HF-CRPA CCQE pull request

- Submitted by Stephen Dolan, Generator **pull request #271**

  - Implementation described in **Phys. Rev. D 106, 073001 (2022)**

  - Builds upon SuSAv2 infrastructure, not many code changes

  - Reviewed by Steven Gardiner, in good shape

- HF-CRPA model (CCQE only)

  - Nuclear response calculated using **H**artree-**F**ock mean field

  - Corrections for long-range correlations handled using **C**ontinuum **R**andom **P**hase **A**pproximation

  - Different flavor of RPA compared to Valencia

- Nonrelativistic, so recommendation is to interpolate to SuSAv2 at high momentum transfer

Code details

- Biggest change is the addition of many new hadronic tensor tables (and minor code changes to switch between them)

  - Nuclear response functions on a grid of (ω, q)

  - Same format as Valencia, SuSAv2

  - See **pull request #271** for the list of tables

- New configurations of HybridXSecAlgorithm allow use of the new tables

  - HybridXSecAlgorithm used in SuSAv2 implementation, delegates to Llewellyn-Smith for a free nucleon

- SuSAv2QELPXSec adjusted to also handle CRPA-flavor QE models

Adding HF-CRPA to a CMC

- All of this should be transparent to users, existing CMCs are expected to "just work"

- Only change needed to enable a CRPA-flavor QE model is in the CMC-specific ModelConfiguration.xml file:

```
<param type="alg" name="XSecModel@genie::EventGenerator/QEL-
CC"> genie::HybridXSecAlgorithm/CRPASuSAv2Hybrid-QEL </param>
```

- No new CMCs like this are added in the pull request

  - Add one for CRPA/SuSAv2 hybrid QE, otherwise the same as the SuSAv2 configuration? (G21_11a_00_000)

  - If so, how should we name it?

Merging status

- I've reviewed the code and think it looks reasonable

  - Changes look more extensive than they actually are

  - Mostly new tables and plumbing to manage them

  - Builds fine on my laptop, I can run CRPA-SuSAv2 hybrid events without trouble

- I would like to do a few more quick checks of existing models based on the same machinery

  - If I run plain SuSAv2 in master vs. the pull request, do I get the same physics? For both neutrinos and electrons

- Assuming those go well, the pull request is merge-ready as far as I'm concerned