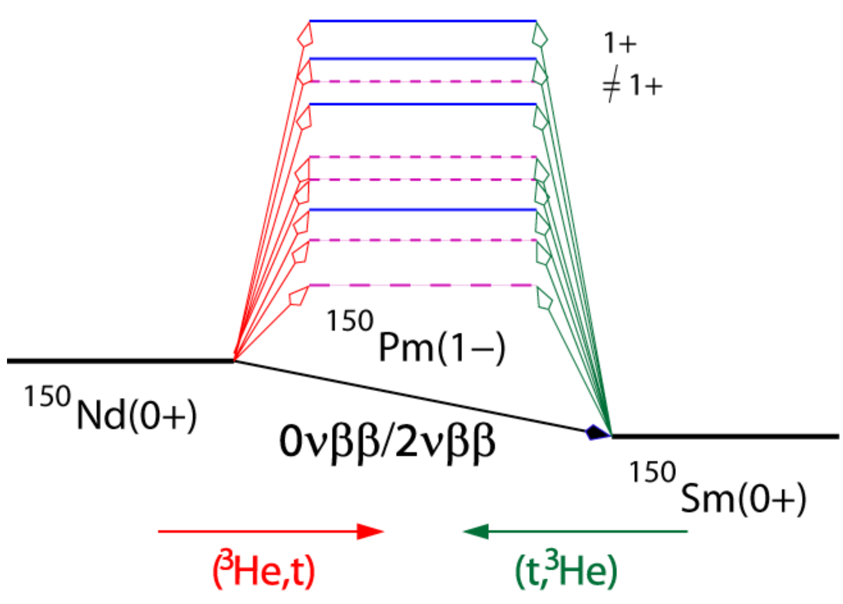
On the path to measuring the neutrino mass

Several large-scale experiments are underway or planned to search for the rare nuclear phenomenon of 0-neutrino double beta decay. The regular 2-neutrino decay mode has been observed, and successful detection of the controversial 0-neutrino mode would prove that neutrinos are their own antiparticles and determine the neutrino mass and the neutrino mass hierarchy. The decay of Neodymium-150 to Samarium-150 is considered to be one of the best candidates for the observation of 0-neutrino double beta decay and the subject of the SNO+ experiment at the SNOLAB facility.

A collaboration of researchers from the US, Europe and Japan, led by the charge-exchange group at NSCL, Michigan State University studied the two "legs" of the double beta decay process (i.e., Neodymium-150 to Promethium-150 and Samarium-150 to Promethium-150) with (Helium-3, Hydrogen-3) and (Hydrogen-3, Helium-3) charge-exchange reactions in experiments performed at the Research Center for Nuclear Physics at Osaka University, Japan and the National Superconducting Cyclotron Laboratory at Michigan State University. The figure provides an overview of the reactions studied.

The results provide key data on nuclear structure properties of relevance for the double beta decay of Neodymium-150 and are important for constraining nuclear matrix element used in rate estimates for the SNO+ experiment and the calculation of the neutrino mass once SNO+ data become available.

The two experiments formed the basis of the Ph.D. thesis work by Carol Guess from Michigan State University and was published in Physical Review C 83, 064318 (2011). This work was supported by the US NSF [PHY-0822648(JINA), PHY-0606007, and PHY-0758099].



The figure illustrates the double beta decay from ^{150}Nd to ^{150}Sm. In the two experiments performed by Guess et al., information to constrain the so-called double-beta decay matrix element, (which is an important factor for determining the neutrino mass if neutrinoless double beta decay of ^{150}Nd is discovered) was obtained. One experiment focused on transitions from ^{150}Nd to ^{150}Pm. These transitions were studied using the (^{3}He,t) reaction. The second experiment focused on transitions from ^{150}Sm to ^{150}Pm, which were studied using the (t,^{3}He) reaction.