SnowMass2021

Amherst Center for Fundamental Interactions
Physics at the interface: Energy, Intensity, and Cosmic frontiers
University of Massachusetts Amherst

ACFI/Snowmass Workshop
"Neutrinoless ββ decay: Beyond the Tonne Scale"
(Part I – Dec 9-11)

co-organized by Neutrino and Rare Processes Frontiers (NF05, RF04)

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Day 1 working bullets (panels #1 and #2)

A message from Francesco Vissani (originator of the “lobster plot”):

“We have learned that seeking proof that neutrinos are Majorana particles is difficult, but this is an undertaking that requires us to measure ourselves against the times of history. I'm sorry I'm not there with you today (busy in another conference) but I'm with you in spirit and wish you good work and the best of luck.”

Working group #1

- Expressing LNV sensitivity in an EFT framework (setting standards for how to do this, complementarity between 0nBB and LHC searches)
- Spirit: some visualizations go a long way, even if incomplete (e.g. the ‘neutrino floor’ plots for WIMPs in the Snowmass 2013 report)
- Beyond/complement the lobster plot: 1) dim-7/9 operators: can we produce a poster child plot (despite model-dependence) to compare against same sign dilepton collider sensitivity and show them together? 2) can Seesaw-I be generalized and communicated? 3) is there a poster child plots for sterile neutrinos we could agree on adopting? 4) produce a consensus sketch for our report(s) with the EFT operators/models associated with increasing energy scales (see e.g. Zohreh’s slide #2), and pin our poster child models to it.
- Standardizations: 1) agree on using T_1/2 x G to factor out the nuclear/interaction part (see Biller’s plot); 2) Vincenzo: Comparison value is the new particle physics scale times coupling (still needs to divide by NME) 3) can we get from theorists an agreed-upon weighted range for NMEs we can all use?

Working Group #2

Drawing conclusions from null/positive observations (and the reverse, what sensitivities are necessary to be interesting)

- Vincenzo critiqued of null observation claims
- If ton scale sees something- Alexander Barabash started discussing this (how well do we need to measure in case of observation?)
- If not? What sensitivity does beyond the ton scale need to reach?
- When do we go for precision expt vs bigger expt?

Working Group #3: Tools to bridge the gap between experiment and theory

- Raised in various guises in both panels – nuclear theory of 0nubb and 2nubb is impenetrable for most experimentalists. To both guide program and assess detector capabilities, do we need better conduits to convey key theory predictions to experiments?
- "Automation" of theory predictions including EFT approaches, extension to light fields, incorporation of nuclear and particle physics uncertainties. Lukas already mentioned exciting work in this direction in Panel 1. Is this one tool enough for the whole community? Is input from wider theory space and / or from experiment needed? Work to define our needs here.
- Event Generators in 0nubb: Untangling the mechanisms of 0nubb can involve e.g. studying electron opening angle and energy sharing. Proper calculation involves handling nuclear and particle theory; the only way to study experimental capabilities is via some event generator often written within collaborations, duplicating work and possibly compromising robustness. Can we imagine a universal event generator with theorist and experimentalist input? If we can, it would be very valuable for cross-comparing experimental capabilities beyond ton scale, both for and after Snowmass. A good model here is e.g. the neutrino oscillation community, where GENIE provides a common development framework. Work to outline our needs here.
- Event generators in 2nubb and 2nuECEC: As above, but targeting the final state kinematics in other channels. The latter is hardest, involving complex atomic physics as well as nuclear physics. Define our needs here.

Working Group #4: The 2νββ Spectrum

- Setting goals for future experiments: What level of precision is needed on the 2νββ rate? What level of precision in the spectrum, and in what energy range? Does angular correlation/energy sharing information in the βs give extra information? If so, what precision is needed?
- Setting goals for theory: What is the level of theory uncertainties on the 2νββ spectral shape? Do these need to be improved?
- NMEs for 2νββ: How reliable are NMEs for cross-isotope comparison? Does there need to be a program to calculate 2νββ rates and measured excited state decays in an internally-consistent framework?

Working Group Room Links

- WG 1:Main room (stay here), https://umass-amherst.zoom.us/j/93043026048?pwd=bklJRHF5LzlHUVczdlkwT2RPaU5UZz09
- WG 2: https://stanford.zoom.us/j/96331716924?pwd=Uno1WHFLTE50Yjh1aUkxeXoxN1U2UT09
- WG 3: https://umass-amherst.zoom.us/j/94869729239?pwd=Y3VsK3pTKzRuRTV0V1NuYmxyK29Ddz0
- WG 4: https://unc.zoom.us/j/98869388054?pwd=MndPYUhuek85OGZRWTg0cW9oeTZodz09