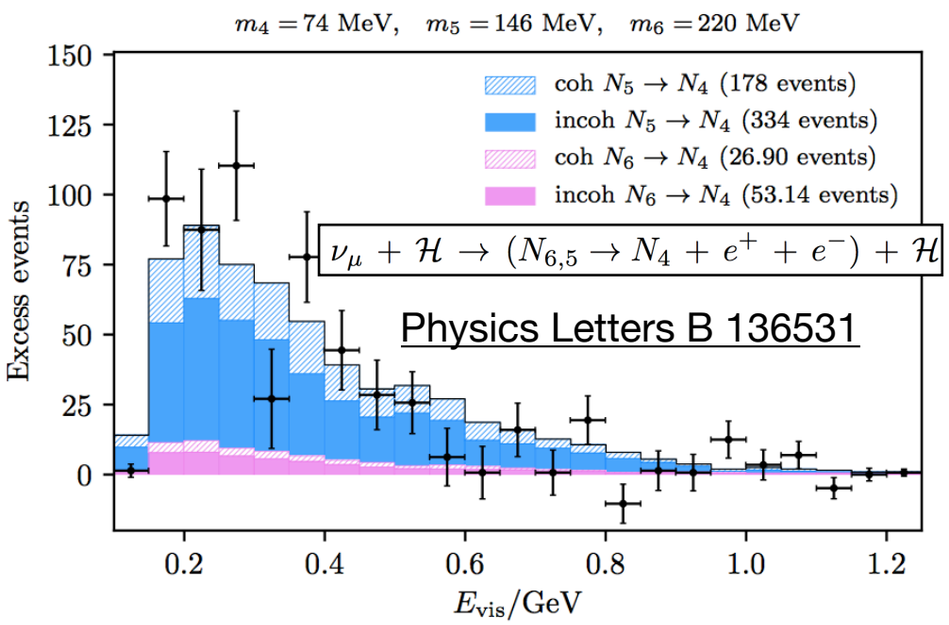
LEE BSM Landscape

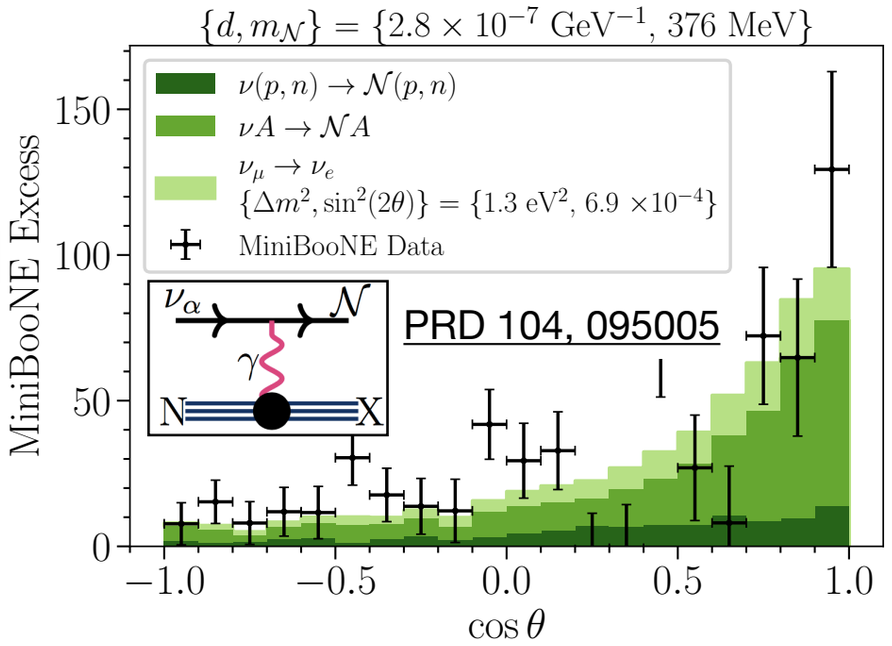
Already started probing with first LEE results

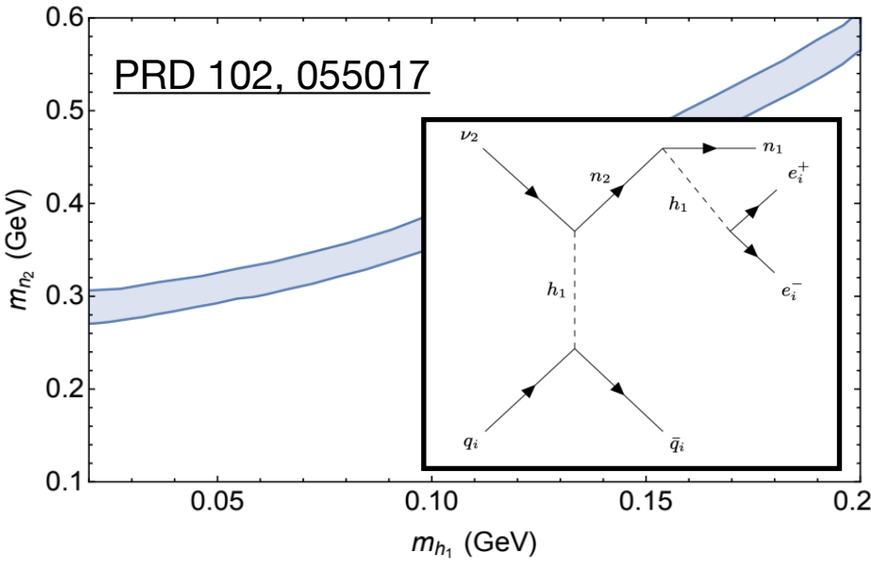
Models \ Reco topology	1e0p	1e1p	1eNp	1eX	e^+e^- + nothing	e^+e^-X	$1\gamma0p$	$1\gamma1p$	$1\gamma X$
eV Sterile ν Osc	✔	✔	✔	✔					
Mixed Osc + Sterile ν	✔[7]	✔[7]	✔[7]	✔[7]			✔[7]		
Sterile ν Decay	✔[13,14]	✔[13,14]	✔[13.14]	✔[13,14]			✔[4,11,12,15]	✔[4]	✔[4]
Dark Sector & Z' *	✔[2,3]				✔[2,3]	✔[2,3]	✔[1,2,3]	✔[1,2,3]	✔[1,2,3]
More complex higgs *					✔[10]	✔[10]	✔[6,10]	✔[6,10]	✔[6,10]
Axion-like particle *					✔[8]		✔[8]		
Res matter effects	✔[5]	✔[5]	✔[5]	✔[5]					
SM γ production							✔	✔	✔

*Requires heavy sterile/other new particles also

~all of these involve BSM neutrino-nucleus interactions!







- **New physic models explaining MiniBooNE must be consistent with the energy, angular, and timing distributions of the excess**
- **Knowledge of the hadronic part of each cross section calculation is crucial (see Pedro Machado's talk and Joshua Isaacson's talk)**

Table References

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  - *[6] Abdallah, Gandhi, Roy, Phys. Rev. D 104, 055028 (2021)*
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  - *[8] Chang, Chen, Ho, Tseng, Phys. Rev. D 104, 015030 (2021)*
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  - *[9] Brdar, Fischer, Smirnov, PRD 103, 075008 (2021)*

Produces true electrons

Produces true photons

Produces e^+e^- pairs