EXO-200 Double-Beta-Decay Experiment

The EXO-200 (Enriched Xenon Observatory) experiment proposes to use a large quantity (~200 kg) of xenon enriched in the Xe^{136} isotope as both a decay and detection medium for neutrinoless double-beta decay. The double beta decay process,

$$Xe^{136} \rightarrow Ba^{136++} + e^{-} + e^{-} \ (+ 2\nu)$$

can proceed in the two neutrino ($2\nu\beta\beta$) mode expected from the Standard Model (already observed in several nuclei other than Xe^{136}), or possibly in the neutrinoless ($0\nu\beta\beta$) mode. The $0\nu\beta\beta$ process is expected to occur only if neutrinos are Majorana particles (in which case neutrinos are their own antiparticles), and at a rate proportional to the square of an "effective" neutrino mass, and hence its **observation would serve as both a ν mass measurement and as the first demonstration that Majorana neutrinos occur in nature.** Majorana particles figure in many extensions of the Standard Model, and play a key role in "leptogenesis", a leading model for the generation of the matter-antimatter asymmetry of the universe.

The candidate events are detected in a liquid xenon (LXe) TPC (time projection chamber) that reconstructs the location of the event, and where good energy resolution distinguishes $0\nu\beta\beta$ events from $2\nu\beta\beta$ events and from backgrounds. In addition, R&D is underway to essentially eliminate non-$\beta\beta$ backgrounds by performing this rare decay search in a coincidence mode by identifying the barium daughter nucleus of double beta decay on an event-by-event basis (barium "tagging"). Barium identification is accomplished by a laser fluorescence technique that is sensitive enough to observe a single ion. Barium tagging is planned for a future ton-scale version of EXO.

This EXO200 experiment is now operating in the DOE underground facility WIPP (Waste Isolation Pilot Plant) in Carlsbad NM. An engineering run was completed in early January using natural xenon, and data analysis has been underway and has proceeded rapidly.

We have studied chemical purity of our LXe and natural radioactive backgrounds. A removable radioactive calibration source has been deployed (Co^{60}, and later, Th^{232} and Cs^{137} will be used) within our cryostat, and TPC response to ionization and scintillation light has been studied including preliminary measurements of energy resolution. First attempts at setting observational limits for interesting physics have already been made.

We are prepared to immediately begin our search for double beta decay this April. New students will be brought into the data analysis effort, as well as the operation of the EXO-200 apparatus. In addition, there will be opportunities to participate in the R&D program for ton-scale EXO.

Contacts at SLAC :

Prof. Martin Breidenbach (mib@slac.stanford.edu), 650-926-2872

Dr. Peter C. Rowson (rowson@slac.stanford.edu), 650-926-2635