Nuclear structure relevant to neutrinoless double-β decay: the valence neutrons in ^{130}Te and ^{130}Xe

B. P. Kay[1], T. Bloxham[2], J. A. Clark[3], C. M. Deibel[3,4], S. J. Freedman[2], S. J. Freeman[5], K. Han[2], A. M. Howard[5], S. A. McAllister[5], A. J. Mitchell[5], P. D. Parker[6], J. P. Schiffer[3], D. K. Sharp[5], and J. S. Thomas[5]

[1] *Department of Physics, University of York, York YO10 5DD, UK*
[2] *Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*
[3] *Argonne National Laboratory, Argonne, IL 60439, USA*
[4] *JINA, Michigan State University, East Lansing, MI 48824, USA*
[5] *Schuster Laboratory, University of Manchester, Manchester, M13 9PL, UK*
[6] *Wright Nuclear Structure Laboratory, Yale University, New Haven, CT 06520, USA*

In order to help constrain predictions of nuclear matrix elements relevant for neutrinoless double-β decay, we have made a measurement of the valence neutron properties of the ground states of ^{130}Te and ^{130}Xe. The ^{130}Te isotope is the neutrinoless-double-β-decay candidate used in the CUORE experiment attempting to measure this hitherto unobserved decay mode. This measurement used a cryogenic Xe target developed at Berkeley. It is found the $0h_{11/2}$ and $1d$ orbitals dominate the vacancies in these isotopes, with the $2s_{1/2}$ making a small contribution. The data suggest the $0g_{7/2}$ is fully occupied. The difference between the ground-state wave functions of the parent and daughter is therefore mostly in the $0h_{11/2}$ and $1d$ vacancy. This is in contrast to recent theoretical calculations [1] where the $g_{7/2}$ also plays a role. The role of pairing, important for assumptions made in QRPA calculations, had been previously studied for ^{130}Te [2]. Here we add new information for ^{130}Xe. Proton-pair correlations indicate a significant splitting of the BCS correlations in these nuclei for protons, but there is no such splitting evidence for neutrons in the neutron-pair removal reactions. To better define the difference between initial and final states, data are also needed on the valence protons, where the $Z = 64$ shell gap may play a significant role; comparisons between ^{128,130}Te(d,^{3}He) data of Auble *et al.* [3] and recent theory [1] indicate a similar discrepancy, with there being no observed occupancy in the $0h_{11/2}$ orbit. This work was supported by the US Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH-11357 (Argonne) and Grant No. DE-FG02-91ER-40609 (Yale), NSF Grant No. PHY-08022648 (JINA), and the UK Science and Technology Facilities Council.

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