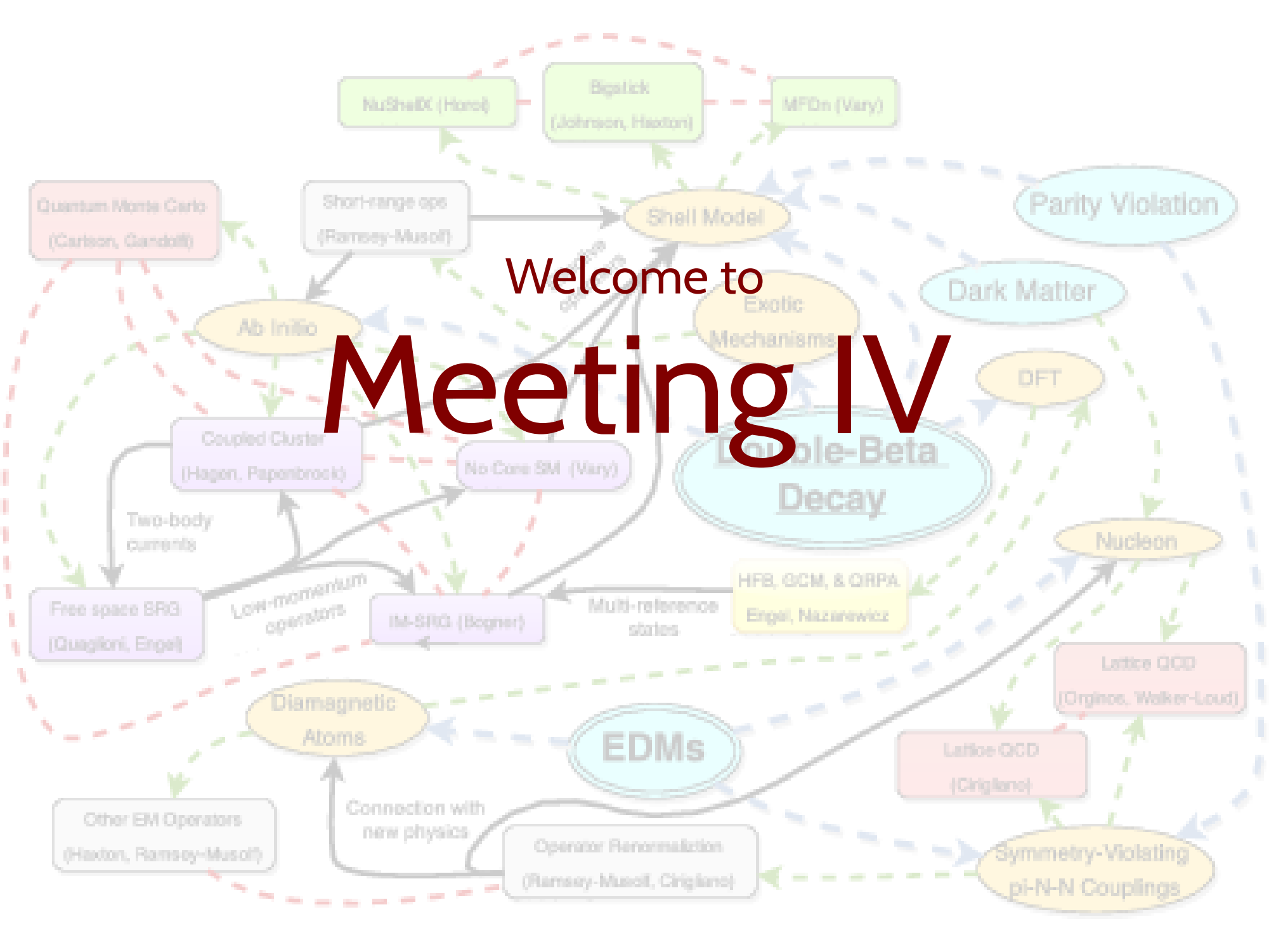
Welcome to
Meeting IV
NuShellX (Horoi)
BigStick (Johnson, Haxton)
MFDn (Vary)
Quantum Monte Carlo (Carlson, Gandolfi)
Short-range ops (Ramsey-Musolf)
Shell Model
Parity Violation
Ab Initio
Exotic Mechanisms
Dark Matter
DFT
Coupled Cluster (Hagen, Papenbrock)
No Core SM (Vary)
Double-Beta Decay
Two-body currents
Nucleon
Free space SRG (Quaglioni, Engel)
Low-momentum operators
IM-SRG (Bogner)
Multi-reference states
HFB, GCM, & QRPA Engel, Nazarewicz
Lattice QCD (Orginos, Walker-Loud)
Diamagnetic Atoms
EDMs
Lattice QCD (Origlano)
Other EM Operators (Haxton, Ramsey-Musolf)
Connection with new physics
Operator Renormalization (Ramsey-Musolf, Origlano)
Symmetry-Violating pi-N-N Couplings

