STRUCTURE OF ^{207}Pb POPULATED IN ^{208}Pb + ^{208}Pb DEEP-INELASTIC COLLISIONS*

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The yrast structure of ^{207}Pb above the $13/2^+$ isomeric state has been investigated in deep-inelastic collisions of ^{208}Pb and ^{208}Pb at ATLAS, Argonne National Laboratory. New and previously observed transitions were measured using the Gammasphere detector array. The level scheme of ^{207}Pb is presented up to ~ 6 MeV, built using coincidence and γ-ray intensity analyses. Spin and parity assignments of states were made, based on angular distributions and comparisons to shell model calculations.

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1. Introduction

^{207}Pb is a one-neutron-hole nucleus with respect to the doubly-magic ^{208}Pb core. The low-lying single-particle states of ^{207}Pb are described by the $\nu p_{1/2}^{-1}$, $\nu f_{5/2}^{-1}$, $\nu p_{3/2}^{-1}$, and $\nu i_{13/2}^{-1}$ orbitals. The $13/2^+$ single-particle state is isomeric with a half-life of $t_{1/2} = 0.806(5)$ s [1]. Little is known concerning the structure of the yrast states above $13/2^+$, which require the core to be broken. It is expected that the $\nu i_{13/2}^{-1}$ state will couple to states within the ^{208}Pb core to produce core-breaking states.

Schramm *et al.* were the first to suggest that a 2485 keV transition lies above the $13/2^+$ state in ^{207}Pb [2]. The 2485 keV transition was placed connecting a $(19/2^-)$ state to the $13/2^+$ isomer, with the expectation that it is a collective E3 transition. Also placed at the time were six new transitions in coincidence with the 2485 keV γ ray, with the spin and parity assignments of the corresponding depopulated states based purely on shell model calculations. The level scheme up to $I^\pi = (29/2^+)$ was suggested.

2. Experiment and results

The experiment was conducted at the ATLAS facility at Argonne National Laboratory, USA. A 75 mg/cm^2 thick target of ^{208}Pb was bombarded with a 1446 MeV beam of ^{208}Pb. γ rays following deep-inelastic collisions were detected by the Gammasphere detector array. Experimental details of this reaction are elaborated in [3].

The γ-ray spectrum gated on the known 2485 keV ^{207}Pb transition is shown in Fig. 1. All previously identified γ-ray transitions are present in the gated spectrum. In addition, several new γ rays are visible, including two at 412 and 569 keV. The focus of the work presented here is the level scheme up to $\sim$ 6 MeV; thus, a number of the new transitions observed are not discussed. Angular distribution spectra were produced with a single gate on

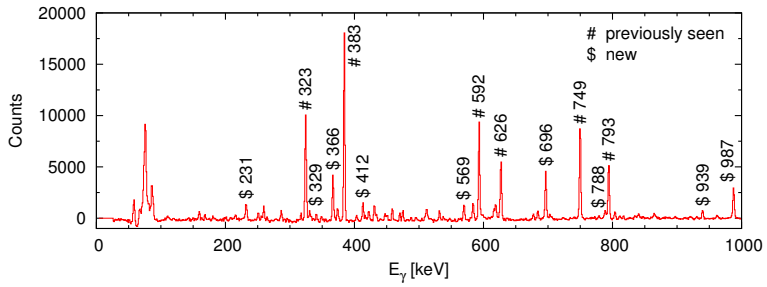

Fig. 1. Spectrum gated on the 2485 keV ^{207}Pb transition, showing transitions above the $13/2^+$ isomeric state. Indicated are, transitions previously seen [2] and a number of new transitions identified in this work.

2485 keV, except for the 2485 keV angular distribution spectra which were ungated. Subsequent angular distributions were fitted with the function of the standard form $W(\theta) = A_0\{1 + A_2P_2(\cos\theta)\}$, where θ is the angle of the γ ray relative to the beam, A_i are the angular distribution coefficients, and P_i are the Legendre polynomials. From measurements of intense transitions in ^{208}Pb with known multipolarities, we expect stretched transitions to have: $A_2 \sim 0.36$ for an octupole, $A_2 \sim 0.22$ for a quadrupole, and $A_2 < 0$ for a dipole [4].

