Title:	Probing the Absolute Mass Scale of Neutrinos
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The experimental efforts of the Neutrino Physics Group at MIT center primarily around the exploration of neutrino mass and its significance within the context of nuclear physics, particle physics, and cosmology. The group has played a prominent role in the Sudbury Neutrino Observatory, a neutrino experiment dedicated to measure neutrino oscillations from ^{8}B neutrinos created in the sun. The group is now focusing its efforts in the measurement of the neutrino mass directly via the use of tritium beta decay. The MIT group has primary responsibilities in the Karlsruhe Tritium Neutrino mass experiment, expected to begin data taking by 2013. Specifically, the MIT group is responsible for the design and development of the global Monte Carlo framework to be used by the KATRIN collaboration, as well as responsibilities directly associated with the construction of the focal plane detector. In addition, the MIT group is sponsoring a new research endeavor for neutrino mass measurements, known as Project 8, to push beyond the limitations of current neutrino mass experiments. The following report summarizes the activities undertaken by the MIT group from 2006-2011 on each of these projects.

***SNO*:** Since 2006, the MIT Neutrino group has been engaged in the analysis of the solar flux data from both the NCD phase of the experiment and the final 3-phase measurements undertaken by the collaboration. Two Ph.D.'s were awarded from MIT for work pertaining to the SNO experiment: (1) a measurement of the cosmic ray and atmospheric neutrino flux at the Sudbury Neutrino Observatory (Thomas Sonley, 2008), and (2) the measurement of the day-night asymmetry using the data collected throughout the entire duration of the experiment (Richard Ott, 2011). A number of other papers and publications have been released since 2006 with full involvement of the MIT neutrino group. All of the milestones for this project have been met.

SNO Collaboration, "*Combined Analysis of all Three Phases of Solar Neutrino Data from the Sudbury Neutrino Observatory", arXiv:1109:0763, submitted to PRC (2011).*

SNO Collaboration , *"Calibration of Muon Reconstruction Algorithms Using an External Muon Tracking System at the Sudbury Neutrino Observatory", Nucl. Instr. and Meth. A 648, 92 (2011).*

SNO Collaboration, *"A Monte Carlo Simulation of the Sudbury Neutrino Observatory Proportional Counters", New J. Phys. 13 (2011) 073006 (2011).*

SNO Collaboration, *``Low Multiplicity Burst Search at the Sudbury Neutrino Observatory", Astrophys. J. 728:83 (2011).*

SNO Collaboration, *"Low Energy Threshold Analysis of the Phase I and Phase II Data Sets of the Sudbury Neutrino Observatory",* Phys. Rev. C 81:055504 (2010).

SNO Collaboration, *"Measurement of the Atmospheric Neutrinos at the Sudbury Neutrino Observatory*", Nucl. Phys. A827, 498 (2009).

SNO Collaboration, "*High Sensitivity Measurement of ^{244}Ra and ^{226}Ra in Water with an Improved Hydrous Titanium Oxide Technique at the Sudbury Neutrino Observatory*", Nucl. Inst. And Meth. 604, 531 (2009).

SNO Collaboration, *"An Independent Measurement of the Total Active ^{8}B Solar Neutrino Flux Using an Array of ^{3}He Proportional Counters at the Sudbury Neutrino Observatory",* Phys. Rev. Lett 101:111301 (2008).

SNO Collaboration, *"Measurement of the ν_e and Total ^{8}B Solar Neutrino Fluxes with the Sudbury Neutrino Observatory Phase I Data Set",* Phys. Rev. C75:045502 (2007).

***KATRIN*:** The MIT group, in conjunction with the University of Washington and the University of North Carolina, has been engaged in the design and construction of the focal plane detector; in particular the background suppression and calibration system of the focal plane region. All hardware items have been constructed and commissioned. The US KATRIN project has been reviewed and successfully passed CD4 status. The focal plane detector has been shipped to KIT for integration with the main spectrometer.

MIT has also designed and developed the global simulation package, known as KASSIOPEIA, for the KATRIN collaboration. The system is now routinely used by the collaboration.

A number of sensitivity studies to relic neutrinos and sterile neutrinos have been explored within the context of the KATRIN experiment. All of the milestones for this project have been met.

A. Kaboth, J. A. Formaggio, and B. Monreal, *"Sensitivity of Neutrino Mass Experiments to the Cosmic Neutrino Background,"* Phys. Rev. D 82:062001 (2010).

J. A. Formaggio and J. Barrett, *"Resolving the Reactor Neutrino Anomaly with the KATRIN Neutrino Experiment",* arXiv:nucl-ex/1105.1326, submitted to Nucl. Phys. A (2011).

***Project 8*:** In 2009, the MIT group proposed a novel, independent technique for measuring neutrino masses from tritium beta decay using coherent cyclotron frequency measurements. The technique prompted the creation of a new collaboration, known as Project 8. An experiment to demonstrate the feasibility of the technique has been proposed and, with the help the of DOE and NSF, constructed.

The Project 8 prototype has recently been commissioned for data taking. The prototype has passed a number of technological milestones, such as zero dead-time data acquisition, stable noise temperature of 60 K (target), and partial pressure of the vessel at 10^{-7} mbar. Noise and calibration spectra have been taken. Data has been taken by the system as of September 2011. All of the milestones for this project have been met.

The MIT group has also proposed a novel bolometric detector to search for eV scale sterile neutrinos.

B. Monreal and J. A, Formaggio, *"Relativistic Cyclotron Radiation Detection of Tritium Decay Electrons as a New Technique for Measuring Neutrino Mass",* Phys. Rev. D80:051301 (2009).

J. A. Formaggio for the Project 8 Collaboration, *"Project 8: Using Radio-Frequency Techniques to Measure Neutrino Mass",* arXiv:nucl-ex/1101.6077, submitted to the Neutrino 2010 Conference in Athens, Greece (2011).

J. A. Formaggio, E. Figueroa-Feliciano, and A. J. Anderson, *``Sterile Neutrinos, Coherent Scattering, and Oscillometry Measurements with Low Temperature Bolometers",* arXiv:1107.3512, submitted to Phys. Rev. D (2011).

Appendix:

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