EXO-200 Status

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April 12th, 2008
APS April Meeting
DOUBLE BETA DECAY

\[ [T_{1/2}^{2\nu\beta\beta}]^{-1} = G^{2\nu\beta\beta} |M^{2\nu\beta\beta}|^2 \]

\[ [T_{1/2}^{0\nu\beta\beta}]^{-1} = G^{0\nu\beta\beta} |M^{0\nu\beta\beta}|^2 \langle m \rangle^2 \]

NEUTRINOLESS

MASS MEASUREMENT

\[ \langle m_{\beta\beta} \rangle = \left| \sum_{i=1}^{3} U_{ei}^2 m_i e^{i\alpha_i} \right| \propto [T_{1/2}^{0\nu\beta\beta}]^{-1/2} \]

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EXO-200
**Xe Isotopes**

- **Current Limits**
  - $T_{1/2}^{0\nu\beta\beta} > 1.2 \times 10^{24} \text{ year}$
  - $T_{1/2}^{2\nu\beta\beta} > 1 \times 10^{22} \text{ year}$

- **Xe Advantages**
  - High Q: 2.48 MeV
  - Scintillation and Ionization
  - Purification, reusability
  - Easy to enrich
  - Background rejection with Ba$^{++}$

Mass spectra from RGA – 2001 test sample enriched to 89.5% in Xe$^{136}$. 

**136 Xe**
**TIME PROJECTION CHAMBER**

**DESIGN CONSIDERATIONS**
- Low Background
- Large Mass
- Resolution

**WHAT WE SEE**

Ground  -75kV  Avalanche Photodiodes

 Ionization

Scintillation
**MEASUREMENT STRATEGY**

\[ \sum E(e^-) \text{ MEASUREMENT} \]

**ANTICORRELATION**

**EXO-200 SENSITIVITIES**

<table>
<thead>
<tr>
<th>Case</th>
<th>Mass (ton)</th>
<th>Eff. (%)</th>
<th>Run Time (yr)</th>
<th>( \sigma_E/E ) @2.5 MeV (%)</th>
<th>Radioactive BG (events)</th>
<th>( T_{1/2}^{0\nu} ) (yr)</th>
<th>90%CL</th>
<th>Majorana Mass (meV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXO200</td>
<td>0.2</td>
<td>70</td>
<td>2</td>
<td>1.6</td>
<td>40</td>
<td>6.4 x 10^{25}</td>
<td>133</td>
<td>186</td>
</tr>
</tbody>
</table>

2) Caurier, et. al., arXiv:0709.2137v1
Cryostat Design

Massive Effort on Materials Qualification - Database of ~330 Entries
D. S. Leonard et al., arXiv:0709.4524 (NIM A)
INSTALLATION AT WIPP

THE MINE

WIPP Facility and Stratigraphic Sequence

Module 1

EXO-200

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### EXO Sensitivities

<table>
<thead>
<tr>
<th>Case</th>
<th>Mass (ton)</th>
<th>Eff. (%)</th>
<th>Run Time (yr)</th>
<th>$\sigma_E/E@2.5\text{MeV}$ (%)</th>
<th>$2\nu\beta\beta$ BG (events)</th>
<th>$T_{1/2}^{0\nu}$ (yr)</th>
<th>Majorana Mass (meV)</th>
<th>QRPA$^1$ NSM$^2$</th>
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</thead>
<tbody>
<tr>
<td>Conservative</td>
<td>1</td>
<td>70</td>
<td>5</td>
<td>1.6</td>
<td>0.5 (use 1)</td>
<td>$2 \times 10^{27}$</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td>Aggressive</td>
<td>10</td>
<td>70</td>
<td>10</td>
<td>1</td>
<td>0.7 (use 1)</td>
<td>$4.1 \times 10^{28}$</td>
<td>5.3</td>
<td>7.3</td>
</tr>
</tbody>
</table>

2) Caurier, et. al., arXiv:0709.2137v1

### Restraining Mixing Hierarchy

![Graph showing normal and inverted neutrino mass spectra with inferred mass differences and effective mass values.](image)

- Normal: $\langle m_{\beta\beta} \rangle \approx 100 \text{ meV}$
- Inverted: $\langle m_{\beta\beta} \rangle \approx 20 \text{ meV}$
- Minimum neutrino mass: $\approx 5 \text{ meV}$
# The Experiment

<table>
<thead>
<tr>
<th>EXO Collaboration</th>
</tr>
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<tbody>
<tr>
<td>Physics Dept, University of Alabama, Tuscaloosa AL</td>
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<td>P.Vogel</td>
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<td>Carleton University, Ottawa, Canada</td>
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<td>Colorado State University, Fort Collins CO</td>
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<td>Physics Dept UC Irvine, Irvine CA</td>
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<tr>
<td>D.Akimov, I.Alexandrov, A.Burenkov, M.Danilov, A.Dolgolenko, A.Kovalenko, V.Stekhanov</td>
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<tr>
<td>ITEP Moscow, Russia</td>
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<tr>
<td>J.Farine, D.Hallman, C.Virtue, U.Wichoski</td>
</tr>
<tr>
<td>Laurentian University, Canada</td>
</tr>
</tbody>
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**Motivation**

**Current Work**

**EXO - Ton Scale**