Proton Capture on ^{7}Be and the Solar Neutrino Problem

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The observed deficit of neutrinos coming from the sun, in comparison to the calculations of solar models, constitutes the Solar Neutrino Problem. This observed ratio is about 1/4 to 1/2. Of the three types of neutrino measurements reported to date, capture on ^{37}Cl, water Cherenkov, and capture on ^{71}Ga, the first two methods are primarily sensitive to neutrinos from beta decay of ^{8}B. Thus, the predicted event rates for these two methods are sensitive to potential inaccuracies in the experimentally determined cross sections of reactions that lead to the creation of this isotope, as these measurements serve as input into the solar model calculations. One significant reaction is the capture of a proton onto a nucleus of ^{7}Be to form ^{8}B. This is the sole reaction creating ^{8}B.

A survey of previous experiments on ^{7}Be(p,γ)^{8}B reveals moderate but significant systematic inconsistencies both between separate measurements and in modeled fits to the individual data sets. These differences are on the order of 25%. Although a resolution of the uncertainty in this one reaction rate cannot account for the solar neutrino problem, an accurately determined solar neutrino emission spectrum is necessary in order to relate the results of current and future neutrino experiments to the various models, such as neutrino oscillations, that have been proposed to account for the observed discrepancy.

We are currently working on an improved measurement of the low-energy cross section of ^{7}Be(p,γ)^{8}B, in collaboration with TUNL†. The radionuclide ^{7}Be ($t_{1/2}$ = 53 d) will be produced via a (p,n) reaction on ^{7}Li. The beryllium will be chemically separated and purified, and subsequently electroplated onto a target backing. During the experiment, the ^{8}B produced by irradiation with the proton beam will be detected by the alpha particles emitted following beta decay to ^{8}Be* ($t_{1/2}$ = 0.77 s). These alphas will be detected in a large area gas ΔE-gas ΔE-silicon E detector telescope of a design similar to the detectors currently used by our group [1,2]. The ΔE detectors are necessary to filter out events resulting from the intense flux of γ rays emitted by the decaying ^{7}Be. The target will be fixed to a wheel that will transfer it, on a time scale of about one second, between the proton beam and the detector. Both the ^{7}Be target and detector system are being developed by LBNL, while the measurement itself will be performed at TUNL, where a special low-energy, high-current accelerator is being built for this experiment.

This experiment will improve on previous work [3] primarily through use of a target containing ten times as much ^{7}Be. This, combined with our detector and the new accelerator, will allow the cross section to be accurately determined to lower energies than previously measured.

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1. D. Moltz *et al.*, Nuc. Instr. Meth **A349** (1994) 210.
2. M. W. Rowe *et al.*, (submitted to Nuc. Instr. Methods).
3. B. W. Filippone *et al.*, Phys. Rev. **C28** (1983) 2222.