Neutrino Studies with ^{100}Mo and MOON

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The nucleus ^{100}Mo has large responses for both the $\beta\beta$ decay and low-energy solar and supernova ν's[1]. Thus Majorana neutrino masses and the charged-current interaction of solar and supernova ν's can be studied effectively using ^{100}Mo. The MOON (Molybdenum Observatory Of Neutrinos) project[2] is a hybrid $\beta\beta$ and solar ν experiment with planned sensitivity to Majorana mass of the order of $< m_\nu > \sim 0.03$ eV as well as capability for spectroscopy of *pp* and ^{7}Be solar ν's. A scaled up version of MOON can be used to study supernova ν's as well[3].

The two β rays from ^{100}Mo are measured in prompt coincidence for the $0\nu\beta\beta$ studies. The large Q value of $Q_{\beta\beta}$=3.034 MeV gives a large phase-space factor $G^{0\nu}$ to enhance the $0\nu\beta\beta$ rate, and the energy and angular correlations for the two β-rays are used to identify the ν-mass term for the $0\nu\beta\beta$.

Low energy solar-ν captures are measured in delayed coincidence with the subsequent β decay of the 16-second daughter ^{100}Tc. The low threshold energy of 0.168 MeV for the solar-ν and the large capture rates allow real-time studies of pp and ^{7}Be ν's. With a low threshold energy and large GT and spin-dipole strengths, ^{100}Mo is also sensitive to electron ν's from supernovae.

The measurement of two β-rays (charged particles) enables one to localize in space and in time the decay-vertex points for both the $0\nu\beta\beta$ and solar-ν studies. The localization is crucial for selecting $0\nu\beta\beta$ and solar-ν signals and for reducing correlated and accidental backgrounds.

MOON is required to have a large amount ($\sim$ one ton) of ^{100}Mo isotope (whether natural or enriched) and good energy and position resolutions. Research and development of possible options are in progress. They include supermodules of plastic fiber scintillators, liquid scintillators with wavelength-shifter read out, multi-photo sensors with avalanche photodiodes, and cryogenic bolometers. The Mo source and scintillator are to be purified to the level of 0.1 ppt[4].

References

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