What We're Supposed to Do

- ***Double-β decay***
- EDMs
- Dark matter
- Parity violation

What We're Supposed to Do

- ***Double-β decay*** Main focus of this meeting
- EDMs Main focus of last winter's meeting
- Dark matter
- Parity violation

Milestones

Year 1

- Beginning of QMC calculations of β decay in light nuclei. ✓
- Comparson of CCEI, IM-SRG and NSCM+core calculations of spectra in the lower sd-shell for systems with valence protons and neutrons. ✓
- Benchmark calculations of effective scalar operators (e.g. radii). in CCEI, IMSRG, and NCSM. ???
- First calculation of CP odd couplings from CEDM operators. ✓
- First calculation of $\bar{s}s$ and $\bar{c}c$ matrix elements for a single nucleon. ✗
- Development and benchmarking of proton-neutron superfluid DFT solver. ✗
- Survey of octupole deformation (which enhances Schiff moments) with standard UNEDfn functionals. Identification of best candidates for octupole enhancement.

Milestones

Year 2

- Completion of QMC calculations of β decay in light nuclei.
- SRG evolution of $\beta\beta$ operators in two-nucleon space.
- Benchmarking of CCEI with IM-SRG and NSCM+core for spectra and GT transitions in p- and sd-shell nuclei with valence protons and neutrons, comparison with QMC results where possible.
- Effective operators for GT β and $\beta\beta$ decay in Magnus IM-SRG jj-coupled code; benchmarks in ^{22}O and ^{24}O.

- Benchmark of phenomenological shell model for $\beta\beta$ decay in ^{48}Ca, in two model spaces.
- Full lattice results at physical pion mass and continuum limit for iso-vector CEDM, first results for iso-scalar CEDM, full results for single-nucleon dark-matter matrix elements.
- Development of GCM framework employing the proton-neutron superfluid DFT solver.
- Correlation analysis of Schiff moments with other observables to constrain T-violating πNN vertices.

Milestones

Year 2

- Completion of QMC calculations of β decay in light nuclei. ✓
- SRG evolution of $\beta\beta$ operators in two-nucleon space. Ready to test
- Benchmarking of CCEI with IM-SRG and NSCM+core for spectra and GT transitions in p- and sd-shell nuclei with valence protons and neutrons, comparison with QMC results where possible. ✓(largely, right?)
- Effective operators for GT β and $\beta\beta$ decay in Magnus IM-SRG jj-coupled code; benchmarks in ^{22}O and ^{24}O. β done (by our distinguished Canadian collaborators). Working on $\beta\beta$.
- Benchmark of phenomenological shell model for $\beta\beta$ decay in ^{48}Ca, in two model spaces. ✓ (in Japan)
- Full lattice results at physical pion mass and continuum limit for iso-vector CEDM, first results for iso-scalar CEDM, full results for single-nucleon dark-matter matrix elements. Lattice effort redirected to $\beta\beta$ decay.
- Development of GCM framework employing the proton-neutron superfluid DFT solver. Pursuing alternative track.
- Correlation analysis of Schiff moments with other observables to constrain T-violating πNN vertices. ?

Milestones

Year 3

- Beginning of QMC calculation of $\beta\beta$ decay in ^{48}Ca.
- Beginning of SRG evolution of non-scalar/isoscalar operator in three-nucleon space.
- Start of deriv. and impl. of three-particle attached equation-of-motion coupled-cluster method.
- Benchmarking of CCEI (with ^{40}Ca core) and full-space coupled-cluster calculations for GT and $\beta\beta$ decay in ^{48}Ca.
- Benchmarking of IM-SRG shell model (with ^{40}Ca core) and direct IM-SRG calculations of β and $\beta\beta$ decay in ^{48}Ca.
- Analytic representation for renormalized phenomenological effective $\beta\beta$ operators in light nuclei.
- $2\nu\beta\beta$ and $0\nu\beta\beta$ decay for ^{130}Te and ^{136}Xe in *jj*77 space with phenomenological Hamiltonians and bare operators.
- Benchmark of full three- and four-body $\beta\beta$ operators against effective sum-over-core two-body operators.
- Renormalization analysis of three-gluon operator and four-quark operators.
- First lattice calculation of two-nucleon dark-matter matrix elements.
- Atomic and nuclear phenomenology for EDM measurements, including influence of higher moments and Breit interaction corrections. Application to cases like ^{229}Pa, a candidate for future FRIB experiment.
- Isospin- and angular momentum-projected GCM with proton-neutron superfluid DFT solver. Computation of $\beta\beta$ matrix elements with UNEDFn Skyrme functionals and novel DME-EFT functionals.
- Survey of octupole deformation with novel DME-EFT functionals. Identification of enhancement.
- Shell-model calculations of dark-matter responses to identify optimal targets.

