3s PROTON HOLES IN THE GROUND STATE OF ^{208}Pb

H. Nann
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

S.K.B. Hesmondhalgh, J.M. Schippers, J. Schreuder, and S.Y. van der Werf
Kernfysisch Versneller Institut, Groningen, The Netherlands

P. Grabmayr, G. Rau, G.J. Wagner, and P. Woldt
University of Tuebingen, Tuebingen, West Germany

M.N. Harakeh
Free University, Amsterdam, The Netherlands

J.B.J.M. Lanen
State University Utrecht, The Netherlands

E.N.M. Quint and P.K.A. de Witt Huberts
NIKHEF-K, Amsterdam, The Netherlands

For the doubly-magic nucleus ^{208}Pb it has recently been argued that short-range and tensor correlations give rise to a depletion of normally filled orbitals close to the Fermi surface. Estimates[1] of this depletion are as large as 30%. Information on the occupancy of the $3s_{1/2}$ proton shell, which is the last normally occupied shell in ^{208}Pb, has come from the charge density distribution of ^{206}Pb and ^{205}Tl. The contribution of the 3s proton orbital to the charge density difference $\Delta\rho(^{206}\text{Pb}-^{205}\text{Tl})$ was determined as $z = 0.7 \pm 0.1$ (Ref. 2). Subsequently the deviation of z from unity was interpreted as evidence for a general 30% quenching of the single particle contribution. Additional evidence for a partial occupancy of the 3s proton orbital in ^{208}Pb has come from the (e,e'p) quasielastic proton knockout reaction.[3] Combining precise relative spectroscopic factors for 3s proton removal from ^{205}Tl, ^{206}Pb and ^{208}Pb through a sum rule with the absolute information from the charge density difference of ^{206}Pb and ^{205}Tl one obtains a largely model-independent value[3] for the occupancy of the 3s proton orbit in ^{208}Pb of (82±12)%.

A complementary measure of the partial occupancy of the 3s proton orbital in ^{208}Pb can be obtained from stripping a proton into the 3s orbital with the $^{208}\text{Pb}(^3\text{He},d)^{209}\text{Bi}$ reaction. This provides a much cleaner signal than the (e,e'p) results, although larger uncertainties in the extraction of spectroscopic factors exist. Therefore we started to investigate the $^{208}\text{Pb}(^3\text{He},d)^{209}\text{Bi}$ reaction with a 50.9 MeV ^{3}He beam from the KVI cyclotron. The outgoing deuterons were momentum analyzed with the QMG/2 magnetic spectrometer. The target consisted of a selfsupporting, enriched ^{208}Pb foil with a thickness of about 0.3 mg/cm^2. Spectra were taken at 0° and 12°, the first two maxima of an ℓ=0 angular distribution in order to see if the known $1/2^+$ states in ^{209}Bi at 2.43, 2.87 and 2.92 MeV are excited. An overall energy resolution of about 15 keV was obtained. This energy resolution enabled us to separate the 2.43 MeV transition from the ground state transition of the contaminant $^{12}\text{C}(^3\text{He},d)^{13}\text{N}$ reaction which has a three orders of magnitude larger yield than the strong $^{208}\text{Pb}(^3\text{He},d)^{209}\text{Bi}$ transitions. The transitions to the $1/2^+$ states in ^{209}Bi at 2.43 and 2.87 MeV were clearly identified showing that the 3s proton orbital is indeed only partially filled. The data are presently being analyzed.

1) V.R. Pandharipande, C.N. Papanicolas and J. Wambach, Phys. Lett. 53, 1133 (1984).

2) J.M. Cavedon et al., Phys. Rev. Lett. 49, 978 (1982); B. Frois et al., Nucl. Phys. A396, 409c (1983).

3) E.N.M. Quint et al., submitted to Phys. Rev. Lett.; see also H. Nann et al., this report.