Welcome to

# Meeting VII

- ***Double-$\beta$ decay***
- EDMs
- Dark matter
- Parity violation

# What We're Supposed to Do

▶ ***Double-β decay***    Main focus of this meeting

▶ EDMs

▶ Dark matter

▶ Parity violation

# Midterm Review

## Excerpts 🙂

forward in the theory and an unexpected obstacle. Combined with very high marks for productivity, creativity, and impact plus an impressive report and presentation, this state of affairs resulted in a numerical reviewer evaluation that is the second highest average overall score (89%) among the four TCs. As mentioned above, this evaluation should be understood in relation to the DBD milestones.
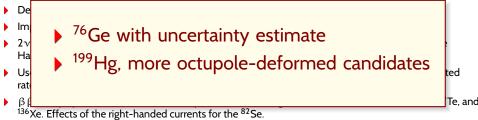
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The reviewers consider the productivity and impact of the DBD Collaboration outstanding, even in the context of the high marks given for this criterion to other TCs. In particular, the reviewers describe a surprisingly large impact of the Collaboration in the community, which is "potentially vast and already significant." The progress report of the Collaboration was highly valued by the reviewers, and the presentations at the review received even higher praise as "excellent."

# 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.

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  - $^{76}$Ge with uncertainty estimate
  - $^{199}$Hg, more octupole-deformed candidates
- Us
  rat
- $\beta\beta$ ... Te, and $^{136}$Xe. Effects of the right-handed currents for the $^{82}$Se.
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# Milestones

- ▶ 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.

# Milestones

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- $^{136}$Xe, $^{130}$Te, with uncertainty est.
- Neutron EDM
- Any and all other stuff

- 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.

# Program

**DBD Summer 2019 Collaboration Meeting**

**Friday 9/6**

- 9:00 Jon Engel -- Intro, report on midterm review
- 9:15 Henry Monge-Comacho -- $\beta\beta$ decay on the lattice
- 9:45 Vincenzo Cirigliano -- Developments in EFT of $\beta\beta$ decay
- **10:15 Coffee**
- 10:45 Peter Gysbers -- Developments in SRG for $\beta\beta$ decay
- 11:15 Saori Pastore (remote) -- $\beta\beta$ decay in QMC*
- 11:45 Discussion
- **12:15 Lunch**
- 2:00 Sam Novario -- Coupled clusters results for $\beta\beta$ decay
- 2:30 Jiangming Yao -- IM-GCM results for $\beta\beta$ decay
- **3:00 Coffee**
- 3:30 Ragnar Stroberg (remote) --- SM-IMSRG results for $\beta\beta$ decay
- 4:00 Jon Engel --- GCM technique of Calvin and Changfeng
- 4:15 Discussion

**Saturday 9/7**

- 9:00 Wick Haxton -- Power counting in HOBET
- 9:30 James Vary -- $\beta\beta$ decay in the NCSM
- 10:00 Scott Bogner -- Factorization and $\beta\beta$ decay
- **10:30 Coffee**
- 11:00 Jordy deVries -- Nuclear EDMs
- 11:30 Yuchen Cao -- Octupole deformation and Schiff moments
- 12:00 Discussion
- **1:00 Adjourn**

# Issues to Discuss

- How to fix new terms in EFT (again)

- Canadian-colleague coordination

- Can we begin to work on uncertainty estimation?

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