Milestones

Year 3

- Beginning of QMC calculation of $\beta\beta$ decay in ^{48}Ca.
- Beginning of SRG evolution of non-scalar/isoscalar operator in three-nucleon space. ✓
- Start of deriv. and impl. of three-particle attached equation-of-motion coupled-cluster method.
- Benchmarking of CCEI (with ^{40}Ca core) and full-space coupled-cluster calculations for GT and $\beta\beta$ decay in ^{48}Ca. Getting there
- Benchmarking of IM-SRG shell model (with ^{40}Ca core) and direct IM-SRG calculations of β and $\beta\beta$ decay in ^{48}Ca. Well, the first part is almost done…
- Analytic representation for renormalized phenomenological effective $\beta\beta$ operators in light nuclei.
- $2\nu\beta\beta$ and $0\nu\beta\beta$ decay for ^{130}Te and ^{136}Xe in *jj*77 space with phenomenological Hamiltonians and bare operators.
- Benchmark of full three- and four-body $\beta\beta$ operators against effective sum-over-core two-body operators. Almost there
- Renormalization analysis of three-gluon operator and four-quark operators.
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- Survey of octupole deformation with novel DME-EFT functionals. Identification of enhancement.
- Shell-model calculations of dark-matter responses to identify optimal targets.

Milestones

Year 4

- Completion of of QMC calculation of $\beta\beta$ decay in ^{48}Ca.
- Completion of implementation of SRG evolution of non-scalar/isoscalar operator in three-nucleon space.
- Effective one-, two-, and three-body interactions and operators for large-scale CCEI in ^{76}Ge and ^{82}Se
- Start of CCEI computations of $\beta\beta$ decay in ^{76}Ge.
- Development of IM-SRG extended space valence interactions and effective operators.
- Implementation of leading approximation to IM-SRG(3) for three-body operators.
- $2\nu\beta\beta$ and $0\nu\beta\beta$ decay for ^{76}Ge, ^{82}Se in extended shell model spaces with improved effective Hamiltonians and transition operators developed by CCEI and IMSRG.
- Use of renormalized operators in heavier isotopes through $sdg_{7/2}h_{11/2}$ shell to learn about expected rates.
- $\beta\beta$ decay by exotic mechanisms. Heavy-neutrino-exchange matrix elements for ^{76}Ge, ^{82}Se, ^{130}Te, and ^{136}Xe. Effects of the right-handed currents for the ^{82}Se.
- Benchmark of GCM+DFT results for $\beta\beta$ decay in ^{48}Ca against ab initio and shell-model methods.
- Analysis of one-quasiparticle states in odd-A octupole-deformed nuclei to find best parity doublets.
- Progress towards neutron EDM from CEDM operators.
- NCSM calculations of ^{18,19}F PNC matrix elements.
- Shell-model calculations of inelastic dark matter responses to constrain otherwise hidden interactions.

Milestones

Year 5

- Beginning of QMC approach to ^{76}Ge.
- Completion of study of SRG evolution of $\beta\beta$ operators in three-nucleon space. Use of results to re-evaluate all many-body $\beta\beta$ calculations.
- CCEI and IM-SRG shell-model calculations of $\beta\beta$ decay in ^{76}Ge. Uncertainty quantification.
- Shell-model (Bigstick) calculation of Schiff moment of ^{199}Hg.
- $\beta\beta$ matrix elements from GCM+DFT. Uncertainty quantification.
- Large-scale survey of Schiff moments for atomic EDM studies. Uncertainty quantification.
- Lattice calculation of the neutron EDM induced by EDMs of the up, down, and strange quark.
- Calculation of two-nucleon dark-matter matrix elements in continuum limit at physical pion mass.

Issues to Discuss

- ~~Collaboration-recommended "best values" for matrix elements~~
- Two-body currents and quenching
- New $\beta\beta$ EFT: do we have to switch frameworks?
- Updating benchmarks and milestones? Road map for next year
- ISU job search
- How to collaborate better

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Issues to Discuss

- ~~Collaboration-recommended "best values" for matrix elements~~
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- ISU job search ✓
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Benchmarking Ideas from August Conference Call

Possible work:

1. ^{6}He in CCEI, SM, QMC
2. Heavier isospin doublets: ^{14}C, ^{18}O, ^{42}Ca: CCEI, IMRSG, NCSM, SM
3. Closed-shell nuclei: ^{48}Ca (most important), ^{22}O, ^{24}O: IMSRG, CCEI, NCSM: Will standard truncations work?
4. ^{8}He? Is halo nature too much for HO-based methods
5. β and $2\nu\beta\beta$ in all of the above
6. In β decay, with and without normal ordering? Regulator?

Ideas to Improve Collaboration?

1. More and better-planned conference calls?
2. ??
3. ???
4. ????

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