Angular distributions are shown in Fig. 2, along with the fitted A_2 coefficient values and deduced multipolarities. Spins and parities of the states were assigned based on the γ-ray multipolarities. Parities of the $23/2_2^{(-)}$ and $29/2^{(+)}$ states were ascertained from the shell model calculations. The deduced level scheme up to ~ 6 MeV, shown in Fig. 3, is in agreement with the previous work of Schramm *et al.* [2]. A 57 keV γ ray is inferred from coincidence relationships.

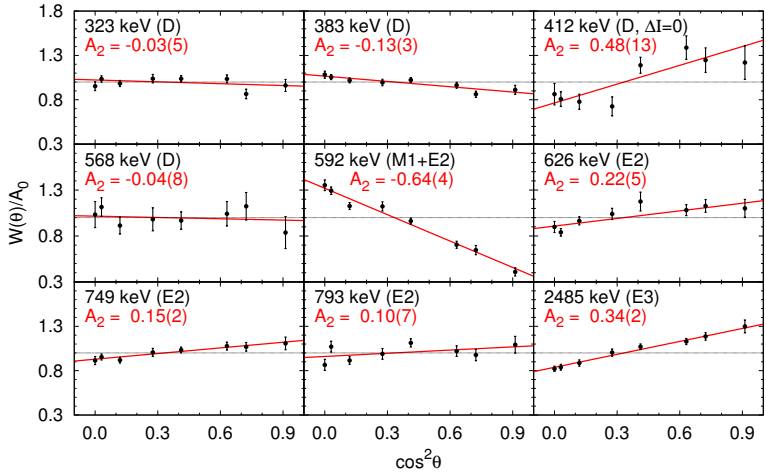

Fig. 2. Angular distributions of transitions in ^{207}Pb above the $13/2^+$ isomeric state. Deduced multipolarities are indicated, D denotes dipoles.

Two shell model calculations were performed using the KHH7B and KHM3Y interactions, descriptions of which can be found in [4]. The KHH7B calculation used in this work differs from the prescription in [4], in that $t = 1$ proton and neutron mixing is considered. Figure 3 compares the calculations to the experiment, displaying a good agreement. The differences between the calculations become apparent when looking to the octupole state, $19/2^-$. Variations in the octupole state can be explained by the number of $\Delta j = \Delta l = 3$ pairs in each calculation, as discussed in [4].

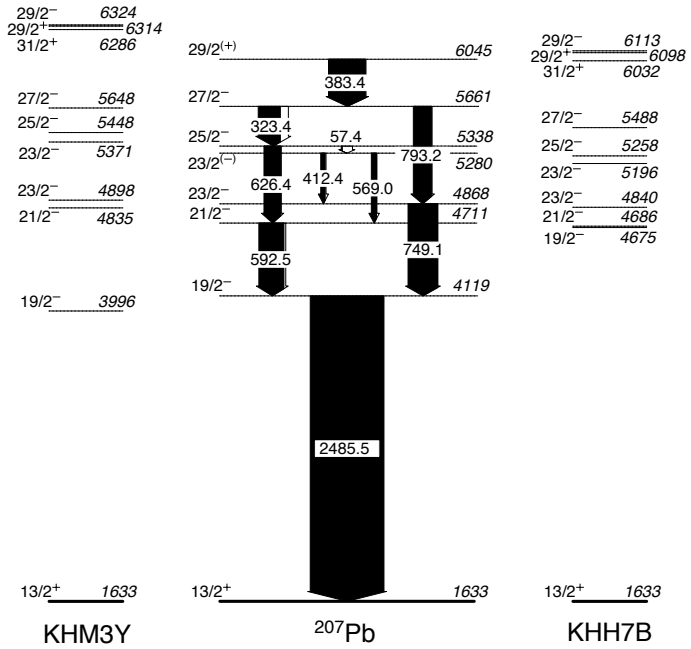

Fig. 3. Experimental level scheme of ^{207}Pb above the $13/2^+$ isomer, compared to two shell model calculations described in [4].

3. Conclusion

The level scheme of ^{207}Pb up to ~ 6 MeV is presented, and is in agreement with the previous work by Schramm *et al.* [2]. An additional excited state and three γ rays were identified. Our spin and parity assignments are based on angular distribution measurements. Future work will detail the extension of the ^{207}Pb level scheme to ~ 10 MeV.

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